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DELHI METRO RAIL CORPORATION LTD.

AIRPORT METRO EXPRESS LINE

CONCESSION CONTRACT NO. AMEL-P1

DESIGN, INSTALLATION, COMMISSIONING, OPERATION AND MAINTENANCE OF AIRPORT METRO EXPRESS LINE NEW DELHI - INDIRA GANDHI INTERNATIONAL AIRPORT - DWARKA SEC. 21

PART I

CONCESSION AGREEMENT

Delhi Metro Rail Corporation Limited
NBCC Place,
Bhishma Pitamah Marg,
Pragati Vihar,
New Delhi –110 003
India

CPM/copy

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Delhi Airport Metro Express Pvt. Ltd. New Delhi

एक सौ रुपये

Rs. 100

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ONE HUNDRED RUPEES

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भारत INDIA

INDIA NON JUDICIAL

दिल्ली DELHI

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CONCESSION CONTRACT

This Agreement is entered into on this the 25th day of August, 2008. BETWEEN

DELHI METRO RAIL CORPORATION LIMITED, a joint venture company of Govt. of India and Govt. of National Capital Territory of Delhi, and having its registered office at NBCC Place, Bhishma Pitamah Marg, Pragati Vihar, New Delhi 110 003 (hereinafter referred to as "DMRC" which expression shall unless repugnant to the context or meaning thereof include its administrators, successors and assigns) of the One Part,

AND

DELHI AIRPORT METRO EXPRESS PRIVATE LIMITED, a company incorporated under the provisions of the Companies Act, 1956 and having its registered office at BSES Bhawan, Nehru Place, New Delhi – 110048, INDIA (hereinafter referred to as the "Concessionaire", promoted by Reliance Infrastructure Ltd, having its registered office at Reliance Energy Centre, Santa Cruz (E), Mumbai 400 055 and M/s. Construcciones y Auxiliar de Ferrocarriles, S.A. having registered office at Jose Miguel Iturrioz, 26 – 20200 Beasain (Guipuzcoa) – SPAIN, which expression shall unless repugnant to the context or meaning thereof include its successors and permitted substitutes) of the Other Part.

RECITALS

Whereas

A. Delhi Metro Rail Corporation Ltd. (DMRC), a joint venture of Govt. of India (GOI) and the Govt. of National Capital Territory of Delhi (GNCTD) is implementing Airport Metro Express Line Project (hereinafter referred to as "Project") in New Delhi, the Capital of India from New Delhi Railway Station to Dwarka Sector 21 via IGI Airport. The approximate length of the Project is 22.7 kilometer.

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Delhi Airport Metro Express Pvt. Ltd. New Delhi

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Delhi Airport metro Express Pvt Ltd
BSES Bhawan
Nehru place
new delhi -110048

S.No. ______ S/o
Name ______
R/o ______
Purpose ______
25 AUG 2008

P. K. BHATIA
L. No. 808
Patiala House, N. Delhi

123287

B. DMRC has decided to develop the Project by engaging Concessionaire for financing, design, procurement, installation of all systems (including but not limited to rolling stock, over head electrification, track, signaling and telecommunication, ventilation and air conditioning, automatic fare collection, baggage check-in and handling, depot and other facilities) and Architectural works/finishes as required for a successful Project. The Design and construction of basic civil structure for the Project shall be done by DMRC and same shall be made available to the Concessionaire progressively for design, supply, installation, commissioning & operation of system and related works.

C. Following a process of prequalification by international Expression of Interest, DMRC Notice of Bid and after submission of RFP Documents by short listed bidders and evaluation there of, DMRC has accepted the Bid of a consortium comprising Reliance Energy Limited (renamed as Reliance Infrastructure Limited vide certificate of incorporation no L99999MH1929PLC001530), and M/s. Construcciones y Auxiliar de Ferrocarriles, S.A (collectively the "Consortium") with Reliance Energy Limited (renamed as Reliance Infrastructure Limited vide certificate of incorporation no L99999MH1929PLC001530), as its Lead Member and has issued its Letter of Acceptance No DMRC/20/II-101/2006/Part-II dated January 21, 2008 ("LOA") accordingly requiring, inter-alia, the execution of this Concession Agreement within 60 (Sixty) days of the date thereof.

D. The Consortium has since promoted and incorporated the Concessionaire as a limited liability Company under the Companies Act, 1956 and has requested DMRC to accept the Concessionaire as the entity which shall undertake and perform the obligations and exercise the rights of the Consortium under LOA including the obligation to enter into this Concession Agreement.

E. DMRC has accepted the request of the Consortium and has accordingly agreed to enter into this Concession Agreement with the Concessionaire for execution of the Project on BOT basis, subject to and on terms and conditions set forth hereinafter.

F. It is deemed necessary and expedient to enter into this Agreement to record the terms of the said Agreement between the Parties.

G. The following documents shall form the part of this Concession Contract:

- The LOA issued vide letter no DMRC/20/II-101/2006/Part-II dated January 21, 2008.
- Concession agreement comprising of Section I to VIII (RFP-Volume II)
- Schedules of Concessionaire agreement comprising of Schedule A to Schedule W (RFP- Volume III) including drawings, specifications etc. included and referred therein.
- Financial Proposal comprising Appendix 12A and Appendix 12B of RFP-Volume I.

All of the foregoing documents, together with this Concession Contract are referred to herein as the Contract Documents. Also incorporated into these Contract Documents, and made part hereof, are all codes, standard specifications, and similar requirements that are referred to therein.

This agreement is signed between **Mr. Mangu Singh, Director (Works)** (for and on behalf of the **"DMRC"**) and **Mr. K.P. Maheshwari, Authorised Signatory** of **DELHI AIRPORT METRO EXPRESS PRIVATE LIMITED** (for and on behalf of the "Concessionaire"). The contract documents mentioned in recital G hereinbefore shall be signed by **Mr. O.P. Singh, CPM (AP)** (for and on behalf of

Contd...3

Delhi Airport Metro Express Pvt. Ltd. Delhi

the DMRC) and Mr. K.P. MAHESHWARI, **Authorised Signatory, DELHI AIRPORT METRO EXPRESS PRIVATE LIMITED** (for and on "Concessionaire").

NOW THEREFORE IN CONSIDERATION OF THE FOREGOING AND THE RESPECTIVE COVENANTS HEREINAFTER CONTAINED, THE PARTIES HEREBY AGREE AND THIS AGREEMENT WITNESSETH AS FOLLOWS:

IN WITNESS WHEREOF THE, PARTIES HAVE EXECUTED AND DELIVERED THIS AGREEMENT AS OF THE DATE FIRST ABOVE WRITTEN.

SIGNED, SEALED AND DELIVERED
For and on behalf of
D M R C
(DELHI METRO RAILWAY CORPORATION LIMITED)
By

(Mangu Singh)
Director (Works)

SIGNED, SEALED AND DELIVERED
For and on behalf of
CONCESSIONAIRE
(DELHI AIRPORT METRO EXPRESS PRIVATE LIMITED)
By

Delhi Airport Metro Express Pvt. Ltd. New Delhi

(K.P. MAHESHWARI)
Director

WITNESS

(VISHAL KHETARPAUL)
MANAGER - INDIA
CONSTRUCCIONES Y AUXILIAR
DE FERROCARRILES, S.A.
CAF
PADILLA, 17-6°
28006 MADRID
SPAIN.

WITNESS

(S.K. GANJI.)
XEN/AP
DMRC, 8- Jantar Mantar
New Delhi.

DELHI AIRPORT METRO EXPRESS PVT. LTD.

1st Floor, BSES Yamuna Power Ltd., Gandhi Market, Minto Road, New Delhi-110002
Tel: +91 11 3999 9174 / 311/ 318/ 173

Extracts of Minutes of the proceedings of the meeting of Board of Directors of the Company held on 20th June 2008

"**RESOLVED THAT** any one of S/Shri K. P. Maheshwari, or A. N. Sethuraman Directors of the Company being persons specifically authorized in this regard be and are is hereby authorized severally to sign, to execute, amend and deliver the Concession Agreement and such other agreements or documents which the company is required to enter into or execute with Delhi Metro Rail Corporation in connection with Delhi Airport Metro Project and in this regard to put the common seal of the Company ,if required, be affixed to such agreement(s),documents etc in the presence of any of the aforesaid Directors in accordance with the provisions of Articles of Association of the Company on the said contracts, documents etc.., and to make necessary corrections, additions, deletions, amendments, alterations, and modifications in the documents submitted to DMRC and/or the competent authorities concerned and

RESOLVED FURTHER THAT any one of S/Shri K. P. Maheshwari, A. N. Sethuraman Directors of the Company be and are hereby authorized severally to do all such acts, deeds, matters and things that may be necessary or incidental thereto for giving effect to this resolution and to take all necessary actions that may be required in this regard."

///Certified to be true\\\

For Delhi Airport Metro Express Private Limited

Authorized Signatory

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Delhi Metro Rail Corporation Ltd.

Delhi Airport Metro Express Pvt. Ltd.

Tel. : 24365202/04
Fax 24365370

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DELHI METRO RAIL CORPORATION LTD.

(A JOINT VENTURE OF GOVERNMENT OF INDIA AND GOVT. OF DELHI)
N.B.C.C. Place, Bhishma Pitamah Marg, Pragati Vihar. New Delhi-110003

No.DMRC/20/II-101/2006/ Part-II

January 21, 2008

LETTER OF ACCEPTANCE

To

M/s Reliance Energy Limited- CAF
Reliance Energy Centre,
Santa Cruz (East),
Mumabi – 400 055
INDIA.

Sub: Tender for Concessionaire for Design, Supply, Installation, Testing, Commissioning of all Systems and Operation & Maintenance of Airport Metro Express Line – AMEL P-1 Tender.

Ref:
1. **Your offer for the above captioned tender submitted on 12.10.2007.**
2. **ALC letter No.ALC/AMEL-P1/707 dated 31.10.2007.**
3. **Your letter dated 03.11.2007.**
4. **ALC letter No.ALC/AMEL-P1/818 dated 22.11.2007.**
5. **Your letter dated 05.12.2007.**
6. **ALC letter No.ALC/AMEL-P1/868 dated 19.12.2007.**
7. **Your letter dated 04.01.2008.**
8. **ALC letter No.ALC/AMEL-P1/890 dated 15.01.2008.**

Dear Sir,

1. We refer to your proposal dated 12.10.2007, in response to our Request for Proposal (RFP) document for the captioned Project.

2. We are pleased to inform you that your aforementioned proposal has been accepted and you are being issued this "Letter of Acceptance".

3. As per RFP document, you are required to form a Special Purpose Vehicle (SPV) before signing of the Concession Agreement. The details of Special Purpose Vehicle should be provided immediately on formation, along-with the registration certificate. The Special Purpose Vehicle formed by you shall comply with all the terms and conditions of the RFP document and of your subsequent proposal.

4. The Concession Fee to be paid by the Special Purpose Vehicle shall be as per your Financial bid incorporating Condition 1 of Appendix-12 B and thus for the first year of commercial operation an amount of INR 510,000,000/- (Rupees Five Hundred Ten Millions only) would be payable to Delhi Metro Rail Corporation. The Concession Fees would be enhanced for subsequent years and will be payable as per the provisions of Clause 8.2 of the Draft Concession Agreement, Volume II of the RFP document. Please note that condition no.2 mentioned by you in Appendix-12 B for retail area development rights at platform of New Delhi (640 sqm.) and Shivaji Stadium (320 sqm.) priced at INR 30 million has not been accepted by DMRC.

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5. The Annual Percentage Revenue Sharing will be as per Clause 8.3 of Concession Agreement, Volume II of the RFP document.

6. The Special Purpose Vehicle formed by you shall provide an unconditional and irrevocable Performance Security of INR 750 million (Rupees Seven Hundred Fifty Million) in the form of Bank Guarantee, in local currency, from an Indian Nationalized Bank or an Indian Scheduled Bank, having its branch at Delhi, before signing of Concession Agreement. The amount of Bank Guarantee, its periodic enhancements and tenure shall be as per Schedule F of the Draft Concession Agreement and Article 5 of the RFP document. The Performa of the Bank Guarantee shall be as per Schedule F of the Draft Concession Agreement. The Bank Guarantee shall be in the prescribed format.

7. The Special Purpose Vehicle formed by you shall sign the Concession Agreement with the Delhi Metro Rail Corporation, within a period of 60 days of receipt of this "Letter of Acceptance".

8. Please note that only your financial offer will become part of Agreement and the Business Plan or any other document submitted by you will not form part of Concession Agreement. Several negotiation / clarification meetings were conducted after the submission of bids. There has been exchange of information / correspondences during the above. The information / correspondences exchanged shall not become part of Concession Agreement except the following which shall form part of the agreement:

(i) The track geometry at Dwarka Sector-21 and its financial implications

The Track Geometry at Dwarka Sector-21 Station shall be as per the drawings supplied to the bidders along with the RFP.

(ii) Additional retail space at concourse level of New Delhi Station and Shivaji Stadium Station

In case the additional retail space is available to the concessionaire at concourse due to increase in the size of the station, the Concessionaire shall pay additional concession fee to DMRC on this account. The rate for this additional concession fee shall be on pro-rata basis as stated by the Concessionaire in Appendix-12 B condition no.2 (Rs. 30 million for 960 sqm. i.e. Rs.31250/- per sqm.). This additional concession fee shall be added to the concession fee of Rs. 510 million mentioned in para 4 above.

The enhancement applicable to the concession fee during subsequent years as per Clause 8.2 of Draft Concession Agreement, shall be on total concession fee including this additional concession fee.

(iii) Cost of operation and maintenance of clearing house to be shared

The cost of operation and maintenance of clearing house shall be shared by the concessionaire.

(v) Operation and maintenance of two 66 KV sub-stations and emergency arrangements for power between Airport Line & Central Secretariat-Badarpur line at Kendriya Bus Terminal, Church Street Sub-station

The operation and maintenance of the two 66kv sub-stations shall be by concessionaire at their cost as per the bid requirements. You have further agreed to have a working arrangement for switching the power between

Airport Line and Central Secretariat – Badarpur line in case of power failure in one line.

Also, the cable routes and High Voltage cables connecting the integrated sub-station to be constructed at the Airport, in place of that initially proposed at Palam Depot.

(vi) You shall not recruit or attempt to recruit any DMRC Employee.

(vii) The arrangements for alternative power supply to Dwarka depot from Dwarka TSS shall be executed by you at your cost.

(viii) The temporary arrangements required for commissioning of Rolling stock at Palam Depot shall be made by you. DMRC will only arrange temporary land for this purpose. The rental charges for this temporary land shall be borne by you.

(ix) DMRC will arrange land for siding at Palam and you shall execute all works related to the siding.

9. This Letter of Acceptance is sent herewith to you in duplicate. **You should return one copy of it duly signed by you on all pages indicating "Unconditional Acceptance" thereof so as to reach the undersigned within one week of issuance of this letter.**

10. You are requested to contact **Project Director, Airport Line Consultant, 8, Jantar Mantar Road, New Delhi – 110 001** for further necessary action in this matter and to start mobilization of resources for undertaking the work immediately.

Thanking you,

Yours faithfully

(Mangu Singh)
Director (Works)

Encl: One copy of this letter in duplicate

N.O.O.

Copy to: - Project Director, Airport Line Consultant, 8, Jantar Mantar Road, New Delhi–110001 – for kind information and further necessary action please.

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Delhi Metro Rail Corporation Ltd.

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SHARE PURCHASE AGREEMENT

This Share Purchase Agreement (*"Agreement"*) is made at New Delhi on this 30th day of June, 2008 to record the terms of purchase of equity shares

BY AND AMONGST

CONSTRUCCIONES Y AUXILIAR DE FERROCARRILES, S.A., a company duly incorporated and validly existing in Spain with its principal place of business at Calle Padilla, No. 17, Madrid, Spain, (hereinafter referred to as "Purchaser", which expression shall, unless repugnant to the context or meaning thereof, be deemed to mean and include its successors in business and permitted assigns) executed by Mr. Gonzalo Calleja Mateo authorised by a power of attorney dated 14 March, 2008 signed by Mr. Andres Arizcorreta Garcia, CEO of CAF;

AND

RELIANCE INFRASTRUCTURE LIMITED a company duly incorporated and validly existing in India with its principal place of business at Reliance Energy Center, Santa Cruz (East), Mumbai-55 (hereinafter referred to as *"Seller"* or *"RInfra"*, which expressions shall unless repugnant to the context thereof be deemed to include their respective heirs, executors, successors, legal representatives and permitted assigns) executed by Mr. Ramesh Shenoy pursuant to a duly authorised board resolution passed by the board of directors of RInfra on 28 April, 2008;

AND

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DELHI AIRPORT METRO EXPRESS PRIVATE LIMITED, a company duly incorporated under the laws of India and having its office at BSES Bhawan, Nehru Place, New Delhi (hereinafter referred to as "***Company***", which expression shall, unless repugnant to the context or meaning thereof, be deemed to mean and include its successors in business and permitted assigns) executed by its director Mr. Krishna Prakash Maheshwari pursuant to a duly authorised board resolution passed by the board of directors of the Company on 20 June, 2008.

(The Purchaser and the Seller are herein collectively referred to as the "***Parties***" and individually as a "***Party***".)

(The respective instruments of authority of each of the Parties is placed as Schedule IV)

(The Company is only a consenting party to this Agreement).

WHEREAS:

A. Delhi Metro Rail Corporation Ltd. ("DMRC"), a joint venture of Govt. of India ("GOI") and the Govt. of National Capital Territory of Delhi ("GNCTD") is engaged in the development of Metro System for Delhi and has been authorised by the Govt. of India to undertake development of Airport Metro Express line Project through BOT basis ("*Project*").

B. Following a process of prequalification by international Expression of Interest, DMRC Notice of Bid and after submission of RFP Documents by short listed bidders and evaluation there of, DMRC has accepted the Bid of a consortium comprising RInfra and the Purchaser, (collectively the "**Consortium**") with RInfra as its Lead Member and has issued the Letter of Acceptance ('LOA') thereto.

C. RInfra has since promoted and incorporated the Company as a limited liability company under the Companies Act, 1956 and has requested DMRC to accept the Company as the

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Consortium under the LOA including the obligation to enter into a concession agreement ('Concession Agreement').

D. The current shareholding pattern of the Company is as follows:

Name of shareholder	*Number of shares held in the Company*	*% shareholding*
RInfra	9998	100
K P Maheswari	1	-
A N Sethuraman	1	-

E. The Seller now wishes to sell 5% shares in the Company and Purchaser has, upon the request of the Seller and relying on the mutual representations, covenants and warranties set out herein, has agreed to purchase the aforesaid shares from the Seller on the terms and conditions set forth herein;

NOW, THEREFORE IN CONSIDERATION OF THE PREMISES AND MUTUAL PROMISES AND COVENANTS SET FORTH HEREIN AND FOR GOOD AND VALUABLE CONSIDERATION, THE RECEIPT AND ADEQUACY OF WHICH IS HEREBY ACKNOWLEDGED, THE PARTIES HERETO AGREE AS FOLLOWS:

1. DEFINITIONS & INTERPRETATION

1.1 In this Agreement, the following words and expressions (including in the recitals hereof or schedules hereto), unless the context otherwise requires, shall have the meanings ascribed to them in **Part A of Schedule I** annexed hereto.

1.2 In this Agreement, except where the context requires otherwise, the Agreement shall be interpreted in accordance with the principles set out in **Part B, of Schedule I** annexed hereto.

2. PURCHASE OF SHARES FROM SELLER

2.1 Conditions Precedent for the sale of Shares

The following conditions must be satisfied by the Seller before the sale of shares to the Purchaser:

(a.) delivery of a legal opinion to the effect that the investment made by the Purchaser would be in accordance with the applicable laws of India;

(b) compliance with the applicable regulations under the Foreign Exchange Management Act, 1999 including filing of Form FC-TRS with the authorised dealer.

(c) the contracts for the supply and maintenance of the rolling stock which include (i) The Rolling Stock Supply Contract, (ii) The Rolling Stock Services Contract and (iii) The Fleet Maintenance Contract have been duly executed by both Parties in accordance with the extant law. For ease of reference, draft copies of these contracts are annexed to this agreement as Schedule III, Part A, Part B and Part C.

2.2 Sale of Shares

On the terms, and subject to the conditions, set forth in this Agreement, the Seller agrees to sell, transfer and deliver to Purchaser for the Consideration, upon the satisfaction of the conditions precedent mentioned in clause 2.1, and Purchaser agrees to purchase from the Seller upon the satisfaction of the conditions precedent mentioned in clause 2.1, five hundred (500) shares of the Company aggregating to five percent (5%) of the paid-up share capital of the Company, free and clear of all Encumbrances in the manner as specified below:

Name of shareholder	*Pre Completion Shareholding Pattern (No of Shares held)*	*Number of shares agreed to be transferred to the Purchaser*	*Post Completion Shareholding Pattern (No of Shares held)*	*Post Completion Shareholding Pattern (% Shareholding)*
RInfra	9998	500	9498	95
CAF	NIL	Not applicable	500	5

2.2 **Consideration**

2.2.1 The consideration for the shares shall be paid at the rate of Rs. 10/- per share aggregating to INRs. 5000/- (Rupees Five Thousand only) ("***Consideration***") which shall be paid by the Purchaser to the Seller by wire transfer of immediately available funds to bank account designated in writing by the Seller. Pursuant to this clause, the amount of consideration that would become payable to the Seller would be as follows:

Name of shareholder	*Number of shares to be transferred*	*Consideration per share*	*Total consideration*
RInfra	500	10/-	5000/-

3. REPRESENTATIONS AND WARRANTIES

3.1 Seller's Representations and Warranties

The Seller hereby covenants to represent and warrant to the Purchaser that each of the representation and warranties set out in **Part A of Schedule II** hereto are true and correct (*"Seller's Representations and Warranties"*) and acknowledge that the Purchaser is entering into this Agreement in reliance upon such representations and warranties.

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3.2 **Company's Representations and Warranties**

The Company hereby covenants to represent and warrant to the Purchaser that each of the representation and warranties set out in **Part B of Schedule II** hereto are true and correct (***"Company's Representations and Warranties"***) and acknowledges that the Purchaser is entering into this Agreement in reliance upon such representations and warranties.

3.3 **Purchaser's Representations and Warranties**

The Purchaser hereby covenants to represent and warrant to the Seller that each of the representation and warranties set out in **Part C of Schedule II** are true and correct (***"Purchaser's Representations and Warranties"***) and acknowledges that the Seller is entering into this Agreement in reliance upon such representations and warranties.

4. INDEMNIFICATION AND SURVIVAL

4.1 The Seller agrees to indemnify and hold the Purchaser and their shareholders, officers, directors, employees, agents, and successors, harmless from and against any damages, losses, liabilities, obligations, claims of any kind, interest, cost, fee, or expenses (including, without limitation, reasonable attorneys' fees and expenses) (collectively, ***"Losses"***), suffered, incurred or paid, directly, through application of the Company's or Purchaser's assets or otherwise, as a result of, in connection with or arising out of:

(a) failure of any representation or warranty made by the Seller or the Company in this Agreement (contained in Part A and Part B of **Schedule II**) to be true and correct in all respects as of the date of this Agreement;

(b) breach of any Law or order of the Governmental Authority; or

(c) breach of any of its obligations under this Agreement.

5. NOTICES

5.1 Any notice pursuant to this Agreement shall be in writing signed by (or by some person duly authorised by) the person giving it and may be served by leaving it or sending it by facsimile, prepaid recorded delivery (by air mail if overseas) or registered post addressed as follows (or to such other address as shall have been duly notified in accordance with this Clause):

<u>If to the Seller</u>:

Fax	: +91 22 30099763
Attention	: Mr. Ramesh Shenoy

<u>If to Purchaser</u>

Fax	: + (34) 91 4366006
Attention	: Mr GonZalo Calleja Mateo

<u>If to the Company</u>

Attention	: Mr. K.P. Maheshwari
Fax	: +91 11 39999173

5.2 All notices given in accordance with this Article shall be deemed to have been served as follows:

(a) if delivered by hand, at the time of delivery;

(b) if posted, by air mail at the expiration of 6 (six) days after the envelope containing the same was delivered into the custody of the postal authorities; and

(c) if communicated by facsimile, on receipt of confirmation of successful transmission.

5.3 All notices communicated by facsimile shall be followed by a copy thereof being sent by post to the notices.

6. GOVERNING LAW, DISPUTE RESOLUTION AND JURISDICTION

6.1 This Agreement shall be governed by, and construed in accordance with, the laws of India, without regard to the principles of conflicts to law of any other jurisdiction.

6.2 Any dispute arising out of or in connection with this Agreement, including any question regarding its existence, validity or termination, shall be referred to and finally resolved by arbitration under the Arbitration and Conciliation Act 1996.

6.3 The number of arbitrators shall be three. One arbitrator shall be appointed by the Purchaser and one shall be appointed by the Seller. The third arbitrator shall be appointed by the two arbitrators.

6.4 The seat of arbitration shall be at New Delhi and the proceedings of arbitration shall be in the English language. The arbitrators' award shall be substantiated in writing.

6.5 Each Party shall bear and pay its respective costs and expenses including professional fees and costs of its respective advisors and counsel.

6.6 The Parties agree to facilitate the arbitral tribunal by:

(i) cooperating in good faith to expedite (to the maximum extent practicable) the conduct of the arbitration;

(ii) making available to one another and to the arbitral tribunal for inspection and extraction all documents, books, records, and personnel under their control or under the control of a person controlling or controlled by such party if determined by the arbitral tribunal to be relevant to the dispute;

(iii) conducting arbitration hearings to the greater extent possible on successive business days; and

(iv) using their best efforts to observe the time periods established by the rules of the arbitral tribunal for the submission of evidence and briefs.

6.7 Any award made by the arbitral tribunal shall be final and binding on each of the Parties and shall be enforceable in any competent court of law.

6.8 For the purposes of this clause, the Parties agree that in the event that the process of the courts is required to be invoked for enforcement of clause 6, including for seeking of any interim relief prior, during or after invocation of clause 6, the competent courts at New Delhi shall have exclusive jurisdiction and both the Parties hereto submit to the same.

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7. MISCELLANEOUS

7.1 No Partnership or Agency

Nothing in this Agreement shall be deemed to constitute a partnership between the Parties or constitute any Party the agent of any other Party for any purpose or entitle any Party to commit or bind any other Party in any manner or give rise to fiduciary duties by one Party in favour of any other.

7.2 Binding Effect

This Agreement is binding upon and shall inure to the benefit of the Parties. The Purchaser and Seller shall be entitled to seek specific performance of this Agreement.

7.3 Assignment

Neither this Agreement nor any right or obligation hereunder or part hereof may be assigned by any Party without the prior written consent of the other Parties (and any attempt to do so shall be void), and except that the Parties may, upon delivery of prior notice to the other Party, assign its rights or obligations to its Affiliate.

7.4 Severability

If any provision of this Agreement is held to be illegal, invalid, or unenforceable under any present or future Law, and if the rights or obligations under this Agreement of the Seller and the Purchaser shall not be materially and adversely affected thereby, (i) such provision shall be fully severable; (ii) this Agreement shall be construed and enforced as if such illegal, invalid, or unenforceable provision had never comprised a part hereof; (iii) the remaining provisions of this Agreement shall remain in full force and effect and shall not be affected by the illegal, invalid, or unenforceable provision or by its severance here from; and (iv) in lieu of such illegal, invalid, or unenforceable provision, there shall be added automatically as a part of this Agreement a legal, valid, and enforceable provision as similar in terms and effect to such illegal, invalid, or unenforceable provision as may be possible. However, if there is no automatic addition as aforesaid the Parties hereto shall mutually agree to provide a legal valid and enforceable provision as similar in terms and effect to such illegal, invalid or unenforceable provision as may be possible.

7.5 No Waiver

No forbearance, indulgence or relaxation or inaction by a Party at any time to require performance of any of the provisions of this Agreement shall in any way affect, diminish or prejudice the right of such Party to require performance of that provision. Any waiver or acquiescence by a Party of any breach of any of the provisions of this Agreement shall not be construed as a waiver or acquiescence of any right under or arising out of this Agreement or of the subsequent breach, or acquiescence to or recognition of rights other than as expressly stipulated in this Agreement.

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7.6 **Entire Agreement**

This Agreement supersedes all prior discussions and agreements between the Parties with respect to the transfer of the shares as set out in Clause 2.2 , and this Agreement contains the sole and entire agreement between the Parties hereto with respect to the subject matter hereof.

IN WITNESS WHEREOF THE PARTIES HERETO HAVE EXECUTED THESE PRESENTS ON THE DAY AND DATE FIRST HEREINABOVE SET OUT.

SIGNED AND DELIVERED BY THE SELLER

By : RAMESH SHENOY
Title : SR. VP & COMPANY SECRETARY
Date : 30th June 2008

CONSTRUCCIONES Y AUXILIAR DE FERROCARRILES S.A. CAF

SIGNED AND DELIVERED BY THE PURCHASER

By : GONZALO CALLEJA
Title : FINANCE MANAGER
Date : 30th JUNE, 2008

SIGNED BY THE COMPANY

By : KRISHNA PRAKASH MAHESHWARI
Title : DIRECTOR
Date : 30th JUNE 2008

Delhi Metro Rail Corporation

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[redacted]

SCHEDULE I

Part A

Definitions

"Act"	means the Companies Act, 1956, as amended or modified from time to time including any re-enactment thereof.
"Affiliate"	means, with respect to any person, any other person directly or indirectly controlling, controlled by, or under common control with, such person provided that, for the purposes of this definition, Controlling, Controlled by and Control as used with respect to any person, shall mean the possession, directly or indirectly, of the power to direct or cause the direction of the management and policies of such person, whether through the ownership of voting securities, by contract or otherwise
"Agreement"	shall mean this Share Purchase Agreement and all attached Schedules and instruments supplemental to or amending, modifying or confirming this Agreement in accordance with the provisions of this Agreement.
"Applicable Law"	means the laws of India including but not limited to all enactments, rules, regulations, circulars and notifications passed by the Government of India or by any Government Authority which are applicable to the Company as also the transaction underlying this Agreement.
"Government Authority"	means any instrumentality, subdivision, court, tribunal, quasi-judicial body, administrative agency, commission, official or other authority in India.
"Shares or Equity Shares"	means a share in the share capital of the Company having a par value of Rs. 10/- per share.

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SCHEDULE I

Part B

Interpretations

Interpretations of this Agreement are as follows:

(a) headings are for convenience only and shall not affect the construction or interpretation of any provision of this Agreement;

(b) where a word or phrase is defined, other parts of speech and grammatical forms and the cognate variations of that word or phrase shall have corresponding meanings;

(c) words importing the singular shall include plural and vice versa;

(d) reference to Recitals, Clauses, Schedules and Annexures are to recitals, clauses, schedules and annexures of this Agreement;

(e) all words (whether gender-specific or gender neutral) shall be deemed to include each of the masculine, feminine and neuter genders;

(f) any reference in this Agreement to a statutory provision includes that provision and any regulation made in pursuance thereof, as from time to time modified or re-enacted, whether before or after the date of this Agreement;

(g) the *ejusdem generis* (of the same kind) rule will not apply to the interpretation of this Agreement. Accordingly, ***include*** and ***including*** will be read without limitation;

(h) the term ***person*** includes any individual, firm, corporation, partnership, company, trust, association, joint venture, government (or agency or political subdivision thereof) or other entity of any kind, whether or not having separate legal personality. A reference to any person in this Agreement shall, where the context permits, include such person's executors, administrators, legal representatives and permitted successors and assigns;

(i) a reference to any document (including this Agreement) is to that document as amended, consolidated, supplemented, novated or replaced from time to time;

(j) a reference to a statute or statutory provision includes, to the extent applicable at any relevant time:

(i) that statute or statutory provision as from time to time consolidated, modified, re-enacted or replaced by any other statute or statutory provision; and

(ii) any subordinate legislation or regulation made under the relevant statute or statutory provision;

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(k) references to writing include any mode of reproducing words in a legible and non-transitory form; and

(l) references to *Rupees, INR* and *Rs* are references to the lawful currency of India and the reference to Rupees.

SCHEDULE II

Part A

SELLER'S REPRESENTATIONS AND WARRANTIES

In this Schedule, capitalised terms have the meanings set forth in the Agreement.

The Seller represents, warrants and agrees as follows:

1. **Ownership of Shares**

The Seller is the lawful and absolute owner of all of the shares, free and clear of all encumbrances. Subsequent to the transfer and delivery of the shares pursuant to this Agreement from the Seller to the Purchaser, the Purchaser along with its Affiliates shall have a good, valid and marketable title to the capital of the Company free and clear of all encumbrances.

2. **Authority and Enforceability**

The Seller has full legal capacity to execute, deliver and perform this Agreement and all other instruments and agreements to be executed and delivered by such Seller as contemplated hereby and to consummate the transactions contemplated under this Agreement.

3. **Consents and Approvals**

3.1 The execution and delivery of this Agreement by the Seller and the consummation by the Seller of the transactions contemplated hereby will not result in a violation or breach of, conflict with, constitute (with or without due notice or lapse of time or both) a default (or give rise to any right of termination, cancellation, payment or acceleration) under, or result in the creation of any encumbrance on any of the properties or assets of any of the Seller, the Company or its subsidiary under:

(i) any provision of the organizational documents of the Company or its subsidiary; and

(ii) any of the terms, conditions or provisions of any contract to which the Seller, the Company or its subsidiary is a party, or by which they or any of their respective properties or assets is bound.

4. **No Conflicts or Violations**

4.1 The execution and delivery of the Agreement by the Seller, the performance of the Seller of its obligations under the Agreement shall not:

(a) violate any provision of any Applicable Law or any writ, judgment, decree, injunction, or similar order applicable to the Company;

(b) conflict with or result in a violation or breach of, or constitute (with or without notice or lapse of time or both) a default under, any of the terms, conditions, or provisions of the Memorandum and Articles of Association of the Company; and

(c) result in the creation or imposition of any Lien upon any of the Shares.

SCHEDULE II

Part B

COMPANY' REPRESENTATIONS AND WARRANTIES

In this Schedule, capitalised terms have the meanings set forth in the Agreement.

The Company represent, warrant and agree as follows:

1. That the Company has been validly incorporated under the existing laws in India and has been regularly complying with the applicable laws in india;
2. That all the necessary corporate approvals that are required under the laws of India for the consummation of the transaction as contemplated under this Agreement have been validly complied with and the Company will register the Purchaser as its shareholder immediately upon the consummation of the transaction as contemplated under this Agreement.

SCHEDULE II

Part C

PURCHASER'S REPRESENTATIONS AND WARRANTIES

In this Schedule, capitalised terms have the meanings set forth in the Agreement.

The Purchaser represents, warrants and agrees as follows:

1. That it has been validly incorporated under the existing laws in Spain and has been regularly complying with the applicable laws in Spain;
2. The Purchasers have full legal capacity under extant Spanish law, to execute, deliver and perform this Agreement and all other instruments and agreements to be executed and delivered by them as contemplated hereby and to consummate the transactions contemplated under this Agreement.
3. The execution and delivery of this Agreement by the Purchaser and the consummation by the Purchaser of the transactions contemplated hereby will not result in a violation or breach of, conflict with, constitute (with or without due notice or lapse of time or both) a default (or give rise to any right of termination, cancellation, payment or acceleration) under:
   (i) any provision of the organizational documents of the Purchaser; and
   (ii) any of the terms, conditions or provisions of any contract to which the Purchaser is a party, or by which it or any of its respective properties or assets is bound.
4. The execution and delivery of the Agreement by the Purchaser and the performance of the Purchaser of its obligations under the Agreement shall not violate any provision of any Spanish Law.

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FINANCIAL PROPOSAL

Delhi Airport Metro Express Pvt Ltd
New Delhi

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RELIANCE Energy
Anil Dhirubhai Ambani Group

Date: 12th October 2007

Reliance Energy Limited
Reliance Energy Centre,
Santa Cruz (East)
Mumbai – 400 055, India

Phone: +91 22 3009 9999
Fax : +91 22 3009 9775

APPENDIX 12

FORM OF BID

DESIGN, INSTALLA11ON, COMMISSIONING, OPERA11ON AND MAINTENANCE OF THE AIRPORTMETRO EXPRESS LINE BETWEEN NEW DELHI-INDIRA GANDHI INTERNA11ONAL AIRPORT -DWARKA SECTOR 21)

FINANCIAL PROPOSAL

Appendix 12 A- FINANCIAL OFFER

1. We offer a Concession Fees of INR 540,000,000/- (INR ... million Five Hundred and fourty only) for the First year after COD.
2. During the Concession period, the above Concession Fees shall be enhanced by 5% (Five percent) every year over and above the concession Fees of the previous sear.
3. The offer mentioned is with conditions along with cost of withdrawal and such conditions are indicated in Appendix 12 B.
4. Details in support of the offer i.e. Business Plan is appended separately

For and on behalf of
Reliance Energy Limited

(Authorized Signatory)

ORIGINAL.

Reliance Energy
Anil Dhirubhai Ambani Group

APPENDIX 12 B

PRICED CONDITION OF OFFER WITH COST OF WITHDRAWAL

Bidders may submit here Qualifications/Conditions/Remarks/Assumptions to their offer along with the cost of withdrawal of each of them. The amount so indicated shall be reduced/ added to the concession fee quoted in Appendix 12 A.

Sr.	Qualifications/Conditions/Remarks/ Assumptions	Cost of withdrawal (Amt of adjustment in concession fees) (in figs &words)	
		ADD	SUBTRACT
1	Our proposal is based on the condition that Depot land of 7.3879 hectare is provided to the Concessionaire at Dwarka Sector 21 as shown in Tender drawings instead of depot land of 7.36 hectare at Palam.	NA	Rs. 180,000,000/- Rupees Eighteen Million Only. Rupees One Hundred and eighty million only.
2	Our proposal is based on the condition that Retail area development rights are available to the Concessionaire at Platform of New Delhi (640 sqr. mtr) and Shivaji Stadium (320 sqr mtr.) stations	NA	Rs. 30,000,000/- Rupees Thirty Million Only.

Authorised Signatory
With Date and Stamp

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Registered Office: Reliance Energy Centre, Santa Cruz (E), Mumbai 400 055

Page no.

@ One correction of words

दिल्ली मेट्रो रेल कॉरपोरेशन लिमिटेड
DELHI METRO RAIL CORPORATION LTD.

AIRPORT METRO EXPRESS LINE

CONCESSION CONTRACT NO. AMEL-P1

DESIGN, INSTALLATION, COMMISSIONING, OPERATION AND MAINTENANCE OF AIRPORT METRO EXPRESS LINE NEW DELHI - INDIRA GANDHI INTERNATIONAL AIRPORT - DWARKA SEC. 21

CONCESSION AGREEMENT

Volume II

Delhi Metro Rail Corporation Limited
NBCC Place,
Bhishma Pitamah Marg,
Pragati Vihar,
New Delhi –110 003
India

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DESIGN, INSTALLATION, COMMISSIONING, OPERATION AND MAINTENANCE OF AIRPORT METRO EXPRESS LINE - NEW DELHI - INDIRA GANDHI INTERNATIONAL AIRPORT-DWARKA SECTOR 21

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THE CONCESSION CONTRACT

THE ARTICLES

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Delhi Metro Rail Corporation Ltd.

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SECTION – I
PRELIMINARY

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ARTICLE: 1
DEFINITIONS AND INTERPRETATIONS

1.1 **Definitions**

The words and expressions beginning with capital letters and defined in this Agreement shall, unless the context otherwise requires, have the meaning ascribed thereto herein, and the words and expressions defined in the Schedules and used therein shall have the meaning ascribed there to in the schedule:

"Accounting Year" means the financial year commencing from 1st day of April of any calendar year and ending on 31st day of March of the next calendar year.

"Additional Commercial Activity" shall have the meaning ascribed thereto in Sub-Article 7.1.7.

"Additional Facilities" means any facilities which the Concessionaire may provide or procure for the benefit of the users of the Project and which are (i) in addition to the Required Buildings and/or Project Systems, and (ii) not situated on the Site.

"Adjusted Equity" means the Equity funded in Indian Rupees and adjusted on the first day of the current month (the "Reference Date"), in the manner set forth below, to reflect the change in its value on account of depreciation and variations in WPI, and for any Reference Date occurring:

a) on or before COD, the Adjusted Equity shall be a sum equal to the Equity funded in Indian Rupees and expended on the Project, revised to the extent of one half of the variation in WPI occurring between the first day of the month of Appointed Date and the Reference Date;

b) from COD and until the 4th (fourth) anniversary thereof, an amount equal to the Adjusted Equity as on COD shall be deemed to be the base (the "Base Adjusted Equity") and the Adjusted Equity hereunder shall be a sum equal to the Base Adjusted Equity, revised at the commencement of each month following COD to the extent of variation in WPI occurring between COD and the Reference Date;

c) after the 4th (fourth) anniversary of COD, the Adjusted Equity hereunder shall be a sum equal to the Base Adjusted Equity, reduced by 0.42% (zero point four two per cent) (This number shall be substituted in each case by the product of 100 divided by the number of months comprising the Concession Period. For example, the figure for a 20 year Concession Period shall be 100/ 240 = 0.416 rounded off to two decimal points i.e. 0.42). thereof at the commencement of each month following the 4th (fourth) anniversary of the Project Completion Date and the amount so arrived at shall be revised to the extent of variation in WPI occurring between COD and the Reference Date; and the aforesaid shall apply, mutatis mutandis, to the Equity funded in Indian Rupees. For the avoidance of doubt, the Adjusted Equity shall, in the event of Termination, be computed as on the Reference Date immediately preceding the Termination Date; provided that no reduction in the Base Adjusted Equity shall be made for a period equal to the duration, if any, for which the Concession Period is extended, but the revision on account of WPI shall continue to be made;

"Affected Party" shall have the meaning set out in Sub-Article 26.1.

"Affiliate" in respect of a Person means any other Person that directly or indirectly, through one or more intermediaries, controlled, is controlled by or in common control with such first Person, where "control" means with respect to the relationship between or among two or more Persons, the possession directly or indirectly or as trusted, personal representative or executor, the power to direct or cause the direction of the affairs of management of a Person, whether through the ownership of voting rights, trustees, personal representative or executor by statute, contract, credit arrangement or otherwise, including the ownership, directly or indirectly of equity having the powers to elect a majority of the board of directors or similar body governing the affairs of such Person

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"Agreement" or Concession Agreement means this Agreement, its Recitals, the Schedules hereto, other annexure and amendments made thereto made in accordance with provisions contained in this Agreement.

"Airport Metro Express Line" or Project means the Express Metro Rail Line stretching from New Delhi Railway Station up to Dwarka Sector 21 via Indira Gandhi International Airport and shall include the Project Assets to be designed, engineered and built on Site and to be operated and maintained during the Concession Period in accordance with the provisions of this Agreement.

"Appointed Date" – means the date on which Financial Close is achieved or an earlier date in case that date is the date of commencement of Concession Period in terms of this Agreement.

"Applicable Laws" means all laws, promulgated or brought into force and effect by GOI or GNCTD including rules, regulations and notifications made thereunder, and judgments, decrees, injunctions, writs and orders of any court of record, as may be applicable to this Agreement and the exercise, performance and discharge of the respective rights and obligations of the Parties hereunder, as may be in force and effect during the subsistence of this Agreement.

"Applicable Permits" means all clearances, permits, authorisations, consents, no objection certificates,, approvals and exemptions required to be obtained or maintained under

Applicable Laws in connection with the design, engineering, financing, procurement, construction, operation and maintenance of the Project during the subsistence of this Agreement.

"Arbitration Act" means the Arbitration and Conciliation Act, 1996 and shall include modifications to or any re-enactment thereof as in force from time to time.

"Arms Length Transaction" is defined as: A transaction in which the parties (a) are unconnected and have no overt common interest (b) are dealing from equal bargaining positions and (c) neither party is subject to other's control or dominant influence. Any such transaction is expected to reflect the true market value of the services provided and has been entered into with fairness, integrity and legality.'

"Associates" means in relation to either Party and/or Consortium Members, a person who controls, is controlled by, or is under the common control with such Party or Consortium Member. As used in this definition, the expression "control" means with respect to a person which is a corporation, the ownership, directly or indirectly, of more than 50% of the voting shares of such person, and with respect to a person which is not a corporation, the power to direct the management and policies of such person, whether by operation of law or by contract or otherwise.

"Available Date" means the date upon which DMRC formally grants access to the Concessionaire of the first Section for the purposes of carrying out the Concessionaire's works as per Schedule "C" including installation of the Systems.

"Bank" means a bank incorporated in India and having minimum net worth of Rs. 1000 crore (Rupees one thousand crore) or any scheduled bank acceptable to Senior Lenders and DMRC but does not include a bank in which Senior Lenders have an interest.

"Bank Rate" – means the rate of interest specified by the Reserve Bank of India from time to time in pursuance of section 40 of the Reserve Bank of India Act 1934 or any replacement of such Bank Rate for the time being in effect.

"Bid" means the documents in their entirety comprised in the bid submitted by the Bidder (Concessionaire/ Consortium) in response to the Tender Notice in accordance with the provisions thereof.

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"COD" means the commercial operations date of the Project after certification for safe operations by the Commissioner, Metro Rail Safety, pursuant to issue of the Completion Certificate or the Provisional Certificate by the Consultant upon completion of the Project in accordance with the Agreement.

"Change in Law" means the occurrence after date of the Bid of

(i) the enactment of any new Indian law;
(ii) the repeal, modification or re-enactment of any existing Indian law;
(iii) the commencement of any Indian law which has not entered into effect until the date of the Bid;
(vi) a change in the interpretation or application of any Indian law by a court of record which has become final, conclusive and binding, as compared to such interpretation or application by a court of record prior to the date of the Bid;

in such a manner that it has a material effect (positive or negative) on

- the Project
- The Concessionaire,

It is expressly clarified that changes in the Indian Income Tax Act, 1961 with regards to the corporate tax on the income of the Concessionaire or a change in the manner of calculation of any tax of any type or any change in the rates of the any existing tax, duty cess etc for what so ever reason it may be, will not be considered as Change of Law.

"Change of Scope" shall have the meaning ascribed thereto in Sub-Article 18.1.

"Commercial Lease" means an agreement to rent all or part of the Site to a third party for a business purpose.

"Company" means the Company acting as the Concessionaire under this Agreement

"Completion Certificate" means the certificate issued by the Consultant pursuant to Sub-Article 17.5.

"Concession" shall have the meaning ascribed thereto in Article 3.

"Concession Fee" shall have the meaning ascribed thereto in Article 8.

"Concession Period" means the period beginning from the Available Date and ending on the Termination Date.

"Concessionaire" means the company identified as such in the Preamble and its successors and permitted substitutes expressly approved in writing by DMRC.

"Concessionaire's Capital Costs" means following:

- Prior to COD, the cost of the Concessionaire's Works as set forth in the Financing Documents plus any further additional capital cost for any Change of Scope instructed since the finalisation of the Financing Documents; and
- After COD, the actual capital cost of the Concessionaire's Works upon Project Completion as certified by the Statutory Auditors.

"Concessionaire's Notice of Additional Commercial Activity" shall have the meaning ascribed thereto in Sub-Article 7.1.7.

"Concessionaire's Works" means the design, financing, procurement, installation, commissioning and testing of the Project Systems and the works of design, procurement and

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construction necessary to complete the Required Buildings for the safe and reliable commercial operation of the Project (Schedule C).

"Consortium" shall have the meaning set forth in Recital above.

"Consortium Member" means a company identified in Recital as forming part of the Consortium.

"Construction Period" means the period beginning from the Available Date and ending on the COD.

"Consultant" means the Consultant appointed by DMRC as its General Consultant (GC) or any other Consultant appointed by DMRC during construction and/or operation period of the Project.

"Contractor" means the person or persons, as the case may be, with whom the Concessionaire has entered into any EPC Contract, the O&M Contract, the Fare Contract or any other agreement or contract for construction, operation and/or maintenance of the Project or matters incidental thereto or any other Project Agreements, but does not include a person who has entered into an agreement for providing financial assistance to the Concessionaire.,

"Cure Period" means the period specified in this Agreement for curing any breach or default of any provision of this Agreement by the Party responsible for such breach or default and shall:

a) Commence from the date on which a notice is delivered by one Party to the other Party asking the latter to cure the breach or default specified in such notice.
b) Not relieve any Party from liability to pay Damages or compensation under the provisions of the Agreement; and
c) not in any way be extended by any period of Suspension under this Agreement

provided that if the cure of any breach by the Concessionaire requires any reasonable action by DMRC or Consultant hereunder, the applicable Cure period shall be extended by the period taken by DMRC or the Consultant to accord their approval

"Damages" shall have the meaning ascribed thereto in Sub-Article 1.2(o).

"Debt Due" means the aggregate of the following sums expressed in Indian Rupees outstanding on the Transfer Date:

a) the principal amount of the debt provided by the Senior Lenders under the Financing Agreements for financing the Total Project Cost (the "principal") but excluding any part of the principal that had fallen due for repayment two years prior to the Termination Date;
b) all accrued interest, financing fees and charges payable under the Financing Agreements on, or in respect of, the debt referred to in Sub-clause (a) above until the Transfer Date but excluding (i) any interest, fees or charges that had fallen due one year prior to the Transfer Date, (ii) any penal interest or charges payable under the Financing Agreements to any Senior Lender, and (iii) any pre-payment charges in relation to accelerated repayment of debt except where such charges have arisen due to Authority Default; and

c) any Subordinated Debt which is included in the Financial Package and disbursed by lenders for financing the Total Project Cost;

"Debt Service Payments" means the sum of all principal and interest payments due and payable in an Accounting Year to the Senior Lenders under the Financing Documents.

Depreciated Value" – means the value of an asset as depreciated annually in the books of account of the Concessionaire in accordance with the provisions of the Applicable Laws.

"Design" means the detailed design and drawings (of any kind) and technical specifications prepared by the Concessionaire to describe the Concessionaire's Works, and which shall be developed from, and in accordance with, the Drawings provided in Schedule 'I' and the Specifications for the Concessionaire's Works provided in Schedule 'D'.

"Development Period" means the period from the date of issue of Letter of Acceptance until the Available Date.

"Disclosed Data" means any information or data and documents made available or issued to the Concessionaire in connection with the Project by or on behalf of DMRC whether before or after the execution of this Agreement.

"Dispute" shall have the meaning set forth in Sub-Article 36.1(a).

"Dispute Resolution Procedure" means the procedure for Dispute resolution set forth in Article 37.

"Divestment Requirements" means the obligations of the Concessionaire for and in respect of the Termination of this Agreement as set forth in Article 30.

"DMRC Delay" shall have the meaning ascribed thereto in Sub-Article 13.9.

"DMRC Representative" means such person or persons as may be authorised in writing by DMRC to act on its behalf under this Agreement and shall include any person or persons having authority to exercise any rights or perform and fulfill any obligations of DMRC under this Agreement.

"DMRC Works" means the civil works of tunnels, viaducts and at-grade track bed, stations structures and the like as described in Schedule 'B' to be procured by DMRC and handed over to the Concessionaire as Sections in accordance with the handover milestones shown in Schedule 'H'.

"Document" or "Documentation" means documentation printed or in written form, tapes, discs, drawings, computer programmes, writings, reports, photographs, cassettes or expressed in any other written, electronic, audio or visual form.

"Effective Date" means the date on which Financial Close is achieved.

"Emergency" means a condition or situation that is likely to endanger the security of the individuals on or about the Airport Metro Express Line, including users thereof, or which poses an immediate threat of material damage to any of the Project Assets.

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"Encumbrances" means in relation to the Project any encumbrances such as mortgage, charge, pledge, lien, hypothecation, security interest, assignment, privilege or priority of any kind having the effect of security or other such obligations and shall include without limitation any designation of loss payees or beneficiaries or any similar arrangement under any insurance policy pertaining to the Airport Metro Express Line, physical encumbrances and encroachments on the Site where applicable herein.

"EPC Contract" means a contract entered into by the Concessionaire for any part of the design, engineering, procurement of materials and equipment, installation, and completion of the Required Buildings and Project Systems.

"Equity" means the sum expressed in Indian Rupees representing the equity share capital of the Concessionaire and shall include the funds advanced by any Member of the Consortium or by any of its shareholders to the Concessionaire for meeting the equity component of the Concessionaire's Capital Costs.

"Escrow Account" means an Account which the Concessionaire shall open and maintain with a Bank in which all inflows and outflows of cash on account of capital and revenue receipts and expenditures shall be credited and debited, as the case may be, in accordance with the provisions of this Agreement.

"Escrow Agreement" shall have the meaning ascribed thereto in Sub-Article 23.2.

"Escrow Bank" means the Bank holding and administering the Escrow Account.

"Fare" means the charge levied on and payable by a passenger for carriage using the Airport Metro Express Line in accordance as prescribed in this Agreement.

"Fare Notification" means the initial notification as provided in this Concession Agreement in respect of the levy and collection of the Fares along with the formula for future changes in the Fare as prescribed in this Agreement.

"Financial Close" means the date on which the Financing Documents providing for funding by the Senior Lenders have become effective and the Concessionaire has access to such funding under the Financing Documents within 30 days of such date.

"Financing Documents" means the documents executed by the Concessionaire in respect of financial assistance to be provided by the Senior Lenders by any means (including *inter alia* loans, guarantees, subscription to non-convertible debentures and other debt instruments) and security agreements , and other documents relating to the financing (including refinancing) of the Project and including any amendments or modifications made to such documents subject to the provisions of Sub-Article 10.1(d).

"Financial Model" means the Financial Model adopted by Senior Lenders, setting forth the capital and operating cost of the Project and revenue therefrom on the basis of which the financial viability of the Project has been determined by the Senior Lenders and includes a description of assumptions and parameters for making calculations and Projections therein.

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"Financing Package" or "Financial Proposal" means the financing package of the Project furnished by the Concessionaire along with its Bid indicating the Concessionaire's capital costs and the sources of financing thereof, and shall be deemed to have been modified to the extent as submitted to the Senior Lenders and as approved by the Senior Lenders for the purposes of funding of the Project.

"Force Majeure" or "Force Majeure Event" shall mean an act, event, condition or occurrence specified in Article 26.

"GOI" means the Government of India.
"GNCTD" means the Government of the National Capital Territory of Delhi.

"Governmental Agency" means GOI, GNCTD or any ministry, department, commission, board, authority, instrumentality or agency, under the control of GOI or GNCTD having jurisdiction over all or any part of the Project or the performance of all or any of the services, rights or obligations of the Concessionaire under or pursuant to this Agreement.

"Gross Revenue" means the sum total of all revenues (Fare and Non Fare) received by the Concessionaire every year during the Concession Period.

"Handover Package" means the assemblage of information provided by the Concessionaire in accordance with Sub-Article 30.3 and containing the information called for in Schedule 'T'.

"Indemnified Party" and "Indemnifying Party" mean the Party entitled to be indemnified by the other Party (or Indemnifying other Party) pursuant to Article 35.

"Independent Assessor" means a company engaged and paid by the Concessionaire to perform a safety inspection and verification of one or more of the Project Systems to satisfy the requirements of the Commissioner of Metro Rail Safety pursuant to obtaining his clearance for the Project to be put into commercial operation.

"Insurance Cover" means the aggregate of the maximum sums insured under the insurances taken out by the Concessionaire pursuant to Article 32, and when used in the context of any act or event, it shall mean the aggregate of the maximum sums insured and payable in relation to such act or event;

"Inspection Report" shall have the meaning ascribed thereto in Sub-Article 15.3.

"Lead Member" means the company identified as such in Recital

"Lenders' Representative" means the person(s) duly authorised by the Senior Lenders to deal with the Parties to the Agreement with regard to the issues arising out of and contained in this Agreement.

"Maintenance Programme" shall have the meaning ascribed to it in Sub-Article 19.3.

"Material Adverse Effect" means material adverse effect of any act or event on the ability of either Party to perform any of its obligations under and in accordance with the provisions of this Agreement.

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"Material Breach" means a breach by either Party of any of its obligations in this Agreement which shall be deemed to have a Material Adverse Effect on the Project and which it shall have failed to cure within the Cure Period.

"Net Cash Flow" means in any Accounting Year revenue income less tax payments, O&M Expense, Concession Fee, Negative Grant and Debt Service Payments to Senior Lenders.

"Non-Fare Revenue" means income of any type generated by the Concessionaire from the use of the Project Assets in any way except income from Fares.

"O&M" means the operation and maintenance of the Project during the Operations Period and includes, all matters connected with or incidental to operations and maintenance, provision of services and facilities and collection of Fare and other revenues in accordance with provisions of this Agreement.

"O&M Contract" means a contract that may be entered into between the Concessionaire and an O&M Contractor for the performance of all or part of the O&M obligations.

"O&M Contractor" means the person or entity if any, with whom the Concessionaire has entered into an O&M Contract for full or partial O&M obligations for and on behalf of the Concessionaire.

"O&M Expense" means expenses incurred by or on behalf of the Concessionaire duly certified by its Statutory Auditors or by DMRC, as the case may be, for all regularly scheduled and reasonably anticipated O&M during Operations Period, including, without limitation

(a) cost of salaries and other employee compensation and contract fee payable to the O&M Contractor, if any
(b) cost of materials, supplies, utilities and other services
(c) premia for insurance
(d) all taxes, duties, cess and fees of any type due and payable for O&M obligations
(e) all repair, replacement, reconstruction, improvement and maintenance cost, and
(f) all other expenditures required to be incurred under Applicable Law, Applicable Permits or this Agreement.

"Operations and Maintenance Manual" shall have the meaning ascribed to it in Sub-Article 19.2.

"Operations Period" means the period commencing from COD and ending on the Termination Date.

"Party" or "Parties" means the parties to this Agreement and "Party" shall mean any of the parties to this Agreement individually

"Performance Security" shall have the meaning as set forth in Sub-Article 5.1

"Project Agreements" means this Agreement, the Financing Documents, the EPC Contract(s), if any, the O&M Contract(s), if any, a Commercial Lease, if any, and any other agreements or contracts entered into by the Concessionaire with DMRC or others relating to the Project during the subsistence of this Agreement.

"Project Assets" means all physical and other assets relating to and forming part of the Site including:

(i) rights over the Site in the form of license, right of way, property development rights, or otherwise,
(ii) the DMRC Works as described in Schedule B,
(iii) the Concessionaire's Works as described in Schedule C,
(iv) the rights of the Concessionaire under the Project Agreements,
(v) financial assets, such as receivable, security deposits, security etc.
(vi) insurance proceeds, and
(vii) Applicable Permits and authorisations relating to or in respect to Project, but does not include Additional Facilities.

"Project Completion" shall have the meaning ascribed thereto in Sub-Article 16.1.

"Project Completion Schedule" means the progressive Project milestone set forth in Schedule 'H' for the realisation of the Project complete in all respects by the Scheduled Project Completion Date.

"Project Systems" means the systems to be engineered, procured, installed, commissioned and tested by the Concessionaire as required for the operation of the Project, including (but not limited to) rolling stock, traction, track, signaling, telecommunications, tunnel ventilation, station ventilation and climate control, automatic fare collection, baggage check-in and handling, and flight information systems, and their maintenance facilities, all as described in Schedule 'C'.

"Provisional Certificate" means the certificate pursuant to Sub-Article 17.6.

"Punch List" shall have the meaning ascribed to it in Sub-Article 17.6.

"Required Buildings" means the depot, operations control centre, stations, electrical substations, tunnel ventilation buildings, etc. required to house Project Systems or otherwise required for the safe and reliable operation of the Project.

"Rs." Or "Rupees" means the lawful currency of the Republic of India.

"SBI PLR" means the prime lending rate per annum for loans with 1(one) year maturity as fixed from time to time by the State Bank of India and in the absence of such rate any other arrangement that substitutes such prime lending rate as mutually agreed between the Parties.

"Scheduled Project Completion Date" shall have the meaning set forth in Sub-Article 16.3.

"Section" means a completed portion of DMRC Works, including tunnel, viaduct, and at-grade lengths of track bed, or station structure.

"Senior Lenders" means the financial institutions, banks, funds and agents or trustees of debenture holders, including their successors and assignees, who have agreed to guarantee or provide finance to the Concessionaire under any of the Financing Documents for meeting costs of all or any part of the Concessionaire's Works and who hold pari passu charge on the assets, rights, title and interest of the Concessionaire.

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"Site" means the real estate licensed by DMRC to the Concessionaire under and in accordance with this Agreement on which the Project is situated and which shall be handed over, together with relevant DMRC Works thereon, to the Concessionaire by Sections in accordance with the milestones given in Schedule 'H'.

"Specification and Standards" means the specifications and standards relating to the quality, capacity and other requirements for the Project as set forth in Schedule 'D' and any modifications thereof, or additions as included in the design and engineering for the Project submitted by Concessionaire and approved by DMRC.

"Start Date" shall have the meaning ascribed to it in Sub-Article 14.1 (a).

"Statutory Auditors" means an independent and reputable firm of Chartered Accountants duly licensed to practice in India acting as the Statutory Auditors of the Concessionaire under the provisions of the Companies Act, 1956 including any statutory modification or re-enactment or replacement thereof, for the time being in force, and appointed in accordance with Sub-Article 25.2.

"Subordinated Debt" means the aggregate of the following sums expressed in Indian Rupees or in the currency of debt, as the case may be, outstanding as on the date of termination:

a) the principal amount of debt provided by lenders or the Concessionaire for meeting the Concessionaire's Capital Cost and subordinated to the financial assistance provided by the Senior Lenders; and

b) all accrued interest on the debt referred to in Sub-clause (a) above but restricted to the lesser of actual interest rate and a rate equal to 5% (five per cent) above the Bank Rate in case of loans expressed in Indian Rupees and lesser of the actual interest rate and six-month LIBOR (London Inter Bank Offer Rate) plus 2% (two per cent) in case of loans expressed in foreign currency, but does not include any interest that had fallen due one year prior to the Termination Date.

provided that if all or any part of the Subordinated Debt is convertible into Equity at the option of the lenders and/or the Concessionaire, it shall for the purposes of this Agreement be deemed to be Subordinated Debt even after such conversion and the principal thereof shall be dealt with as if such conversion had not been undertaken;

"Substitution Agreement" means the agreement referred to in Article 29 and to be entered into among the Concessionaire, DMRC and the Senior Lenders in the form set forth in Schedule 'U' providing, inter alia, for the substitution of the Concessionaire by any other person including DMRC subject to and in accordance with the provisions of this Agreement and the Substitution Agreement.

"Taxes" means any Indian taxes including excise duties, customs duties, value added tax, sales tax, local taxes, cess and any impost or surcharge of like nature (whether Central or local) charged, levied or imposed on the goods, materials, equipment and services incorporated in and forming part of the Project, or on the construction, operation and maintenance thereof or on the Project Assets, but excluding any interest, penalties and other sums in relation thereto imposed on any account whatsoever

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Termination" means the expiry with normal efflux of time or termination of this Agreement and the Concession hereunder due to Concessionaire Event of Default, DMRC Event of Default or for the Convenience of DMRC.

"Termination Date" means the date on which this Agreement and the Concession hereunder expires pursuant to the provisions of this Agreement or is terminated by a Termination Notice.

"Termination Notice" means the communication issued in accordance with this Agreement by any one Party to the other Party terminating this Agreement.

"Termination Payment" means the amounts payable by DMRC to the Concessionaire under this Agreement upon the Termination of this Agreement. For the avoidance of doubt it is expressly agreed that the amount payable shall be subject to the limitations specified in this Agreement

"Tests" mean the tests to be carried out as set forth in and in accordance with Schedule 'J' to determine the Project Completion and/or the reliability of the Project Systems.

"Total Revenues" means the sum of Fares received and Non-Fare Revenues earned (whether paid or not) during a period.

"User" means a person who uses the Project line or any part of the Project on payment of the Fare

"Vesting Certificate" shall have the meaning attributed to it in Sub-Article 31.5.

"WPI" means the wholesale price index published by the Ministry of Industry, GOI and shall include any index, which substitutes the WPI and any reference to the WPI, shall unless the context otherwise requires be construed as a reference to the WPI published for the period ending with the preceding month.

1.2 **Interpretation:**

In this Agreement, unless the context otherwise requires,

(a) any reference to a statutory provision shall include such provision as is from time to time modified or re-enacted or consolidated so far as such modification or re-enactment or consolidation applies or is capable of applying to any transactions entered into hereunder;

(b) references to Indian law shall include the laws, acts, ordinances, rules, regulations, or bye laws which have the force of law in the territory of India and as from time to time may be amended, modified, supplemented, extended or reenacted ;

(c) the words importing singular shall include plural and vice versa, and words denoting natural persons shall include partnerships, firms, companies, corporations, joint ventures, trusts, associations, organizations or other entities (whether or not having a separate legal entity) and shall include successors and assigns;

(d) the table of contents, headings and subheadings in this Agreement are for convenience of reference only and shall not be used in and shall not affect the construction or interpretation of this Agreement;

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(e) the words "include" and "including" are to be construed without limitation and shall be deemed to be followed by "without limitation" or "but not limited to" whether or not they are followed by such phrases;

(f) references to "construction" includes, unless the context otherwise requires, investigation, design, engineering, procurement, delivery, transportation, installation, processing, fabrication, testing, commissioning and other activities incidental to the construction;

(g) any reference to time shall mean a reference to Indian Standard Time ;

(h) any reference to day shall mean a reference to a calendar day,;

(i) any reference to month shall mean a reference to a calendar month

(j) Any reference to Lakh means hundred thousand (100,000) and crore means ten million (10,000,000);

(k) the Schedules to this Agreement form an integral part of this Agreement and will be in full force and effect as though they were expressly set out in the body of this Agreement;

(l) any reference at any time to any agreement, deed, instrument, license or document of any description shall be construed as reference to that agreement, deed, instrument, license or other document as amended, varied, supplemented, modified or suspended at the time of such reference provided that this Article shall not operate so as to increase liabilities or obligations of DMRC hereunder or pursuant hereto in any manner whatsoever;

(m) references to Recitals, Articles, , Sub-Articles, Paragraphs, or Schedules in this Agreement shall, except where the context otherwise requires, be deemed to be references to Recitals, Articles, Articles, Sub-Articles, paragraphs, and Schedules of or to this Agreement;

(n) any agreement, consent, approval, authorisation, notice, communication, information or report required under or pursuant to this Agreement from or by any Party or the Consultant shall be valid and effectual only if it is in writing under the hands of duly authorised representative of such Party or the Consultant, as the case may be, in this behalf and not otherwise

(o) the damages payable by either Party to the other of them as set forth in this Agreement, whether on per diem basis or otherwise, are mutually agreed genuine pre-estimated loss and damage likely to be suffered and incurred by the Party entitled to receive the same and are not by way of penalty or liquidated damages (the "Damages");

(p) unless otherwise expressly provided in this Agreement any Documentation required to be provided or furnished by the Concessionaire to DMRC and/or the Consultant shall be provided free of cost and in three copies and if DMRC and/or the Consultant are required to return any such Documentation with their comments and/or approval, they shall be entitled to retain two copies thereof.

(q) any word or expression used in this Agreement shall unless otherwise defined or construed in this Agreement bear its ordinary English meaning and for these purposes , the General Articles Act, 1897 shall not apply.

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1.3 Measurements and Arithmetic Conventions

All measurements and calculations shall be in metric system and calculations done to 2 decimal places, with the third digit of 5 or above being rounded up and below 5 being rounded down.

1.4 Priority of contract documents and errors/discrepancies

This Agreement and all other documents forming this Agreement are to be taken as mutually explanatory and, unless otherwise expressly provided elsewhere in this Agreement, the priority of this Agreement and other documents and agreements forming part hereof shall, in the event of any conflict between then, be in the following order:

(i) This Agreement; and
(ii) All other agreements and documents forming part thereof;

i.e. the Agreement at 1.4 (i) shall prevail over the agreements and documents at 1.4(ii) above.

1.4.1 Subject to 1.4 above in case of ambiguities or discrepancies within this Agreement, the following shall apply:

(i) between two or more Articles of this Agreement, the provisions of a specific Article relevant to the issue under consideration shall prevail;
(ii) between the articles of this Agreement and the Schedules, the Articles shall prevail;
(iii) between Schedules and Annexures, the Schedules shall prevail;
(iv) between the written description on the Drawings / Specifications and Standards, the latter shall prevail;
(v) between the dimension scaled from the Drawing and its specific written dimension, the latter shall prevail;
(vi) Between any value written in numerals and that in words, the latter shall prevail.

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ARTICLE 2
SCOPE

i) The Project shall be executed on the Site, which is described in Schedule 'A' of this Agreement.

ii) The scope of the Project shall include performance and execution by DMRC of all design, engineering, financing, procurement, construction, and testing of the civil works to the limits identified in Schedule 'B' and performance and execution by the Concessionaire of all design, engineering, financing, procurement, construction completion, installation, commissioning and testing of the Concessionaire's Works shall be done as described in Schedule 'C' of this Agreement, together with the subsequent operation and maintenance of the entire Project. The Scope shall also include the creation of additional infrastructure and Project System to augment the AMEL System during the Concession Period, to meet the passenger carrying capacity demanded.

iii) The Concessionaire shall execute the Concessionaire's Works in accordance with the Specifications and Standards set forth in Schedule 'D', and shall operate and maintain the Project in accordance with Schedule "L".

iv) The Scope of the Project shall also include performance and fulfillment of all other obligations of the Concessionaire in accordance with the provisions of this Agreement and matters incidental thereto or necessary for the performance of any or all obligations of the Concessionaire under the Agreement.

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SECTION – II
THE CONCESSION

ARTICLE 3
GRANT AND ACCEPTANCE OF CONCESSION

3.1 Subject to and in accordance with the terms and conditions set forth in this Agreement, DMRC hereby grants to the Concessionaire and the Concessionaire hereby accepts the Concession for a period of 30 (thirty) years commencing from the Available Date, including the exclusive right, license and authority during the subsistence of this Agreement to implement the Project and the Concession in respect of the Airport Metro Express Line.

3.2 Subject to and in accordance with the provisions this Agreement, the Applicable Laws and the Applicable Permits, DMRC hereby grants to the Concessionaire, the Concession set forth herein including the exclusive right, license and authority during the subsistence of the Agreement to :

(a) Right of Way, access and license to the Site for the purpose of and to the extent conferred under the Agreement

(b) to develop, design, engineer, finance, procure, construct, commission and test the Concessionaire's Work during the Construction Period;

(c) upon completion of the Airport Metro Express Line, manage, operate & maintain the Project as a commercial enterprise for providing the members of the public with a safe, comfortable and reliable Project including all systems and sub-systems and regulate the use thereof by third parties;

(d) perform and fulfill all of the Concessionaire's obligations under this Agreement;

(e) bear and pay all expenses, costs and charges incurred in the fulfillment of all the Concessionaire's obligations under this Agreement ;and

(f) not assign or create any lien or Encumbrance on the Concession hereby granted or on the whole or any part of the Project nor transfer, lease or part possession therewith save and except as expressly permitted by this Agreement or the Substitution Agreement.

3.3 Subject to the terms and conditions of this Agreement and in consideration of above the Concessionaire shall construct and operate and maintain the Project in conformity with this Agreement, at its own cost, expense and risk along with the following rights:

(a) levy, demand, collect and appropriate the Fares from persons liable to payment of Fares for using the Project or any part thereof and refuse entry of any person if the due Fare is not paid;

(b) undertake activities and derive Revenue from any and or all of the other permissible revenue sources (other than fare box revenue) granted under the Agreement

3.4 The Concession Period shall commence on the Available Date and shall end on the Termination Date.

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ss or activity other than the business or
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e reasonably requested by the either Party.

pt to recruit DMRC employees.

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ARTICLE 4
CONDITIONS PRECEDENT

4.1 Save and except as provided in Articles 4, 5 and 22, the rights and obligations of the Concessionaire under this Agreement are subject to the satisfaction in full of the following conditions precedent to be fulfilled on or before Financial Close unless any such condition has been waived as provided in Sub-Article 4.1:

(a) Concessionaire shall have obtained such Applicable Permits (as listed in Schedule 'E') as being required prior to Financial Close unconditionally or if subject to conditions then all such conditions have been satisfied in full and such Applicable Permits are and shall be kept in full force and effect for the relevant period during the subsistence of this Agreement;

(b) the Concessionaire shall have been granted way leaves required in connection with the Project including:

(i) rights of way, free from all Encumbrances, for the construction of the depot;

(ii) permission/license to enter upon and utilise any and all parts of the Site pursuant to and in accordance with this Agreement.

This condition 4.1 (b) shall be fulfilled by DMRC in terms of this Agreement as per schedule laid out for the progressive handing over of the Site to the Concessionaire.

(c) certified true copies of all Project Agreements, and in particular the Financing Documents, the EPC Contract(s), the O&M Contract(s) (if any), and the shareholders funding agreement (except where ever specifically so exempted as condition precedent by DMRC), have been delivered by the Concessionaire to DMRC;

(d) all of the representations and warranties of the Concessionaire set forth in Article 11.2 are true and correct as on date of this Agreement and as on the Effective Date;

(e) DMRC shall have received from the Concessionaire copies (certified as true copies by an authorised officer of the Concessionaire) of the constitutional documents of the Concessionaire;

(f) DMRC shall have received copies (certified as true copies by a Director of the Concessionaire) of all resolutions adopted by the Board of Directors of the Concessionaire authorising the execution, delivery and performance by the Concessionaire each of the Project Agreements;

(g) DMRC shall have received from the Indian legal counsel of the Concessionaire a legal opinion with respect to the authority of the Concessionaire to enter into this Agreement and the Project Agreements and the Financing Documents.

4.2 Any of the conditions precedent set forth in Sub-Article 4 save and except condition of Sub-Article (b) and (c) thereof, may be waived fully or partially by DMRC at anytime in its sole discretion.

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4.3 **Obligation to Satisfy the Conditions Precedent.**

4.3.1 Each Party shall make all reasonable endeavours to satisfy the Conditions Precedent within the time stipulated and shall provide the other Party with such reasonable assistance as may be required to assist that Party in satisfying the Conditions Precedent for which the Party is responsible.

4.3.2 The Parties shall notify each other in writing at least once a month on the progress made in satisfying the Conditions Precedent. Each Party shall promptly inform the other Party when any Condition Precedent for which it is responsible has been satisfied.

4.4 If all of the Conditions Precedent set forth in Sub-Article 4 have not been satisfied on or before the Financial Close and the DMRC has not waived, fully or partially, such unsatisfied conditions under Sub-Article 4.2, DMRC may, notwithstanding anything to the contrary contained in this Agreement, terminate this Agreement in accordance with provisions of Sub-Article 29.2 without being liable in any manner whatsoever to the Concessionaire and forfeit the Performance Security by way of Damages, provided that where DMRC does not fulfill its obligations under Sub-Article 4.3 and terminates this Agreement under this Sub-Article 4.4 it shall refund in full the Performance Security.

ARTICLE 5
PERFORMANCE SECURITY

5.1 Not later than at the time of signing of this Agreement the Concessionaire shall, for due and faithful performance of its obligations during the Concession Period, provide to DMRC an unconditional and irrevocable bank guarantee from a Bank in the form set forth in Schedule 'F' (the "Performance Security") for a sum equivalent to Rs. 750 million (Rupees seven hundred fifty million) in the form set forth in Schedule-- F and initially valid up to the 31st day of October 2010 and thereafter, to be extended from time to time as required.

5.2 Failure of the Concessionaire to maintain the availability of the Performance Security to DMRC by extending its validity at least 60 days before its due expiry at any time during the term of this Agreement shall entitle DMRC to encash the Performance Security before its expiry and to terminate this Agreement in accordance with the provisions of Sub-Article 29.

5.3 The Performance Security shall be released by DMRC to the Concessionaire in tranches as follows:

(a) On achieving COD	50%
(b) After COD plus 10 years	30%
(c) On completion of the Concession Period	20%

5.4 In the event of the Concessionaire being in default in the due and faithful performance of its obligations under this Agreement and failing to remedy such default within the Cure Period, the DMRC shall without prejudice to its other rights and remedies hereunder be entitled to encash and appropriate the Performance Security as Damages for such default. Upon such encashment and appropriation of the Performance Security, DMRC shall grant a period of 30 (thirty) days to the Concessionaire to provide fresh Performance Security and in case of partial appropriation to replenish to the original level and the Concessionaire shall within the time so granted furnish to DMRC such Performance Security failing which DMRC shall be entitled to Terminate this Agreement under Sub-Article 29.2. The provision set forth in Sub-Article 5.2 and this Sub-Article 5.3 shall apply mutatis-mutandis to replenishments or such fresh Performance Security.

5.5 Notwithstanding anything to the contrary contained in Sub-Article 5.4, upon furnishing of fresh Performance Security in accordance with Sub-Article 5.4, the Concessionaire shall be granted an additional period of 60 (sixty) days as Cure Period for remedying the defaults and complying with his obligations under this Agreement. In the event of the Concessionaire continuing to be in breach of the provisions of this Agreement after such Cure Period, DMRC shall be entitled to terminate this Agreement under the provisions of Sub-Article 29.2.

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ARTICLE 6
FARES

6.1 During the Operation Period the Concessionaire shall be entitled to demand, collect and appropriate Fare from the Users in accordance with this Agreement and the Fare Notification as set forth in below and in Sub Article 6.3.

It is agreed that the maximum one way Fare and Monthly Fare between the pairs of stations as prescribed below shall be the initial fares valid for first two years of operation. The Concessionaire expressly agrees that initial Fare shall be as provided in this Agreement and as revised from time to time based on the annual Fare Revision Formula as provided in this agreement, provided further that the Concessionaire may determine and collect Fare at such lower rates as it may, by public notice to the Users, specify in respect of all or any category of Users.

(a) Maximum One Way Fare

(i) between New Delhi Railway Station and IGI Airport : Rs. 150 (Rs One Hundred and fifty)

(ii) between Dwarka Sector 21 and IGI Airport : Rs. 30 (Rs Thirty)

(b) Maximum Monthly Fare (valid for a maximum of 60 single journeys in a month)

(i) between New Delhi Railway Station and IGI Airport : Rs 2000 (Rs Two Thousand)

(ii) between Dwarka Sector 21 and IGI Airport : Rs. 600 (Rs Six Hundred)

No additional charges shall be levied for the handling and transportation of luggage of the users.

6.2 **Fare Revision Formula**

The Concessionaire and DMRC agree that after completion of the initial two years of operation, the Concessionaire shall be entitled for an increase in fare which shall be limited to 90% (ninety percent) of the variation in the WPI occurring between COD and two years after COD. Such revisions will also be permissible at the end of every two years thereafter till Termination.

Provided that for ease of payment and collection at the time of subsequent revisions such Fare shall be rounded off to the nearest five rupees in respect of pair of stations between Dwarka Sector 21 and IGI Airport and 10 (Ten) rupees in respect of other station pairs.

6.3 The Concessionaire hereby acknowledges and agrees that upon payment of Fare, any User shall be entitled to use the Project for travel and the Concessionaire shall not place or cause to be placed any restriction on such use except to the extent specified in any Applicable Law, Applicable Permit or the Provisions of this Agreement.

6.4 The Concessionaire thus acknowledges that the Fare Notification, inter alia, provides for revision in the Fare in accordance with the formula provided in Article 6.2 above and hereby confirms that save and except as provided in this Agreement and the Fare Notification, the Concessionaire is not entitled to and shall not seek any relief whatsoever from DMRC, GOI or GNCTD on account of increase or otherwise in WPI or on any other account except in accordance with the express provisions of this Agreement.

6.5 The Fares collected by the Concessionaire or DMRC or DMRC's nominee pursuant hereto shall be deposited in the Escrow Account and appropriated in accordance with the provisions of Article 23.

6.6 The value of Fares deducted from use of common DMRC/AMEL Stored Value Tickets, as apportioned to the Concessionaire by DMRC Central Clearing House, shall be accounted in the Escrow Account, in accordance with the provisions of Article 23.

6.7 The Concessionaire may delegate its right to collect Fares to the O&M Contractor or to any other person, provided however that notwithstanding such delegation, the Concessionaire shall be and remain solely liable and responsible for the collection of Fare in accordance with this Agreement and its deposit into the Escrow Account.

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ARTICLE 7
NON-FARE REVENUES

7.1 In addition to the right to charge and collect Fares, as set forth in Article 6, the Concessionaire shall be entitled to participate in Commercial Leases and other activities which may yield additional revenues to the Concessionaire, subject to the provisions of this Article 7. All such Non Fare Revenue collected by the Concessionaire pursuant hereto shall be deposited in the Escrow Account and appropriated in accordance with the provisions of Article 23. Such activities may include, *inter alia*, the following:

7.1.1 Advertisements

The Concessionaire shall be entitled, subject to all Laws and Regulations and to obtaining all necessary Consents, to display visual advertisements inside the rolling stock, the stations, or along the route. Without derogating from the aforesaid, should the Concessionaire wish to display advertisements, including stations, elevated alignment sections and/or tunnels, the Concessionaire shall bear full and sole responsibility for reaching all necessary agreements and obtaining all necessary Consents in relation thereto, including the consent of the Municipalities and any other Relevant Authority. However, display of advertisement within the Airport Boundary (either inside the stations or on other structures) is not permitted. Notwithstanding the provisions of Sub-Article 7.1.1, and without derogating from the provisions of Sub-Article 7.3, DMRC may instruct the Concessionaire to remove advertisements which it considers to be abusive or offensive or contrasting the public interest.

7.1.2 Vending Machines

The Concessionaire shall be entitled to install and operate vending machines in the un-paid area of the concourse level of New Delhi, Shivaji Stadium, and Dhuala Kuan stations, subject to the Laws and regulations and the provisions of this Agreement.

7.1.3 Communications

In addition to providing for its own communications needs, the Concessionaire shall be entitled to provide LCX cables and equipment in stations and tunnels for the operation of passenger mobile telephones, and provide a route for cables of commercial communications operators, subject to the provisions of all Laws and Regulations. The Concessionaire shall bear full and sole responsibility for obtaining all necessary Consents for such use, including any necessary licenses from any applicable Government Agency.

7.1.4 Additional Entrances from Adjacent Property

(i) The Concessionaire shall be entitled to design and construct, or to allow the design and construction of, additional entrances to the Stations from adjacent properties, provided however that the agreement executed for this purpose between the Concessionaire and any third party which holds the appropriate legal rights in such adjacent property shall be subject to the requirements and restrictions on Commercial Leases in Sub-Article 7.1.6.

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(ii) The Concessionaire shall bear full and sole responsibility for the compliance of any additional entrances from adjacent property with all Laws and Regulations, Standards and Codes and with the requirements of the applicable planning authority and for obtaining all necessary Consents in connection therewith. For the removal of doubt, where the execution of any such additional entrance requires an amendment to the Concessionaire's design the provisions of Sub-Article 10.1(d) shall apply.

7.1.5 **Retail and Service Outlets**

(i) The Concessionaire shall be entitled to design and construct, or to allow the design and construction of, shops, kiosks and the like within public areas of New Delhi, Shivaji Stadium and Dhaula Kuan Stations, provided however that the agreement executed for this purpose between the Concessionaire and any third party for any legal rights in such areas shall be subject to the requirements and restrictions on Commercial Leases in Sub-Article 7.1.6.

(ii) The Concessionaire shall bear full and sole responsibility for the continuous compliance of any shops, kiosks and the like within public areas of Stations with all Laws and Regulations, Standards and Codes, including with the requirements of NFPA 130 and/or any local codes applicable for the emergency evacuation of public areas, and with the requirements of the applicable planning authority and for obtaining all necessary Consents in connection therewith. For the removal of doubt, where the execution of any such additional entrance requires an amendment to the Concessionaire's design the provisions of Sub-Article 10.1(d) shall apply.

7.1.6 **Property Development and Development Rights**

(i) Subject to the limitations of the Site stated in Schedule 'A' and/or shown in the layout drawings in Schedule 'I', DMRC will allow the Concessionaire right and/or license to utilize the land over, under and around of the depot and within the stations for property development/commercial exploitation during the concession period with a view to improving the financial viability of the Project. The Concessionaire may construct, or cause or permit to have constructed, at his own cost, buildings and/or built-up areas in addition to the Required Buildings at the specified locations, after first obtaining the approval of DMRC in writing. All such buildings and/or built-up areas shall follow relevant building rules and regulations, Airport Authority of India (AAI) and fire safety regulations and all other applicable municipal approvals, statutory laws and regulations. Such development shall be subject to a Commercial Lease for a term not exceeding the remaining term of the Concession Period and shall be in a form and containing such conditions as may be prescribed by DMRC.

(ii) No property developed by the Concessionaire in accordance with this Sub-Article 7.1.6 shall be sold but shall only be let out for rental purpose during the Concession Period. Such buildings and/or built up area, with all the attendant facilities, developed by or on behalf of Concessionaire shall be handed over to DMRC at the Termination of the Concession free of encumbrances, and all moneys due or previously paid for the rights to such property beyond the Termination of the Concession Period shall be paid to DMRC, and all Commercial Leases entered into by the Concessionaire shall include provisions to this effect including that of termination prior to or concurrent with the Termination of the Concession.

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7.1.7 Additional Commercial Activities

In addition to the activities contained in Sub-Articles 7.1.1 (Advertisements), 7.1.2 (Vending Machines), 7.1.3 (Communications), 7.1.4 (Additional Entrances from Adjacent Property), 7.1.5 (Retail and Service Outlets), and 7.1.6 (Property Development and Development Rights), the Concessionaire shall be entitled to perform any other Non-Fare Revenue activity (each one an "Additional Commercial Activity") subject to the prior approval of DMRC. With respect to any such Additional Commercial Activity, the following provisions shall apply:

(i) Within a reasonable time in advance, and in any case not less than 60 (sixty) days in advance, of entering into any agreement in relation to any Additional Commercial Activity in which the Concessionaire may wish to be involved, the Concessionaire shall issue DMRC with a notice of such intention (a "Concessionaire's Notice of Additional Commercial Activity"). Such notice shall include a summary detailing the intended Additional Commercial Activity, any expected implications thereof on the Project, its Projected revenues, the works and the manpower required, any agreements which the Concessionaire intends to enter into in connection therewith and shall clearly identify, at a minimum:

(a) the degree to which the proposed Additional Commercial Activity may affect the quality of the Project or the likelihood of successful execution of the Project or may otherwise materially adversely affect the Project;

(b) the proposed Additional Commercial Activity may interfere with the relationship of DMRC with third parties;

(c) that the financial strength of the Concessionaire and/or the Contractor(s) is sufficient to perform the proposed Additional Commercial Activity;

(d) the degree to which the proposed Additional Commercial Activity materially affects the risks or costs to which DMRC is exposed;

(e) the degree to which the proposed Additional Commercial Activity materially affects the Concessionaire's ability to transfer the Project or the State's ability to receive and operate the Project upon the transfer thereof on the Termination Date.

(ii) DMRC shall examine the Concessionaire's Notice of Additional Commercial Activity, taking into consideration all relevant issues detailed in the Concessionaire's Notice of Additional Commercial Activity. In addition, DMRC shall examine whether the intended Additional Commercial Activity is considered, in its opinion, to be abusive or offensive or otherwise contrasting the public interest.

(iii) Where DMRC determines that, in its opinion, such Additional Commercial Activity is expected to adversely affect DMRC's interests in the Project or to otherwise contrast the public interest, it may, within 60 (sixty) days from receipt of the Concessionaire's Notice of Additional Commercial Activity, object to the Concessionaire's intended Additional Commercial Activity by instructing the Concessionaire and/or any

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subsidiary thereof to refrain from engaging in the intended Additional Commercial Activity.

(iv) If DMRC determines at any time after the aforementioned 60 (sixty) days period that the actual implications of the Additional Commercial Activity deviate or will deviate from the expected implications detailed in the Concessionaire's Notice of Additional Commercial Activity, and that the actual implications thereof have such an adverse effect on DMRC's interests in the Project and/or the public interest or are expected to have such effect, it may, notwithstanding the expiry of the aforementioned 60 (sixty) day period, exercise its right to object to such Additional Commercial Activity by instructing the Concessionaire and/or any subsidiary thereof to cease its engagement in the Additional Commercial Activity or refrain from any further Additional Commercial Activity in order to minimize to the extent possible or otherwise avoid any adverse effect on DMRC's interests in the Project and/or the public interest. The Concessionaire shall comply with DMRC's instructions and shall cause any subsidiary thereof to comply with the same.

7.2 Nothing contained in this Article 7 or any other provision of this Agreement shall be construed as derogating from the Concessionaire's full and sole responsibility for the feasibility and the exercise of the Non-Fare Revenue activities. The Concessionaire shall bear all costs deriving from the exercise of such activities. Without derogating from the generality of the forgoing, should the performance of any Non-Fare Revenue activity necessitate obtaining or amendment of any Consent, the Concessionaire shall bear full and sole responsibility for obtaining all necessary Consents in relation to such activity.

7.4 The Concessionaire shall ensure that all transactions are Arms Length Transaction and include binding provisions, giving effect to the to DMRC's rights under this Article 7 and the provisions of Article 30 for Divestment, are incorporated in all the relevant agreements procured by the Concessionaire and/or any Subsidiary thereof with respect to any Non-Fare Revenue activity, including provisions to allow for any changes to such agreements as may be necessitated by the exercise of DMRC's rights hereunder.

7.5 It is hereby clarified that nothing contained in this Article 7 shall be deemed as imposing any obligation on DMRC or any Government Agency to grant any Consent required by the Concessionaire for the purpose of generating any Non-Fare Revenue. This is mere an enabling provision and any proposal of Concessionaire may be refused without ascribing any reason for the same.

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ARTICLE 8
CONCESSION FEE AND OTHER PAYMENTS BY THE CONCESSIONAIRE

8.1 **License Fee**

In consideration of the grant of site and right of way under this Agreement, the License Fee payable by the Concessionaire to the DMRC shall be Re.10000.00 (Rupee Ten thousand) per year during the term of this Agreement

8.2 ***Concession Fee (as per Bid):***

The Concessionaire agrees to provide to DMRC cash payment as Concession Fee equal to the sum set forth in the Bid of the Bidder and accepted by DMRC namely, **Rs. 510,000,000 million (Rupees Five Hundred and Ten Million)** in accordance with the provisions of this Article 8.2 in the first year from COD. Further the above Concession Fee shall be increased by 5% (cumulative) every year thereafter and be paid annually till Termination.

The Concession Fee shall be paid in advance within 90 (ninety) days of the commencement of the year for which it is due and payable.

Additional retail space at Concourse level of New Delhi Station and Shivaji Stadium Station

In case the additional retail space is available to the concessionaire at concourse due to increase in the size of the station, the Concessionaire shall pay additional concession fee to DMRC on this account. The rate for this additional concession fee shall be on pro-rata basis as stated by the Concessionaire in Appendix-12B condition no.2 (Rs. 30 million for 960 sqm i.e. Rs. 31250/- per sqm). This additional concession fee shall be added to the concession fee of Rs. 510 million.

The enhancement applicable to the concession fee during subsequently years as per this clause, shall be on total concession fee including this additional concession fee.

Cost of operation and maintenance of clearing house to be shared: The cost of operation and maintenance of the sharing house will be shared by DMRC and Concessionaire.

8.3 **Percentage Revenue Sharing:**

Starting from COD, the Concessionaire further agrees to apportion its Gross Revenue to DMRC as follows:

a) One percent of Gross Revenue from first to fifth year

b) Two percent of Gross Revenue from sixth to tenth year

c) Three percent of Gross Revenue from eleventh to fifteenth year

d) five percent of Gross Revenue from sixteenth year onwards till the Termination Date

The Concessionaire shall remit the applicable share of Gross Revenue to DMRC on a quarterly basis within 10 days of the end of each calendar quarter.

8.4 DMRC at any time during the Concession Period, at its sole discretion can verify the Fare realized by the Concessionaire. DMRC for purpose of determining the true picture may undertake a traffic sampling for a continuous period of seven day or such other action as deemed fit. The numbers arrived at and duly verified by DMRC appointed Consultant and auditors for the purpose shall be considered final and binding on the Concessionaire. Similarly DMRC may verify the collection of non fare revenue also.

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SECTION –III
OBLIGATIONS AND UNDERTAKINGS

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ARTICLE 9
OBLIGATIONS OF DMRC

9.1 DMRC agrees to observe, comply and perform the following:

(a) DMRC at its own cost undertake, comply with and perform all its obligations set out in this Agreement or arising herein under

(b) enable access to the Site, free from Encumbrances, from public roads and highways in accordance with this Agreement progressively as per the agreed milestone;

(c) provide the Site in accordance with the programme given in Schedule 'H' and thereafter permit peaceful use thereof by the Concessionaire as licensee under and in accordance with the provisions of this Agreement without any let or hindrance from DMRC or persons claiming through or under it;

(d) upon written request from the Concessionaire and subject to the Concessionaire complying with the Applicable Laws, assist and provide all reasonable support to the Concessionaire in obtaining Applicable Permits;

(e) upon written request from the Concessionaire, assist the Concessionaire in obtaining access to all necessary infrastructure facilities and utilities, including water, electricity and telecommunication facilities at rates and on terms no less favourable to the Concessionaire than those generally available to commercial customers receiving substantially equivalent services;

(f) subject to and in accordance with the Applicable Law assist the Concessionaire in getting the government and police assistance to regulate the traffic on the Site.

(g) not do any act, deed or thing that may in any manner be violative of any of the provisions of this Agreement and.

(h) support, cooperate with and facilitate the Concessionaire in the implementation and operation of the Project in accordance with the provisions of this Agreement

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ARTICLE 10
OBLIGATIONS OF THE CONCESSIONAIRE

10.1 The Concessionaire shall at its own cost and expense observe, undertake, comply with and perform, in addition to and not in derogation of its obligations elsewhere set out in this Agreement, the following:

(a) make, or cause to be made, necessary applications to the relevant Governmental Agencies with such particulars and details, as may be necessary for obtaining all Applicable Permits, and obtain such Applicable Permits in conformity with the Applicable Laws;

(b) submit to DMRC certified true copies of each of the Project Agreements within 7 (seven) days of their execution;

(c) not enter into any Project Agreement the term of which extends beyond the Termination Date without DMRC's consent;

(d) not make any replacement, amendment or modifications to any of the Project Agreements without the prior written consent of DMRC;

(e) give DMRC not less than 30 (thirty) days written notice prior to entering into, amending or replacing any Project Agreement so as to enable DMRC to provide its consent or offer its comments, if any thereon which, if made, shall be duly considered and given effect to by the Concessionaire before entering into, amending or replacing such Project Agreement;

(f) remove promptly from the Project Site all surplus construction machinery and materials, waste materials (including, without limitation, hazardous materials and waste water), rubbish and other debris (including without limitation accident debris) and shall keep the Site in a neat and clean condition and in conformity with the Applicable Laws and Applicable Permits;

(g) procure, as required, the appropriate proprietary rights, licenses, agreements and permissions for materials, methods, processes and systems used or incorporated into the Project;

(h) provide to DMRC reports on regular basis during the Construction Period and the Operations Period in the form and manner set forth in this Agreement and Schedule 'W';

(i) acquire such real estate, as the Concessionaire may deem appropriate for the Additional Facilities and to indemnify and save harmless and defend GOI, DMRC, and GNCTD from and against all proceedings, claims, demands, costs, expenses, losses and damages arising out of or relating to the securing of rights to use such real estate by the Concessionaire

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(j) ensure and procure that each Project Agreement and Commercial Lease contains provisions that entitle DMRC to step into such agreement in its discretion in place and substitution of the Concessionaire in the event of Termination of this Agreement ;

(k) appoint, supervise, monitor and control the activities of Contractors under their respective Project Agreements as may be necessary;

(l) make reasonable efforts to maintain harmony and good industrial relations among the personnel employed in connection with the performance of the Concessionaire's obligations under this Agreement;

(m) comply with all Applicable Permits and Applicable Laws in the performance of the Concessionaire's obligations under this Agreement including those being performed by any of the Contractors;

(n) develop, implement and administer a safety, health and environment program for the Project, the users thereof, and the Contractors personnel engaged in the provision of any services under any of the Project Agreements including correction of safety violations and deficiencies, and taking of all other actions necessary to comply with the Schedule 'S' requirements and Applicable Laws;

(o) take all reasonable precautions for the prevention of accidents on or about the Project and provide assistance and emergency medical aid to accident victims;

(p) not to place or create and nor permit any Contractor or other person claiming through or under the Concessionaire to create or place any Encumbrance or security interest over all or any part of Site or the Project Assets, or on any rights of the Concessionaire therein or under this Agreement, save and except as expressly set forth in this Agreement;

(q) be responsible for safety, soundness and durability of the Project including all structures forming part thereof;

(r) not claim or demand possession or control of any roads, structures or real estate which do not form part of the Airport Metro Express Line;

(s) after receiving vacant possession of the Site or part thereof, ensure that such Site remains free from all encroachments and take all steps necessary to remove such encroachments, if any

(t) make such official payment to police department or any Government Agency as may be required for the provision of such services as are not provided in the normal course or are available on payment;

10.2 The Concessionaire shall submit to DMRC the drafts of the Project Agreements including in particular the EPC Contract, the Financing Documents, and the O&M Contract for its review. DMRC shall have the right but not the obligation to provide, and/or have the Consultant provide, comments and observations, if any, in respect of the Project Agreements within 30 (thirty) days of the receipt thereof by DMRC and the Concessionaire shall consider all such

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comments/observations. Any such comments/observations by DMRC and/or the Consultant on any Project Agreements or the failure to provide such comments shall not relieve or absolve in any manner whatsoever the Concessionaire of its obligations, duties and liabilities under this Agreement nor shall it make DMRC and/or Consultant liable to the Concessionaire in any manner whatsoever and shall be without prejudice to the rights of DMRC hereunder.

10.3 During the Construction Period, the Concessionaire shall be responsible for maintaining all such Sections of the Site as have been handed over to it, provided however that should any defect in any part of the DMRC Works become apparent within 12 (twelve) months of the handing over of that Section to the Concessionaire, the Concessionaire may so advise the Consultant and, if so, shall afford access to the relevant DMRC Works contractor for its correction.

10.4 The Concessionaire shall, at all times, afford access to the Site to the authorised representatives of DMRC, the Consultant, Senior Lenders, and to the persons duly authorised by any Governmental Agency having jurisdiction over the Project, including those concerned with safety, security or environmental protection to inspect the Project and to investigate any matter within their authority and upon reasonable notice, the Concessionaire shall provide to such persons reasonable assistance necessary to carry out their respective duties and functions with minimum disruption to the construction, operation and maintenance of the Project consistent with the purpose for which such persons have gained such access to the Site.

10.5 Structure of the Concessionaire and Obligations relating to the Change of Ownership

10.5.1 The Concessionaire has been incorporated as a validly existing company in the Companies Act, 1956 and shall remain a valid exiting active company from the date of incorporation of the Concessionaire, throughout the Concession period and as long as the Concessionaire has outstanding obligations and/ or guarantees towards DMRC.

10.5.2 From the date of incorporation of the Concessionaire and throughout Concession Period, the Concessionaire's and memorandum and articles of association shall not be materially amended, supplemented or otherwise modified unless agreed to by DMRC, and agreement not to be unduly withheld by DMRC.

10.5.3 From the date of incorporation of the Concessionaire and throughout the Concession Period, the Concessionaire shall remain a special purpose company with the sole purpose of observing and fulfilling the obligations of the Concessionaire in this Agreement, accepting the right granted thereto and performing other such activities directly connected to or such ancillary activities expressly permitted to in this Agreement.

10.5.4 Through out the Concession Period, the Concessionaire shall have no subsidiaries and/ or shareholdings and/ or other holdings in any company and/ or holding of securities convertible to shares of any company or options for such securities, except for holdings of securities registered on stock exchanges, which do not confer on the Concessionaire the status of an interested party and except for holding in subsidiaries established if any under the provisions of this agreement with prior written approval of DMRC and on such terms as stipulated by DMRC.

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10.5.5 The organizational structure and management of the Concessionaire and its personnel shall at all times be suited to and shall fully reflect the Concessionaire's compliance with its obligations under this agreement.

10.6 **Change in Ownership Structure of the Concessionaire**

10.6.1 The Concessionaire shall not undertake or permit any Change in Ownership except with the prior written approval of DMRC and except as permitted under this Agreement.

10.6.2 For the purpose of this Agreement, the Change of Ownership means any sale or other disposal other than to Affiliates of the transferor of any legal, beneficial or equitable interest in any or all of the equity share capital of the Concessionaire (including control over the exercise of voting rights conferred on that equity share capital or the control over right to appoint directors or other managers), which results in a structure of the Concessionaire other than the equity holders of the Concessionaire prior to change:

(i) Controlling the composition of the majority of the board of directors of the Concessionaire

(ii) Controlling the voting power of the board of directors or any class of shareholders of the Concessionaire

(iii) Holding directly or indirectly, more than one half of the equity of the Concessionaire

10.6.3 Notwithstanding anything contrary contained in this Agreement, during the Concession period following will apply with regard to share holding structure and Change of Ownership of the Concessionaire:

i. the aggregate equity share holding of the Consortium Members and their Associates in the issued and paid up equity share capital of the Concessionaire shall not be less than 100% (one hundred per cent) until the date falling 2 (two) years after COD and 51% (fifty-one per cent) for 10 (ten) years following COD,

ii. provided however that the equity share of the Lead Member of the Consortium in the issued and paid up share capital of the Concessionaire shall not be less than 30% (thirty per cent) until the date falling 2 (two) years after COD and 26% (twenty-six per cent) until the date falling 10 (ten) years after COD and that the purchaser of the Lead Member's equity share thereafter shall be subject to the prior approval of DMRC

iii. Further any Change of Ownership or change in equity structure of the Concessionaire shall be with prior consent of DMRC and shall be further subjected to the limitation that the new shareholder holders of the Concessionaire shall assume full responsibility under this Agreement including that of repayment of any residual loan of the Project.

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ARTICLE 11
REPRESENTATIONS AND WARRANTIES

11.1 Representations and Warranties of DMRC.

DMRC represents and warrants to the Concessionaire that:

(a) It has full power and authority to execute, deliver and perform its obligations under this Agreement and to carry out the transactions contemplated herein and that it has taken all actions necessary to execute this Agreement, exercise is rights and perform its obligations, under this Agreement.

(b) It has taken all necessary actions under the Applicable Laws to authorize the execution, delivery and performance of this agreement

(c) It has the financial standing and capacity to perform its obligations under the agreement

(d) This Agreement constitutes its legal, valid and binding obligation enforceable against it in accordance with the terms hereof; and

(e) DMRC is subject to the laws of India with respect to this Agreement and it hereby expressly and irrevocably waives any sovereign immunity in any jurisdiction in regard to matters set forth in this Agreement.

(f) It has complied with Applicable Laws in all material respects.

(g) All information provide by it in the Tender Notice and Invitation to Bid cum RFP in connection with the Project is to the best of knowledge or belief, true and accurate in all material respects.

(h) Upon the Concessionaire paying the Concession Fee and performing the covenants herein, it shall not at any time during the term hereof, interfere with the peaceful exercise of the rights and discharge of the obligations by the Concessionaire, in accordance with this Agreement

(i) To the extent DMRC has knowledge, there are no facts or information related to the Project and Disclosed Data relating to that which DMRC has intentionally not disclosed to the Concessionaire and which, if learned by the Concessionaire, might reasonably be expected to materially affect the Concessionaire's evaluation of the risks the Concessionaire is assuming pursuant to this Agreement or might reasonably be expected to deter the Concessionaire from completing the transactions contemplated by this Agreement on the terms of this Agreement

11.2 Representations and Warranties of the Concessionaire

The Concessionaire represents and warrants to DMRC that:

(a) It is duly organized, validly existing and in good standing under the laws of India and

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has taken the full power and authority to execute and perform its obligations under this Agreement and to carry out the transactions contemplated hereby

(b) It has taken all necessary corporate and other action under Applicable Laws and its constitutional documents to authorize the execution and delivery of this Agreement and to validly exercise its rights and perform its obligations under this Agreement.

(c) It has the financial standing and capacity to undertake the Project in accordance with the terms of this Agreement

(d) This Agreement constitutes its legal, valid and binding obligation enforceable against it in accordance with the terms hereof and its obligations under this Agreement will be legally valid, binding and enforceable obligations against it in accordance with the terms thereof.

(e) It is subject to laws of India with respect to this Agreement and it hereby expressly and irrevocably waives any immunity in any jurisdiction in respect of this Agreement on matters arising thereunder including any obligations, liability or responsibility hereunder.

(f) All the information furnished in the Bid is, and shall be, true and correct as on the date of this Agreement, Effective Date and COD and the Balance Sheet and Profit and Loss Account of the Concessionaire for each of its Accounting Years after the Effective Date furnished to DMRC shall give true and fair view of the affairs of the Concessionaire;

(g) It shall furnish a copy of the audited accounts of the Concessionaire within 120 (one hundred twenty) days of the close of its each Accounting Year after the Effective Date and any material change subsequent to the date of such accounts shall be notified to DMRC by the Concessionaire within 30 (thirty) days of its occurrence and warrants that the accounts and the information furnished as aforesaid shall be true and correct;

(h) The execution, delivery and performance of this Agreement will not conflict with, result in the breach of, constitute a default under or accelerate performance required by any of the terms of the Memorandum and Articles of Association of the Concessionaire or any Member of the Consortium or any Applicable Laws or any covenant, contract, agreement, arrangement, understanding, decree or order to which, it is a Party or by which it or any of its properties or assets is bound or affected;

(i) There are no actions, suits, proceedings, or investigations pending or, to the Concessionaire's knowledge, threatened against it at law or in equity before any court or before any other judicial, quasi judicial or other authority, the outcome of which may result in the breach of this Agreement or which individually or in the aggregate may result in any material impairment of its ability to perform any of its obligations under this Agreement

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(j) It has no knowledge of any violation or default with respect to any order, writ, injunction or any decree of any court or any legally binding order of any Governmental Agency which may result in any Material Adverse Effect or impairment of the Concessionaire's ability to perform its obligations and duties under this Agreement;

(k) It has complied with all Applicable Laws in all material aspects and has not been subject to any fines, penalties, injunctive relief or any other civil or criminal liabilities which in the aggregate have or may have Material Adverse Effect on its financial condition or its ability to perform its obligations and duties under this Agreement;

(l) Each Consortium Member was and is duly organised and existing under the laws of the jurisdiction of its incorporation and has full power and authority to consent to and has validly consented to and requested DMRC to enter into this Agreement with the Concessionaire pursuant to the LOA and has agreed to and unconditionally accepted the terms and conditions set forth in this Agreement;

(m) All rights and interests of the Concessionaire in and to the Project shall pass to and vest in DMRC on the Termination Date free and clear of all liens, claims, and Encumbrances without any further act or deed on the part of the Concessionaire or DMRC and that none of Project Assets including materials, supplies or equipment forming part thereof shall be acquired by the Concessionaire subject to any agreement under which a security interest or other lien or Encumbrance is retained by any person save and except as expressly provided in this Agreement; and

(n) No representation or warranty by the Concessionaire contained herein or in any other document furnished by it to DMRC, or to any Governmental Agency in relation to Applicable Permits contains or will contain any untrue statement of material fact or omits or will omit to state a material fact necessary to make such representation or warranty not misleading.

(o) The Consortium members and their Associates have the financial standing and resources to fund the required equity and to raise the debt necessary for undertaking and implementing the Project in accordance with this Agreement

(p) Each Consortium Member is duly recognized and validly existing under the laws of the jurisdiction of its incorporation, and has requested the Government to enter into this Agreement with the Concessionaire pursuant to the Letter of Acceptance, and has agreed to and unconditionally accepted the terms and conditions set forth in this Agreement.

(q) No representation or warranty by it contained herein or in any other document furnished by it to DMRC or to any other Government department in relation to Applicable Permits contains or will contain any untrue or misleading statement of material fact or omits or omit to state a material fact necessary to make such representation or warranty not misleading.

(r) No sums in cash or kind, have been paid or will be paid, by it or on its behalf, to any person by way of fees, commission or otherwise for securing the Concession or

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entering into this Agreement or for influencing or attempting to influence any officer or employee of DMRC or Consultants in connection therewith.

11.3 Disclosure

In the event that any occurrence or circumstance comes to the attention of either Party that renders any of the aforesaid representations or warranties untrue or incorrect, such party shall immediately notify the other Party of the same. Such notification shall not have the effect of remedying any breach of the representation or warranty that has been found to be untrue or incorrect nor shall it adversely affect or waive any obligation of either Party under this Agreement.

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ARTICLE 12
DISCLAIMER

12.1 The Concessionaire acknowledges that prior to the execution of this Agreement, the Concessionaire has after a complete and careful examination made an independent evaluation of the passenger demand, of the market for services and/or facilities, of the Specifications and Standards, and of the Site, of the Scope of the Project, Tender Notice, local conditions, physical qualities of ground, subsoil and geology and all the information provided by DMRC or gathered otherwise, and has determined to the Concessionaire's satisfaction the nature and extent of such difficulties, risks and hazards as are likely to arise or may be faced by it in the course of performance of its obligations hereunder.

12.2 Save as provided in Article 11.1, DMRC makes no representation whatsoever, express, implicit or otherwise, regarding the accuracy and /or completeness of the information provided by it and the Concessionaire confirms that it shall have no claim whatsoever against DMRC in this regard

12.3 Save as Article 11.1 (i), DMRC gives no warranty or guaranty of whatever nature in respect of Disclosed Data or data provided to the Concessionaire and specifically (but without limitation), DMRC does not warrant that the Disclosed data represents all of the information in its possession or power (either during conduct of the Concessioning process for the Project or at a time of this agreement) relevant or material to or in connection with the Project or the obligations of the Concessionaire under this Agreement or any of the Project Documents.

12.4 DMRC shall not be liable to the Concessionaire in respect of any failure to disclose or make available to the Concessionaire (whether before, on or after execution of this Agreement) any information, documents, data or any failure to review or update the Disclosed Data, nor any failure at any stage to inform the Concessionaire of any inaccuracy, error, omission, defects or inadequacy in the Disclosed Data. .

12.5 The Concessionaire acknowledges and hereby accepts the risk of inadequacy, mistake or error in or relating to any of the matters set forth in Sub-Article 12.1 above and hereby confirms that DMRC shall not be liable for the same in any manner whatsoever to the Concessionaire, the Consortium Members or their Associates or to any person claiming through or under any of them.

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SECTION – IV
DEVELOPMENT AND OPERATIONS

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ARTICLE 13
Use and Development of the Site

13.1 DMRC hereby grants to the Concessionaire for the Development Period access to the Site for carrying out such surveys, investigations and/or tests as the Concessionaire may deem necessary. Such surveys, investigations and/or tests are to be carried out at the Concessionaire's cost, expense and risk and without causing disruption to the DMRC Works.

During the Development Period and the Construction Period, and subject to giving prior written request, the Concessionaire shall be permitted to visit the DMRC Works under construction along with the Consultant, however DMRC is under no obligation to accept or to act on any comments or advice from the Concessionaire.

13.2 DMRC hereby grants to the Concessionaire for the Concession Period the access to the Site (as described in Schedule 'A') and to survey, design, engineer, procure, construct, operate and maintain the Project, in accordance with this Agreement. Such right and license of the Concessionaire to the use the Site shall be subject to:

(a) Any existing utilities on, under or above the Site are kept in continuous satisfactory use, if necessary by the use of suitable temporary or permanent diversions with the authority of the controlling body of that utility;

(b) Any existing roads or right of ways are kept in continuous satisfactory use, if necessary, by the use of suitable temporary or permanent diversions with the authority of the controlling body of that road or right of way. For any diversion or construction, of temporary roads, DMRC will assist the Concessionaire in acquiring the right of way;

(c) Subject to compliance with the Concessionaire's Safety Plan then in effect, a right of access by the DMRC itself and any of its agents to perform their obligations and rights under the Concession Agreement or any other functions that they have, and to conduct any study or trial for the purpose of research;

(d) DMRC retains the right to cross the Project above and/or outside the scheduled fixed and moving dimensions of the Project without in any way adversely affecting the development and or operation of the Project

(e) It is expressly agreed that trees on the Site are property of the Government and that Concessionaire will preserve all the trees and if any such tree is required to be necessarily cut the same shall be done only with prior approval of concerned Government Authority and under information to DMRC and the Consultant.

13.3 The license and the right to use the Site shall be granted for the purpose of carrying out the functions placed upon and exercising the rights granted to the Concessionaire under the Agreement, and not for any other purposes.

13.4 The Concessionaire shall bear all costs and charges for special and temporary rights of way required by it in connection with access to the Site. The Concessionaire shall obtain at its cost such facilities on or outside the Site as may be required by it for the purposes of the Project and the performance of its obligations under this Agreement.

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13.5 Not later than the Start Date, the Concessionaire shall commence the Concessionaire's Works on the Project and complete them in accordance with this Agreement. It is expressly agreed that because of the urgency, importance and tight time schedule of the Project, the Concessionaire to start the execution of the work within 30 days from the Letter of Acceptance (Start Date). This means that the execution on the Project will start well before the Available Date.

13.6 The Site shall be made available to the Concessionaire pursuant hereto by DMRC free from all Encumbrances and occupations and without the Concessionaire being required to make any payment to DMRC on account of any costs, expenses and charges for the use of such Site for the duration of the Concession Period save and except as otherwise expressly provided in this Agreement.

13.7 DMRC shall procure for the Concessionaire access to each Section of the Site, free of Encumbrances, including connection to at least one adjacent public road or highway, not later than the date shown for that Section in Schedule 'H'. The Concessionaire undertakes to execute the implementation of the Concessionaire's Works in accordance with the milestones and time schedule set out in the Schedule 'H', as submitted by the Concessionaire within its Proposal and accepted after review by DMRC, and as may be amended by DMRC in accordance with the provisions of this Agreement. Without derogating from the generality of the foregoing, the Concessionaire acknowledges that the delivery of different Sections of the Site pursuant to Schedule 'H' and the execution of the Concessionaire's Works will be performed in stages, whether simultaneously or consecutively, and the provisions of this Agreement shall apply to each and all milestones for the achievement of such stages. Should any delay occur in the performance of any such milestone, for any reason whatsoever, the Concessionaire undertakes to minimize, and cause its Contractors and any other person acting on its behalf to minimize, such delay and to avoid, and cause its Contractors and any other person acting on its behalf to avoid, any additional delays in respect of the performance of other milestones.

13.8 Except in the case of Force Majeure or specific suspension of the work by DMRC (in which case provision of Article 26 & 27 will apply) for reasons not attributable to the Concessionaire, if the Concessionaire fails to achieve any such Project milestone in Schedule H other than Project Completion, within a period of 90 (ninety) days from the date set forth in Schedule "H' (as such may be subject to any adjustment provided under Sub-Article 13.9), then it shall pay Damages to DMRC at the rate of Rs. 200,000.00 (Rs. Two Lac) per day until such milestone is achieved. DMRC may either recover such Damages from the Performance Security or demand payment thereof from the Concessionaire. The Concessionaire shall make such payment within 15 (fifteen) days of receiving such demand from DMRC and any delay in making such payment shall attract interest at an annualised rate of SBI PLR plus two per cent. If the Concessionaire fails to achieve Project completion as per the Scheduled Project Completion Date as set forth in Schedule 'H' (as such may be subject to any adjustment provided under Sub-Articles 13.9 and/or 15.6), then it shall pay damages to DMRC as per Article 16.

13.9 If DMRC does not procure for the Concessionaire such access to any Section or Sections not later than the date(s) given in Schedule 'H' for any reason other than a Force Majeure Event or a breach of this Agreement by the Concessionaire, then the Consultant shall determine any adjustment to the Project Completion Schedule and, if applicable, to the Scheduled Project Completion Date and extension to the Concession Period to which the Concessionaire is entitled due to such delay and shall notify DMRC accordingly. DMRC shall adjust the Project Completion Schedule and Scheduled Project Completion Date and extend the Concession Period in accordance with the Consultant's recommendations.

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ARTICLE 14
PERFORMANCE OF THE DESIGN

14.1 In respect of the Concessionaire's obligations with respect to the Design of the Concessionaire's Works, the following shall apply:

(a) The design work shall commence within 30 (thirty days) of issue of Letter of Acceptance (Start Date).

(b) All interface related design issues (with all civil construction contractors and other designated contractors) shall be completed within 6 (six) months from the Start Date. For this purpose the Concessionaire shall maintain a design interface team and shall lead the design co-ordination with civil and designated contractors. DMRC and/or the Consultant shall co-ordinate such meetings at the written request of the Concessionaire. Any unresolved issue beyond this period shall be the responsibility of the Concessionaire and has to be resolved by the concessionaire at its cost.

(c) The Concessionaire shall submit his Design in 3 submittals as explained in Schedule 'D'.

(d) The Concessionaire shall prepare and submit with reasonable promptness and in such sequence as is consistent with the Project Completion Schedule, three copies each of all Design documents within each submittal to DMRC and the Consultant for review and comments.

(e) By forwarding the Design for review and comment in accordance with Sub-Article 14.1(a) above, the Concessionaire represents that it has determined and verified that the design and engineering including field construction criteria related thereto is in conformity with the Specifications, Standards and quality set forth in this Agreement for and in respect of the Airport Metro Express Line.

(f) Within 30 (thirty) days of the receipt of the Design, DMRC and the Consultant shall review the same and the Consultant shall collate its comments and with those of DMRC and convey the consolidated list to the Concessionaire with particular reference to the conformity or otherwise with the Specifications and Standards set forth in this Agreement. It is expressly agreed that notwithstanding any review and comment by DMRC and the Consultant on any Design document, or any failure of DMRC and/or the Consultant to provide any comments thereon, DMRC shall not be liable for the same in any manner whatsoever and the Concessionaire shall remain solely responsible for its Design and shall not be relieved or absolved in any manner whatsoever of its obligations, duties and liabilities as set forth in this Agreement. .

(g) If the comments of DMRC or the Consultant indicate that the Design is not in conformity with the Specifications and Standards set forth in this Agreement, such Design shall be revised by the Concessionaire to the extent necessary and resubmitted to DMRC for review and comments. The Consultant shall give the consolidated comments of DMRC and the Consultant, if any, within 15 (fifteen) days of the receipt of such revised Design provided, however, that any comments of DMRC or the Consultant, or the failure of DMRC or the Consultant to give any comments on

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such revised Design document, shall not relieve or absolve the Concessionaire of its obligation to conform to such Specifications and Standards.

(h) The Concessionaire shall not be obliged to await the comments of DMRC or the Consultant on the Design submitted pursuant hereto beyond the periods set forth in sub-Articles (d) and (e) above.

14.2 The Concessionaire shall be responsible for delays in Project Completion Schedule caused by reasons of any Design not being in conformity with the Specifications and Standards, and the Concession Period shall not be extended in any manner whatsoever on account of submission or revision of any Design.

14.3 Within 90 (ninety) days of the COD, the Concessionaire shall furnish DMRC with "as built" drawings reflecting the Airport Metro Express Line as actually designed, engineered and constructed. The "as built" drawings shall include, without limitation, updated versions of all drawings submitted as part of the Design, as well as an "as built" survey illustrating the layout of the Airport Metro Express Line and setback lines, if any, of the buildings and structures forming part of Project Facilities.

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ARTICLE 15
MONITORING AND SUPERVISION OF CONSTRUCTION

15.1 The Concessionaire shall, before commencement of construction of the Concessionaire's Works:

(a) submit to DMRC with due regard to Project Completion Schedule as set forth in Schedule 'H' and Scheduled Project Completion Date, its detailed supply, construction/installation, commissioning and testing time schedule and shall formulate and provide CPM/PERT charts for the completion of the said activities; and

(b) have requisite organisation and designate and appoint a Project manager and such other managers, officers and representatives as it may deem appropriate to supervise the Concessionaire's Works and to deal with the DMRC Representative and be responsible for all necessary exchanges of information required pursuant to this Agreement.

15.2 During the Construction Period, the Concessionaire shall furnish to DMRC and the Consultant monthly progress reports of actual progress of the Construction Works comprised in the Project and shall give all such other relevant information as may be required by DMRC and/or the Consultant.

15.3 The Consultant shall inspect the Concessionaire's Works periodically but at least once a fortnight during the Construction Period and make out an Inspection Report of such inspection (the "Inspection Report"). It shall send a copy of its Inspection Report to DMRC and the Concessionaire. The Concessionaire shall take necessary action to remedy the lapses, if any, stated in the Inspection Report for ensuring compliance with the provisions of this Agreement. Such inspection or submission of Inspection Report by the Consultant shall not relieve or absolve the Concessionaire of its obligations and liabilities hereunder in any manner whatsoever.

15.4 For the purposes of determining that Concessionaire's Works are being undertaken in accordance with the Specifications and Standards, the Consultant shall require the Concessionaire to carry out such Tests at such time and frequency and in such manner as may be necessary in accordance with the Specifications and Standards for quality assurance. The Concessionaire shall with due diligence carry out, or cause to be carried out, all such tests in accordance with the instructions of the Consultant and furnish the results of such tests forthwith to the Consultant. The Concessionaire shall promptly carry out such remedial measures as may be necessary to cure the defects or deficiencies, if any, indicated in such test results and furnish a report to the Consultant in this behalf.

15.5 If the Consultant or DMRC shall reasonably determine that the rate of progress of the implementation of the Concessionaire's Works is such that the Project Completion is not feasible on or before the Scheduled Project Completion Date by the Concessionaire, it shall so notify the Concessionaire about the same and the Concessionaire shall within 15 (fifteen) days thereof notify the DMRC and the Consultant about the steps it proposes to take to expedite progress and the period within which it shall achieve COD.

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15.6 (a) Upon recommendation of the Consultant or suo-moto DMRC may, by written notice, require the Concessionaire to suspend forthwith the whole or any part of the Concessionaire's Works if in the reasonable opinion of the DMRC such work is being carried on in a manner which threatens the safety of the works or of the users of the Project.

(b) The Concessionaire, shall upon instructions of the DMRC pursuant to sub-Article (a) above suspend the Concessionaire's Works or any part thereof for such time and in such manner as may be specified by DMRC and subject to sub-Article (c) below, the costs incurred during such suspension to properly protect and secure the Concessionaire's Works or such part thereof as is necessary in the opinion of the Consultant ("Preservation Costs"), shall be borne by the Concessionaire.

(c) If the suspension pursuant to Sub-Article (a) above, is caused by:

(i) any reason other than default or breach of this Agreement by the Concessionaire including breach of any of the obligations of the Concessionaire under this Agreement, the Preservation Costs shall be borne by the Concessionaire;

(ii) reason of default or breach of this Agreement by DMRC the Preservation Costs shall be borne by DMRC; or

(iii) reason of any Force Majeure Event, the Preservation Costs shall be borne by the Concessionaire save and except to the extent otherwise expressly provided in Article 26.

(d) If suspension of the Concessionaire's Works is for reasons not attributable to the Concessionaire, the Consultant shall determine any extension to the Project Completion Schedule, the Scheduled Project Completion Date and the Concession Period, to which the Concessionaire is reasonably entitled and shall notify DMRC accordingly. DMRC shall extend the Project Completion Schedule, the Scheduled Project Completion Date and the Concession Period in accordance with the recommendations of the Consultant. It is expressly agreed that any such extension shall be limited to a maximum period in such a manner that the COD is not later than the 15th day of September 2010. Both Concessionaire and DMRC confirm that time is the essence for the completion of Project as per Project Completion Schedule and both the Parties agree to cooperate with each other for completion of the Project strictly as per schedule.

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ARTICLE 16
COMMERCIAL OPERATION

16.1 Project Completion occurs when:

(a) In the opinion of the Commissioner for Rail Safety, as evidenced by his issuing a written clearance for the same, the Project Systems are capable of safe and reliable commercial operation by the Concessionaire; and

(b) the Consultant has verified the readiness of the Concessionaire's personnel (or those of the O&M Contractor, if and to the extent applicable) to operate and maintain the Project Systems.

On satisfaction of these two conditions the Consultant shall issue the Completion Certificate or Provisional Certificate, as the case may be, in the relevant form given in Schedule 'K'. The COD shall be the date stated by the Consultant in the Completion Certificate or the Provisional Certificate, as the case may be, in accordance with the provisions of Article 17.

16.2 The Project shall only be deemed to be ready for use by the public when the Completion Certificate or the Provisional Certificate is issued under this Agreement and the Concessionaire shall not levy and collect any Fare from any passenger carried until it has received such Completion Certificate or the Provisional Certificate.

16.3 The Concessionaire guarantees that the Project Completion shall be achieved not later than the Scheduled Project Completion Date of the 31st day of July 2010 or such revision to this date as may by made in accordance with the provisions of this Agreement.

16.4 If the Project Completion is not achieved by the Scheduled Project Completion Date for any reason other than conditions constituting Force Majeure or for reasons attributable to DMRC or any Governmental Agency, the Concessionaire shall pay to DMRC as Damages for delay in the achievement of the COD, an amount calculated at the rate of 0.5% (point five per cent) of the Performance Security per day of delay upto 15th September 2010. Thereafter the amount of Damages for the delay shall be 1% (one percent) of the Performance Security per day of delay.

16.5 If the COD does not occur within 2 (two) months from the Scheduled Project Completion Date, DMRC shall be entitled to Terminate this Agreement in accordance with the provisions of Sub-Article 29.2 and the Concessionaire shall not be entitled to any damage whatsoever in case of delay on its account.

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ARTICLE 17
TESTS

17.1 The Concessionaire shall engage the services of such Independent Assessors as the Commissioner of Metro Rail Safety may require to certify that any or all of the Project Systems are ready and capable for safe operation.

17.2 All Tests shall be conducted in accordance with Schedule 'J', the Specifications and Standards, and the Applicable Laws and Applicable Permits, or as required by the Independent Assessor. DMRC shall designate a DMRC Representative to witness and observe the Tests. All Tests shall be held in accordance with the schedule notified by the Concessionaire to the Independent Assessor, the Consultant and the DMRC Representative, who may either witness the Tests themselves or designate their representatives for this purpose, if they choose.

17.3 The Consultant shall monitor the results of the Tests to determine the compliance of the Airport Metro Express Line with the Specifications and Standards. The Concessionaire shall provide copies of all Test data including detailed Test results to the Consultant and DMRC.

17.4 At least 30 (thirty) days prior to the likely completion of the Project, the Concessionaire shall notify the Consultant and DMRC of the same and shall give notice of its intent to conduct any final Tests. The Concessionaire shall give to the Consultant and the DMRC at least 15 (fifteen) days' prior notice of the actual date on which it intends to commence the Tests and at least 10 (ten) days' prior notice of the commencement date of any subsequent Tests. The Consultant shall have the right to suspend or delay any Test if it is reasonably anticipated or determined during the course of the Test that the performance of the Project or any part thereof does not meet the Specifications and Standards.

17.5 The Concessionaire shall provide certificates from an Independent Assessor for the design and Tests of the Project Systems such that the Project can be safely and reliably placed in commercial operations. The Consultant shall be of the opinion that all parts of the Project have been completed, including passing all Tests not required or reviewed by the Independent Assessor, then the Consultant shall forthwith issue to the Concessionaire and DMRC a Completion Certificate in the form set forth in Schedule 'K'.

17.6 If the Independent Assessor shall certify the Tests of the Project Systems to be successful and that the Project can be legally, safely and reliably placed in commercial operations, even though certain works or things forming part thereof are not yet complete and/or Tests not required or reviewed by the Independent Assessor have not been passed (including, if applicable, any conditions made by the Commissioner of Metro Rail Safety in his written clearance), then the Consultant may, at the request of the Concessionaire, issue a provisional certificate of completion ("Provisional Certificate") substantially in the form set forth in Schedule 'K'. In such an event such Provisional Certificate shall have appended thereto a list of outstanding items signed jointly by the Consultant and the Concessionaire ("Punch List"). All Punch List items shall be completed by the Concessionaire within 90 (ninety) days of the date of issue of such Provisional Certificate. Subject to payment of Damages equal to Rs.200,000 (Rs. Two hundred thousand) per week or part thereof on account of any delay beyond the aforesaid period of 90 (ninety) days, the Concessionaire shall be entitled to a further period of upto 60 (sixty) days for completion of Punch List items. Upon completion of all Punch List items to the satisfaction of the Consultant, the Consultant shall issue the

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Completion Certificate to the Concessionaire. Failure to complete the Punch List items in the manner set forth in this Sub-Article 17.6 shall entitle DMRC to Terminate this Agreement in accordance with the provisions of Sub-Article 29.2.

17.7 If the Consultant certifies to DMRC and the Concessionaire that it is unable to issue the Completion Certificate or Provisional Certificate because of events or circumstances which excuse the performance of the Concessionaire's obligations in accordance with this Agreement and as a consequence thereof the Tests could not be held or had to be suspended, the Concessionaire shall re-schedule the Tests and hold the same as soon as reasonably practicable.

17.8 Upon receipt of a report from the Independent Assessor and/or the Consultant, or after conducting its own review or inspection, if DMRC is not satisfied with the results of any Tests, it shall within 7 (seven) days thereof notify the Concessionaire of its reasons to conclude that the Completion Certificate should not be issued, in which case the Concessionaire shall promptly take such action as will achieve such satisfaction. Such procedure shall be repeated as necessary after rectification and remedy of reasons/ causes by the Concessionaire on account of which the Tests were unsuccessful, until the Completion Certificate or Provisional Certificate has been issued in accordance with this Agreement by the Consultant.

17.9 The Concessionaire shall bear all the expenses relating to Tests under this Agreement.

17.10 In the event that DMRC retains the services of it own technical advisor in addition to the Independent Assessor, the Concessionaire and the Independent Assessor shall coordinate with DMRC appointed technical advisor and provide all documentation requested.

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ARTICLE 18
CHANGE OF SCOPE

18.1 DMRC may, notwithstanding anything to the contrary contained in this Agreement, require provision of such additional works and services which are not included in the Scope of the Project as contemplated by this Agreement ("Change of Scope"). Any such Change of Scope shall be made in accordance with the provisions of this Article 18. It is understood by both the Parties that such Change in Scope shall be of nature that it does not adversely affect the COD. All such changes shall be made by DMRC by an order (the "Change of Scope Order") issued in accordance with the procedure set forth in this Article 18.

18.2 **Procedure for Change of Scope**

(a) DMRC shall whenever it determines that a Change of Scope is necessary it shall issue to the Concessionaire a notice specifying in reasonable detail the works and services contemplated thereunder (the "Change of Scope Notice").

(b) upon receipt of such Change of Scope Notice, the Concessionaire shall with due diligence provide to DMRC and the Consultant such information as is necessary together with preliminary documentation in support of:

(i) the impact, if any, which the Change of Scope is likely to have on the Project Completion Schedule if the work is required to be carried out before COD, and

(ii) the cost to the Concessionaire of complying with such Change of Scope Notice (including, without limitation, material and labour cost information furnished in accordance with the current schedule of rates applicable to the works assigned by DMRC to its contractors, including the premium on such rates).

(iii) the options suggested for implementing the proposed Change of Scope and the effect, if any, each such option would have on the costs and time for the implementation thereof including a detailed breakdown by work classifications. Provided, however, that the costs of providing such information shall be reimbursed to the Concessionaire by DMRC to the extent such costs are certified to be reasonable by the Consultant.

(c) If DMRC desires, after receipt of information set forth in sub-Article (b) to proceed with the Change of Scope, it shall convey the desired option to the Concessionaire by issuing a Change of Scope Order and thereupon the Parties shall make good faith efforts to mutually agree upon the costs and time for implementing of the same. Upon reaching an agreement relating to such costs and time, DMRC shall issue a written confirmation of the Change of Scope Order and thereupon the Concessionaire shall proceed with performance of such order. In the event, the Parties are unable to agree, DMRC may, by issuing a confirmation in writing of such Change of Scope Order, require the Concessionaire to proceed with the performance of the Change in Scope Order pending resolution of such dispute.

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18.3 A change of Scope Order will be effective and binding upon issuance of a confirmation of such Change of Scope Order by DMRC. Notwithstanding a dispute regarding cost and time for implementation of such Change of Scope Order, the Concessionaire shall proceed with the performance of such Change of Scope Order promptly following DMRC's confirmation pursuant to Sub-Article 18.2(c). Pending resolution of such dispute, DMRC shall pay to the Concessionaire an amount equal to the costs and at such time(s) that are certified by the Consultant to be reasonable with final adjustments to be made in accordance with the resolution of dispute under the Dispute Resolution Procedure.

18.4 All claims by the Concessionaire pursuant to this Article 18 shall be supported by such documentation as is reasonably sufficient for DMRC to determine the accuracy thereof, including invoices from Contractors and subcontractors and certification of such claims by the Statutory Auditors.

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ARTCILE 19
OPERATION AND MAINTENANCE

19.1 During the Operation Period, the Concessionaire shall operate and maintain the Project by itself, or through O&M Contractors in accordance with this Agreement and, if required, shall modify, repair or otherwise make improvements to the Project to comply with Schedule L and Specifications, Standards and other requirements set forth in this Agreement, Applicable laws and Applicable Permits, and manufacturer's guidelines and instructions with respect to rail systems, and more specifically:

(a) provide suitably trained personnel for O & M activities at all times

(b) permitting safe, smooth and uninterrupted train service during normal operating conditions;

(c) charging, collecting and retaining the Fares in accordance with this Agreement;

(d) minimizing disruption to operations in the event of accidents or other incidents affecting the safety and use of the Airport Metro Express Line by providing a rapid and effective response and maintaining liaison procedures with emergency services. In case of disruption of services, the Concessionaire shall ensure to transfer all "Checked In" passenger and luggage to the airport within shortest possible time and by reasonable means at no extra cost to the passengers.

(e) undertaking routine maintenance including prompt repairs of any wear or damage found;

(f) carrying out periodic preventive maintenance to Project Assets including but not limited to track, rolling stock and operating systems;

(g) undertaking major maintenance such as track replacement, repair to structures, signaling and communication systems, overhauling of rolling stock, traction system, other equipments, etc;

(h) preventing with the assistance of concerned law enforcement agencies unauthorised entry to and exit from the Project;

(i) preventing with the assistance of the concerned law enforcement agencies encroachments on the Project and preserve the right of way of the Project;

(j) maintaining a public relations unit following best practices model to interface with and attend to suggestions from users of the Project, the media, Government Agencies, and other external agencies; and

(k) adherence to the safety, health and environmental standards and requirements set out in Schedule 'S'.

(l) operations and maintenance of all Project Assets diligently and efficiently and with accordance with the best industry practices;

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(m) maintaining punctuality and reliability in operating the Project;

(n) maintaining a high standard of cleanliness and hygiene on or about the Project;

19.2 Operations and Maintenance Manual

19.2.1 The Concessionaire shall, in consultation with the Consultant, prepare not later than 180 (one hundred and eighty) days before the Scheduled Project Completion Date, the operations and maintenance manual (the "Operations and Maintenance Manual") detailing the Concessionaire's procedures for the operation of the Project under normal, degraded and emergency conditions and for its regular and periodic maintenance, and shall ensure and procure that at all times during the Operations Period the Project is maintained in such a way, it complies with the Specifications and Standards and the operations and maintenance requirements set forth in Schedule L. The Concessionaire shall supply, two months before the COD, 10 (ten) copies of the Operations and Maintenance Manual to DMRC and 3 (three) copies to the Consultant.

19.2.2 The Operations and Maintenance Manual shall, in particular, include provisions for maintenance of Project Assets and shall provide for life cycle maintenance, routine maintenance and reactive maintenance which may be reasonably necessary for maintenance and repair of the Project Asset, including replacement thereof, such that its overall condition conforms to the best possible operating requirement.

19.2.3 Further, the Operations and Maintenance Manual shall also prescribe five year operating benchmarks to be achieved by the Concessionaire in consistence with the provisions of this Agreement.

19.3 Maintenance Programme

Not later than forty five (45) days before the beginning of each Accounting Year, the Concessionaire, during the Operation Period shall in consultation with the Consultant prepare and provide to DMRC, its proposed programme of preventive, urgent and other scheduled maintenance subject to the minimum maintenance requirements set forth in Operations and Maintenance Manual and in Schedule 'L' necessary to maintain the Project at all times in conformity with the Specifications and Standards (the "Maintenance Programme"). Such Maintenance Programme shall include but not be limited to the following:

(a) intervals and procedures for the carrying out of inspection of all elements of the Project;

(b) criteria to be adopted for deciding maintenance needs;

(c) preventive maintenance schedule;

(d) intervals at which the Concessionaire shall carry out periodic maintenance;

(e) intervals for major maintenance and the scope thereof; and

(f) line closures schedule for each type of maintenance (length and time).

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19.4 Maintenance shall include replacement of equipment/consumables, horticultural maintenance and upkeep of all Project Assets in good order and working condition. Maintenance shall not include the extension of any rail tracks, stations, depot or Railway Systems unless part of the Project.

19.5 The Concessionaire shall keep the stations, access areas and other public areas in a clean, tidy and orderly condition free of litter and debris.

19.6 During the Operations Period, the Concessionaire shall carry out upgrading of the Project Systems and/or modifications to the Project where such modification is necessary for the Project to operate in conformity with the Specifications and Standards prescribed under this Agreement or any subsequent revision thereto. Provided, that the Concessionaire shall notify DMRC of the proposed modifications along with details thereof at least fifteen days before commencing work on such modifications and shall reasonably consider such suggestions as DMRC may make within 15 (fifteen) days of receipt of such details by DMRC.

19.7 The Concessionaire may modify the Maintenance Programme as may be reasonable in the circumstances and the procedures specified in Articles 19.3 to 19.6 shall apply mutus mutandis to such modifications.

19.8 **Safety, Vehicle Breakdown and Accident**

19.8.1 The Concessionaire shall ensure safe conditions for the Users and in the case of unsafe conditions, track damage, vehicle breakdowns and accidents, the Concessionaire shall follow the relevant operating procedures, which shall include the removal of obstruction and debris expeditiously. Such procedures shall be in accordance with Applicable Laws, Applicable Permits and provisions of this Agreement.

19.8.2 The Concessionaire shall ensure that any interruption of operations is remedied without delay.

19.8.3 The Concessionaire shall ensure that the safety, health and environment standards and requirements specified in Volume III Schedule 'S' are strictly complied with. Compliance with Schedule 'S' will be monitored by the Consultant and a breach by the Concessionaire of its obligations in respect of this Schedule identified by the Consultant shall be notified immediately and is required to be cured within 24 hours of its notification notwithstanding inspection, reporting procedures outlined elsewhere in this Agreement.

19.8.4 Each Safety incident determined by the Safety Review Board (Volume III Schedule R), to be chargeable to the Concessionaire as a breach of this Agreement, shall lead to the award of a penalty point. A total of 5 (five) penalty points in any continuous period of 365 days shall constitute a Material Breach of this Agreement and the provisions of Article 29 shall apply.

19.9 **Emergency De-commissioning**

19.9.1 If, in the reasonable opinion of the Concessionaire there exists an emergency which warrants the immediate decommissioning and closure to passenger use of whole or any part of the Project, the Concessionaire shall be entitled to de-commission and close the whole or the relevant part of the Project to traffic for so long as such emergency and the consequences thereof warrant, provided however that such emergency decommissioning will be notified to

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DMRC promptly. DMRC may issue directions to the Concessionaire for dealing with such situations and the Concessionaire shall abide by such directions.

19.9.2 The Concessionaire shall re-commission the Project or the affected part thereof as quickly as practicable after the circumstances leading to its de-commissioning and closure have ceased to exist.

19.9.3 Save as otherwise permitted under Sub-Article 19.8, the Concessionaire shall not close any part of the Project for undertaking maintenance or repair works except with the prior written approval of the DMRC (which may delegate its authority to the Consultant). Such approval shall be sought by the Concessionaire through a written request to be made at least 7 (seven) days before the proposed closure, and shall be accompanied by particulars indicating the nature and extent of repair works, the area and/or section required to be closed, and the period of closure. The Concessionaire shall also furnish particulars indicating the minimum time required for completing such repair works. Within 5 (five) days of receiving such request, DMRC or the Consultant, as the case may be, shall grant permission with such modifications as it may deem necessary. Upon receiving such permission, the Concessionaire shall be entitled to close the area and/or section in accordance with such permission and re-open it within the period stipulated in such permission.

19.10 For any closure of all or part of the Project to passenger use during the first Operations Year, the Concessionaire shall pay Damages to DMRC calculated at the rate of 0.1% (zero point one percent) per day or part thereof of the average daily Fare of that Section until such time the Section has been re-opened for passenger use.

19.11 Save and except as otherwise be expressly provided in this Agreement, if the Project or any part thereof shall suffer any loss or damage during the Concession Period, from any cause whatsoever, the Concessionaire shall, at its cost and expense rectify and remedy such loss or damage forthwith in a manner so as to make the Project conform in every respect to the Specifications and Standards, quality and performance as prescribed by this Agreement.

19.12 In the event the Concessionaire does not maintain and/ or repair the Project or a part thereof upto and in accordance with the Specifications and Standards and/or in accordance with the Maintenance Programme or the Operations and Maintenance Manual, and shall have failed to commence remedial works within 30 (thirty) days of receipt of notice in this behalf from DMRC or the Consultant, or the O&M Inspection Report, as the case may be, DMRC shall, without prejudice to its rights under this Agreement, including Termination thereof, be entitled to undertake the repair and maintenance of the Project at the risk and cost of the Concessionaire and to recover the same from the Concessionaire. In addition to recovery of the aforesaid cost of repair and maintenance by DMRC, a sum equal to 25% (twenty five per cent) of such cost shall also be recovered by DMRC from the Concessionaire as Damages. DMRC shall have the right and the Concessionaire hereby expressly grants to DMRC the right to recover the same directly from the Escrow Account and for that purpose the Concessionaire hereby expressly authorises DMRC and hereby gives irrevocable instructions to the Escrow Bank to make payment from the Escrow Account in accordance with the instructions of DMRC under this Sub-Article.

19.13 In the event DMRC does not exercise its option to undertake the required repair and maintenance after expiry of the 30 (thirty) days period stipulated in Sub-Article 19.12 it shall

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recover Damages from the Concessionaire for default in operating and maintaining the Project in conformity with this Agreement. Such Damages shall be payable after the aforesaid period of 30 (thirty) days and until the default is cured. The amount of Damages shall be calculated for each day of default at the higher of the following, namely (a) at the higher of 0.5% (zero point five percent) of average daily Fare and (b) 0.1% (zero point one per cent) of the cost of such repair or rectification as estimated by the Consultant. Recovery of such Damages shall be without prejudice to the rights of DMRC under this Agreement, including the right of Termination thereof.

19.14 If the Concessionaire commences any works for curing any defects or deficiencies in the Project, it shall complete such works expeditiously in accordance with the provisions of this Agreement. If such works are carried out in a manner that results in a delay of more than 30 (thirty) days as compared to the time required in accordance with good industry practice, DMRC shall recover Damages from the Concessionaire as if a default had occurred under Sub-Article 19.13.

19.15 The Damages set forth in Article 19.13 may be assessed and specified forthwith by the Consultant, provided that DMRC may in its discretion recover a smaller sum as Damages, if DMRC determines that breach has been cured promptly and that the Concessionaire is otherwise in compliance of its obligations under such Agreement. The Concessionaire shall pay such smaller Damages, and even if it contests the Damages, the decision of Managing Director, Delhi Metro Rail Corporation shall be final and binding and the Dispute Resolution Procedure shall not apply.

19.16 The Concessionaire shall not be considered in breach of its obligations under this Agreement if any part of the Project is not available for passenger use after the COD on account of any of the following for the duration thereof:

(a) an event of Force Majeure;

(b) measures taken to ensure the safe use of the Project except when unsafe conditions occurred because of failure of the Concessionaire to perform its obligations under this Agreement;

(c) unsafe conditions directly caused by a defect in the DMRC Works which was not apparent at the time of handing over of the Section; or

(d) compliance with a request from DMRC or the directions of any Governmental Agency the effect of which is to close all or any part of the Project.

Notwithstanding the above, the Concessionaire shall keep all unaffected parts of the Project open to passenger use provided they can be safely operated.

19.17 Overriding powers of DMRC

19.17.1 If in the reasonable opinion of DMRC, the Concessionaire is in material breach of its obligations under this Agreement and, in particular, the Maintenance Requirements, and such breach is causing or likely to cause material hardship or danger to the Users, DMRC may, without prejudice to any of its rights under this Agreement including Termination thereof, by notice require the Concessionaire to take

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reasonable measures immediately for rectifying or removing such hardship or danger, as the case may be.

19.17.2 In the event that the Concessionaire, upon notice under Article 19.17, fails to rectify or remove any hardship or danger within a reasonable period, DMRC may exercise overriding powers under this Article 19.17 and take over the performance of any or all of the obligations of the Concessionaire to the extent deemed necessary by it for rectifying or removing such hardship or danger; provided that the exercise of such overriding powers by DMRC shall be of no greater scope and of no longer duration than is reasonably required hereunder; provided further that any costs and expenses incurred by DMRC in discharge of its obligations hereunder shall be deemed to be O&M Expenses, and DMRC shall be entitled to recover them from the Concessionaire in accordance with the provisions of Articles 19.13 to 19.17 along with the Damages specified therein.

19.17.3 In the event of a national emergency, civil commotion or any other act specified in Article 26.7, DMRC may take over the performance of any or all the obligations of the Concessionaire to the extent deemed necessary; provided that the exercise such control over the Project and give such directions to the Concessionaire as deemed necessary, provided that the exercise of such overriding powers of DMRC shall be of no greater scope and of no longer duration than is reasonably required which caused the exercise of such powers by DMRC.

19.18 DMRC as Operator:

DMRC is already operating the phase I of the Delhi Metro Project and shall be doing so for Phase II of the Project which is under implementation. DMRC has established their own Operating Organisation with proper training facilities. DMRC may take up the Train Operation of the Project, if so desired by the Concessionaire, at a fee as mutually agreed. However the Concessionaire shall be responsible for all the maintenance and other operational activities which are not taken up by DMRC as required for the Project.

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ARTICLE 20
MONITORING AND SUPERVISION DURING OPERATION

20.1 The Concessionaire shall undertake periodic inspection of the Project to determine the condition of the Project, including its compliance or otherwise with the Operations and Maintenance Manual, the Maintenance Programme, Specifications and Standards and the maintenance required and shall submit reports of such inspection ("Maintenance Reports") to DMRC and the Consultant. The scope and timing of such periodic inspections shall be scheduled in the Operations and Maintenance Manual.

20.2 DMRC shall review the Maintenance Reports and inspect the Project at least once a month during the Operations Period and make out an Inspection Report of such inspection (an "O&M Inspection Report"). DMRC shall send a copy of its O&M Inspection Report to the Concessionaire. The Concessionaire shall within 30 (thirty) days of the receipt of the O&M Inspection Report remedy the defects and deficiencies, if any, set forth in such O&M Inspection Report and submit its report in respect thereof to DMRC within the said 30 (thirty) days period (an "O&M Inspection Compliance Report"). Where the remedying of such defects or deficiencies is likely to take more than 30 (thirty) days in accordance with , the Concessionaire shall undertake the works in accordance with such practice and submit progress reports of such works every fortnight. The O&M Inspection Report may also require the Concessionaire to undertake such tests as may be specified by DMRC for the purpose of determining that the Project is at all times in conformity with the Specifications and Standards. The Concessionaire shall undertake such Tests without any delay and furnish a copy of the results thereof to DMRC along with a written statement specifying in reasonable detail the measures, if any, that it proposes to undertake for curing the defaults or deficiencies indicated in such results. Such inspection or submission of O&M Inspection Report by DMRC or submission of O&M Inspection Compliance Report by the Concessionaire shall not relieve or absolve the Concessionaire of its obligations and liabilities hereunder in any manner whatsoever.

20.3 DMRC may inspect the Project at any time for a review of the compliance by the Concessionaire with its maintenance obligations under this Agreement.

20.4 The Concessionaire shall furnish to DMRC within 7 (seven) days of completion of each calendar month during the Operations Period, a statement of Revenues in the form set forth in Schedule 'M' (the "Monthly Revenue Statement").

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ARTICLE 21
PASSENGER COUNTING

21.1 For the purpose of determination and/or verification of the actual usage of the Project, DMRC shall, in addition to inspection of Concessionaire's records, be entitled to undertake passenger counts at such frequency and in such manner as DMRC may deem appropriate. The Concessionaire shall provide all facilities and assistance as DMRC may reasonably require for undertaking such passenger counts.

21.2 If the data collected from passenger counting undertaken pursuant to Sub-Article 21.1 demonstrates that actual usage is more than the usage according to the records of the Concessionaire, the actual usage for the purposes of this Agreement shall be deemed to be the passenger numbers as determined by such DMRC passenger sampling pursuant to this Article 21.

21.3 The Concessionaire may, in consultation with DMRC, commission an independent agency to conduct the passenger counts under this Article. The report of such agency shall be furnished to DMRC for such use as it may deem fit.

21.4 In the event of any dispute arising as to the actual usage on the Project DMRC appointed independent auditors' decisions shall be final.

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SECTION - V
FINANCING ARRANGEMENTS

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ARTICLE 22
FINANCIAL CLOSE

22.1 The Concessionaire shall provide to DMRC a copy of the Financing Package furnished by it to the prospective Senior Lenders. As and when such Financing Package is agreed with the Senior Lenders. with or without modifications, and such agreement is confirmed by the signing of the agreed Financing Package by both the Concessionaire and the Senior Lenders, a copy of the same shall be furnished by the Concessionaire to DMRC forthwith.

22.2 Notwithstanding anything to the contrary contained in this Agreement, the Concessionaire covenants with DMRC that it shall achieve Financial Close within 180 (one hundred eighty) days from the date of LOA. If the Concessionaire shall fail to achieve Financial Close within the said 180 (one hundred eighty) days period, the Concessionaire shall be entitled to a further period of 60 (sixty) days subject to an advance weekly payment by the Concessionaire to DMRC of a sum of Rs.100,000 (Rupees one hundred thousand) per week or part thereof for any delay beyond the said 180 (one hundred eighty) day period, as Damages on account of such delay in achieving Financial Close within the said 180 (one hundred eighty) day period by the Concessionaire.

22.3 It is expressly understood by both the Parties that in view of time constrained nature of the Project, DMRC shall require the Concessionaire to start the work from the Start Date (30 days from the issue of Letter of Acceptance) from the Concessionaire's Equity portion of the capital even before the Financial Close is achieved and the Concessionaire shall be under obligation to start the work and continue the same to the satisfaction of DMRC. In the most unlikely event of the Concession being Terminated before achieving the Financial Close, the Concessionaire shall be entitled to payment of actual expenditure incurred on the work as specifically ordered by DMRC.

22.4 Notwithstanding anything to the contrary contained in this Agreement, DMRC shall be entitled to terminate this Agreement forthwith, without being liable in any manner whatsoever to the Concessionaire, by a communication in writing to the Concessionaire pursuant to Sub-Article 29.2 if the Concessionaire shall have failed to pay in advance the Damages to DMRC under and in accordance with Sub-Article 22.2 above.

22.5 Notwithstanding anything to the contrary contained in this Agreement, if the Financial Close shall not occur within 240 (Two hundred forty eighty) days including the extended period as set forth in Sub-Article 22.2 above, all rights, privileges, claims and entitlements, if any, of the Concessionaire under or arising out of this Agreement shall be deemed to have been waived by and to have ceased with the concurrence of the Concessionaire, and the Concession Agreement shall be deemed to have been terminated by mutual agreement of the Parties.

22.6 Upon Termination of this Agreement under Sub-Articles 22.4 or 22.5, DMRC shall be entitled to encash the Performance Security and appropriate the proceeds thereof as Damages. On the other hand, the Concessionaire shall be entitled for fair value of the actual work executed by it under specific orders of DMRC pending Financial Close.

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ARTICLE 23

ESCROW ACCOUNT

23.1 Opening of Escrow Account and Deposits into Escrow Account

On Financial Close, (in any case not later than 30 days of financial close) the Concessionaire shall open and establish the Escrow Account with a Bank (the "Escrow Bank") and all funds constituting the Financing Package for meeting the Concessionaire's capital costs shall be credited to such Escrow Account. During Operations Period all Fare and Non-Fare Revenues collected by the Concessionaire shall be exclusively deposited therein. In addition, any Fares collected by DMRC in exercise of its rights under this Agreement during the Concession Period and all disbursements or payments by DMRC to the Concessionaire pursuant hereto shall also, subject to the rights of deductions and appropriations therefrom of DMRC under this Agreement, be deposited by DMRC in the Escrow Account.

23.2 Disbursements from Escrow Account

23.2.1 The Concessionaire shall give, at the time of the opening of the Escrow Account, irrevocable instructions by way of an Escrow Agreement substantially in form set forth in Schedule 'Q' (the "Escrow Agreement") to the Escrow Bank instructing, inter alia, that the deposits into the Escrow Account shall, subject to Sub-Article 23.2.3, be appropriated in the following order every month and if not due in a month then appropriated proportionately in such month and retained in the Escrow Account and paid out therefrom in the month when due unless otherwise expressly provided in the instruction letter:

(i) All taxes due and payable by the Concessionaire;

(ii) All expenses in connection with and relevant to the Concessionaire's Works by way of payment to the EPC Contractor and such other persons as may be specified in the Financing Documents;

(iii) O&M Expenses subject to the ceiling, if any set forth in the Financial Documents

(iv) All License Fee, Concession Fee and Revenue Share due to DMRC from the Concessionaire under this Agreement;

(v) Any payments and Damages due and payable by the Concessionaire to DMRC pursuant to this Agreement; and

(vi) The whole or part of the expense on repair work including Fees collection expenses incurred by DMRC on account of exercise of any of its rights under this Agreement provided DMRC certifies to the Escrow Bank that DMRC had incurred such expenses in accordance with the provisions of this Agreement;

(vii) Monthly proportionate provision of Debt Service Payments due in an Accounting Year and payment of Debt Service Payments in the month when due;

(viii) Debt service in respect of Subordinate Debt ;

(ix) Any reserve requirements required to be settled in terms of Financial Documents

(x) Balance in accordance with the instructions of the Concessionaire.

23.2.2 The Concessionaire shall not in any manner modify the order of payment specified in Sub-Article 23.2.1 except with the prior written approval of DMRC.

23.3 Notwithstanding anything to the contrary contained in the Escrow Agreement and subject to the provisions contained in Sub-Articles 30.5 and Article 32, upon Termination of this Agreement, all amounts standing to the credit of the Project Escrow Account shall be appropriated and dealt with in the following order:

(a) all Taxes due and payable by the Concessionaire;
(b) all Concession Fees due and payable to DMRC under this Agreement;
(c) all accrued Debt Service Payment;
(d) any payments and Damages due and payable by the Concessionaire to DMRC pursuant to this Agreement, including Termination claims;
(e) all accrued O&M Expenses;
(f) any other payments required to be made under this Agreement; and
(g) balance, if any, on the instructions of the Concessionaire.

23.4 The instructions contained in the Escrow Agreement shall remain in full force and effect until the obligations set forth in Sub-Article 23.3 have been discharged.

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ARTICLE 24
INSURANCE

24.1 Insurance during the Construction Period:

Throughout the Construction Period the Concessionaire shall effect and maintain, or cause to be effected and maintained, in the joint names of DMRC and the Concessionaire and at no cost to DMRC, such insurances, including but not limited to insurance of the Concessionaire's Works and such Sections of the DMRC Works as he has been given use of and liability to third parties, up to such maximum sums as may be required under and in accordance with the Financing Documents, Applicable Laws and such insurance as the Concessionaire may reasonably consider necessary or desirable. The Concessionaire shall also effect and maintain such insurance as may be necessary for mitigating the risks that may devolve on DMRC as a consequence of any act of omission by the Concessionaire during the Construction Period. For the avoidance of doubt, the level of Insurance to be maintained by the Concessionaire after the repayment of Senior Lenders' dues in full shall be determined on the same principles as applicable for determining the level of Insurance prior to such repayment of Senior Lenders' dues.

24.2 Insurance during the Operations Period:

Not later than 4 months prior to the anticipated COD, the Concessionaire shall obtain and maintain in the names of DMRC and the Concessionaire and the O&M Contractor and at no cost to DMRC such insurance as may be required under any of the Financing Documents, Applicable Laws and such insurance as the Concessionaire may reasonably consider necessary or desirable during the Operations Period in respect of the Project and its operations. Provided, however, the level of insurance to be maintained shall, at all times, cover the full replacement costs of both the DMRC Works and the Concessionaire's Works and possible liability to Users and other third parties.

24.3 Without prejudice to the provisions contained in Article 24.2, the Concessionaire shall, during the Operation Period, maintain Insurance cover including but not limited to the following:

i. Loss, damage or destruction of the Project Assets, including assets handed over by DMRC to the Concessionaire, at replacement value;
ii. Comprehensive third party (including users) liability insurance including injury to or death of personnel of DMRC or others who may enter the Project area;
iii. The Concessionaire's general liability arising out of the Concession;
iv. Liability to third parties for goods or property damage;
v. Workman's compensation insurance;
vi. Any other insurance required to protect the Concessionaire, it's officers and employees (including that of the Contractor, if any), including all Force Majeure Events that are insurable and not otherwise covered in items (i) to (v) above.

24.4 For the sake of brevity, the aggregate of the maximum sums insured under the insurance taken out by the Concessionaire pursuant to this Article 24 are herein referred to as the "Insurance Cover".

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24.5 Evidence of Insurance Cover:

All insurance obtained by the Concessionaire in accordance with this Article 24 shall be maintained with insurer or reinsurers, and on terms acceptable to DMRC and to the Senior Lenders. Within thirty days of obtaining any insurance cover, the Concessionaire shall furnish to DMRC, copies of certificates of insurance, copies of the insurance policies signed by an authorised representative of the insurer and copies of all premia payment receipts in respect of such insurance received from each insurance carrier, and such insurance will not be cancelled, changed or not renewed until the expiration of at least 45 (forty five) days after written notice of such cancellation, change of non-renewal has been received by DMRC.

24.6 Remedy on Failure to Insure:

If the Concessionaire shall fail to effect and keep in force the insurance for which it is responsible pursuant hereto, DMRC shall have the option to keep in force any such insurance, and pay such premia and recover the costs thereof from the Concessionaire.

24.7 Waiver of Subrogation:

All insurance policies supplied by the Concessionaire shall include a waiver of any right of subrogation of the insurers thereunder against, inter alia, DMRC, and its assigns, subsidiaries, Affiliates, employees, insurers and underwriters and of any right of the insurers of any set-off or counterclaim or any other deduction, whether by attachment or otherwise, in respect of any liability of any such person insured under any such policy.

24.8 Concessionaire Waiver:

The Concessionaire hereby further releases, assigns and waives any and all rights of recovery against, inter alia, the DMRC, and its Affiliates, subsidiaries, employees, successors, permitted assigns, insurers and underwriters, which the Concessionaire may otherwise have or acquire in or from or in any way connected with any loss covered by policies of insurance maintained or required to be maintained by the Concessionaire pursuant to this Agreement (other than third party liability insurance policies) or because of deductible Articles in or inadequacy of limits of any such policies of insurance.

24.9 Application of Insurance Proceeds:

Unless otherwise required by the Financing Documents the proceeds from all insurance claims except those covering life and injury shall be paid to the Concessionaire by credit to the Escrow Account and the Escrow Agent shall, subject to its obligations under the Financing Documents, and notwithstanding anything contained in Article 23, apply such proceeds for any necessary repair, reconstruction, reinstatement, replacement, improvement, delivery or installation of the Airport Metro Express Line.

24.10 In the case of Termination of the Concession Agreement for what so ever reason it may be, the Concessionaire will assign all the insurance covers, benefits accruing there from and the insurance claims to DMRC.

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ARTICLE 25
ACCOUNTS AND AUDIT

25.1 The Concessionaire shall maintain full accounts of all Fares and Non-Fare Revenues derived/collected by it from and on account of use of the Airport Metro Express Line and of O&M Expenses and other costs paid out of the Project Escrow Account and shall provide copies of the said accounts duly audited and certified by the Concessionaire's Statutory Auditors within 120 (one hundred twenty) days of the close of each Accounting Year to which they pertain, during the subsistence of this Agreement. Such audited accounts shall form the basis of various payments by either Party under this Agreement. The Concessionaire shall also furnish, within one week of its publication, a certified copy of the audited accounts and annual report published by the Concessionaire under the Applicable Laws.

25.2 The Concessionaire shall appoint and have during the subsistence of this Agreement as its Statutory Auditors a firm of Chartered Accountants duly licensed to practice in India out of the mutually agreed list of 10 (ten) independent and reputable firms of Chartered Accountants in India (the "List of Chartered Accountants"). Subject to a 30 days notice to DMRC and the replacement Statutory Auditors being appointed from the List of Chartered Accountants, the Concessionaire may terminate the appointment of any Statutory Auditor appointed in accordance with this Article. The fees and expenses of the Statutory Auditors shall be borne by the Concessionaire.

25.3 On or before the thirtieth day of May each Year, the Concessionaire shall provide for the preceding Accounting Year a statement duly audited by its Statutory Auditors giving summarised information on (i) the passenger count for each class of passenger using the Airport Metro Express Line for each station and liable for payment of Fares therefore, (ii) Fares charged and the amount of Fares received, (iii) Non-Fare Revenues, and (iv) such other information as DMRC may reasonably require.

25.4 Notwithstanding anything to the contrary contained in this Agreement, DMRC shall have the right but not the obligation to appoint at its cost another firm of chartered accountants from the List of Chartered Accountants (the "Additional Auditor") to audit and verify all those matters, expense, costs, realisations and things which the Statutory Auditors of the Concessionaire, are required to do, undertake or certify pursuant to this Agreement.

25.5 DMRC shall have the right to appoint for the duration of the Operations Period as Concurrent Auditor a firm of Chartered Accountants from the List of Chartered Accountants (the "Concurrent Auditor") who shall undertake concurrent audit of the Concessionaire during the Operations Period. The charges and expenses of such Concurrent Auditor shall be borne by the DMRC.

25.6 In the event of their being any difference between the finding of the Additional Auditor or the Concurrent Auditor, as the case may be, and the certification provided by the Statutory Auditors of the Concessionaire, such Auditors shall meet to resolve such differences and if they are unable to resolve the same such disputed certification shall be resolved by recourse to the Dispute Resolution Procedure.

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SECTION – VI
FORCE MAJEURE

ARTICLE 26
FORCE MAJEURE

26.1 Force Majeure" shall mean any event or circumstance or combination of events or circumstances that has a Material Adverse Effect on either Party (the "Affected Party") but only if and to the extent that such events and circumstances are not within the Affected Party's reasonable control.

26.2 The Following circumstances and events shall constitute an event or circumstance of Force Majeure to the extent that they or their consequences satisfy the above requirements:

a) the effect of natural elements or other acts of God, including but not limited to any storm, flood, drought, lightening, earthquake, cyclone or other natural disaster;

b) fire, accident, breakage of facilities or equipment, structural collapse or explosion which the Party claiming to have been subject to Force Majeure demonstrates to have been attributable to a cause other than

i. inherent defects of any equipment, or
ii. circumstances within the reasonable control of the Affected Party or its contractors;

c) epidemic or quarantine

d) acts of war (whether declared or undeclared), sabotage, terrorism or acts of public enemy (, civil disturbances, revolution, rebellion or insurrection, exercise of military or usurped power or any attempt at usurpation of power;

e) radioactive contamination or ionization radiation

f) events of strikes, work to rule actions, go-slows or similar labour related problems caused in whole or in part by agitation or unrest except where such events which are site specific or attributable to the Party claiming relief.

26.3 **Duty to Report**

26.3.1 A Party claiming to be affected by an event of Force Majeure shall notify the other Party in writing of the occurrence of the event of Force Majeure as soon as reasonably practicable, and in any event, within 15(Fifteen) days after the Affected Party knew, or ought reasonably to have known, of its occurrence and the probable material effect that the event of Force Majeure is likely to have on the performance of its obligations under this Agreement.

26.3.2 Any notice pursuant to this Article 26.3.1 shall include full particulars of:

a) the nature and extent of the event of Force Majeure which is the subject of any claim for relief under this Article 26 with evidence in support thereof;

b) the estimated duration and the effect or probable effect which such event of Force Majeure is having or will have on the Affected Party's performance of its obligations under this Agreement; and

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c) the measures which the Affected Party is taking or proposes to take, to alleviate the impact of such event Force Majeure ; and
any other information the Affected Party wishes to present in support of its claim.

26.3.3 For so long as the Affected Party continues to claim to be affected by such event of Force Majeure, it shall continue to provide to the other Party, written reports on every alternate day, containing information as required by this Article 26 and such other information as the other Party may reasonably request the Affected Party to provide.

26.3.4 Any party claiming to have been affected by an event of Force Majeure shall not be entitled to any relief unless it has complied with all the provisions of Articles 26.3.1, 26.3.2, and 26.3.3 above.

26.4 Excuse from Performance of Obligations

An Affected Party who is rendered wholly or partially unable to perform its obligations under this Agreement shall be excused from performance of such of its obligations as are directly and materially adversely affected by the event of Force Majeure, provided however that:

a) an obligation to make any payment or meet any financial obligation shall not be excused on account of an event of Force Majeure, and
b) the suspension of performance of its obligations by the Affected Party shall be of no greater scope and of no longer duration than is reasonably necessitated by the event of Force Majeure, and
c) the Affected Party shall continue to make all reasonable efforts to mitigate or limit the damage to the other Party arising out of or as a result of the existence or occurrence of such event of Force Majeure and to cure the same with due diligence; and
d) when the Affected Party is able to resume performance of its obligations under this Agreement, it shall give to the other Party written notice to that effect and shall promptly resume performance of its obligations hereunder.
e) any Insurance Proceeds shall be entirely applied to repair, replace or restore the assets damaged on account of the Force Majeure event unless otherwise required by the Lenders.

26.5 **No Liability for Other Losses, Damages, etc.**

Save and except as expressly provided in this Article 26, neither Party shall be liable in any manner whatsoever to the other Party in respect of any loss, damage, cost, expense, claims, demands and proceedings relating to or arising out of the occurrence or existence of any event of Force Majeure or the exercise by it of any right pursuant to this Article 26.

26.6 In the event that the Parties are unable to agree in good faith about the occurrence or existence of a Force Majeure Event, such dispute shall be finally settled in accordance with the Dispute Resolution Procedure, provided however that the burden of proof as to the occurrence or existence of such Force Majeure Event shall be upon the Party claiming relief and/or excuse on account of such Force Majeure Event.

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SECTION – VII
SUSPENSION AND TERMINATION

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ARTICLE 27
MATERIAL BREACH AND SUSPENSION

27.1 If the Concessionaire shall be in Material Breach of this Agreement DMRC, shall be entitled in its sole discretion and without prejudice to its other rights and remedies under this Agreement including its right of Termination hereunder, to (i) suspend all or any of the rights of the Concessionaire under this Agreement including the Concessionaire's right to collect and appropriate all Fares and Non-Fare Revenues, and (ii) exercise the rights of the Concessionaire under this Agreement itself or authorise any other person to exercise the same during such suspension. Such suspension by DMRC shall be by a communication in writing to the Concessionaire and shall be effective forthwith upon the issue thereof to the Concessionaire. Any Fares and/or Non-Fare Revenues collected by or on behalf of DMRC during such suspension shall be deposited in the Escrow Account to the exclusion of the Concessionaire. Provided, however, that the period of such suspension under this Article 27 shall not exceed 120 (one hundred twenty) days, provided that upon written request from the Concessionaire and the Senior Lenders to DMRC it may increase to 180 days.

27.2 Subject to Sub-Article 27.1, DMRC shall have the right to utilise the proceeds of Fares and Non-Fare Revenues for meeting the costs incurred by DMRC to remedy and rectify the cause of such suspension and for defraying the O&M Expenses incurred during such suspension period. Provided, however, that if the Concessionaire is making diligent efforts to remedy and rectify such cause, then DMRC shall allow the Concessionaire reasonable time and opportunity for such remedy or rectification.

27.3 The suspension of the rights of the Concessionaire by DMRC pursuant to Sub-Article 27.1 above shall be revoked by DMRC forthwith upon the Concessionaire having remedied the Material Breach during such suspension period to the satisfaction of DMRC unless in the meantime this Agreement has been terminated by DMRC in accordance with Article 29.

27.4 At any time during the period of suspension under this Article 27, the Concessionaire may in writing notify to DMRC that it does not intend to cure the breach or default that had caused such suspension. Within 7 (seven) days of receipt of such notice, DMRC shall terminate this Agreement as if a Material Breach of this Agreement had occurred on account of a Concessionaire Event of Default.

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ARTICLE 28
COMPENSATION FOR BREACH OF AGREEMENT

28.1 In the event of Concessionaire being in Material Breach of this Agreement and such breach is cured before Termination, the Concessionaire shall pay to DMRC as compensation, all direct additional costs suffered or incurred by DMRC arising out of such breach by the Concessionaire, in one lump sum within 30 (thirty) days of receiving the demand or at the Concessionaire's option in 3 (three) equal semi-annual installments with interest an annualised rate of SBI PLR plus 2% (two per cent).

28.2 In the event of DMRC being in Material Breach of this Agreement and such breach is cured before Termination, DMRC shall pay to the Concessionaire as compensation, all direct additional costs suffered or incurred by the Concessionaire arising out of such breach by DMRC, in one lump sum within 30 (thirty) days of receiving the demand or at DMRC's option in 3 (three) equal semi-annual installments with interest an annualised rate of SBI PLR plus 2% (two per cent).

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ARTICLE 29
TERMINATION

29.1 Termination for the Concessionaire Event of Default

29.1.1 Concessionaire Event of Default

The following events shall constitute an event of default by the Concessionaire (a "Concessionaire Event of Default") unless such Concessionaire Event of Default has occurred as a result of DMRC Event of Default or a Force Majeure Event;

(i) The Concessionaire fails to achieve Financial Close in accordance with the provisions of Article 22;

(ii) The Concessionaire fails to achieve any Project milestone other than Scheduled Project Completion Date within the period set forth in Schedule 'H' and fails to cure such default within a period of 90 (ninety) days from the date of its occurrence,

(iii) The Concessionaire is in Material Breach of this Agreement;

(iv) The Concessionaire commits default in complying with any of the terms and conditions of this Agreement, save and except those defaults specifically identified or in respect of which Cure Period has been expressly provided in this Agreement, and fails to remedy or rectify the same within the period provided in a notice in this behalf from DMRC which shall:

(a) require the Concessionaire to remedy the breach or breaches referred to in such notice within 1 (one) month (or such longer period as may be agreed by the DMRC at its absolute discretion); or

(b) permit the Concessionaire to put forward within 15 days of such notice a reasonable programme for the remedying of the breach or breaches, such programme to specify in reasonable detail the manner in which such breach or breaches is or are proposed to be remedied and the latest date by which it is proposed that such breach or all such breaches shall be remedied.

(v) The Concessionaire creates any Encumbrance, charges or lien in favour of any person save and except as otherwise expressly permitted under Article 32;

(vi) The shareholding of the Consortium Members or of the Lead Member falls below the minimum then prescribed under Sub-Article 10.5 and the Concessionaire does not cure such default within 90 (ninety) days of its occurrence;

(vii) The transfer, pursuant to law of either (a) the rights and/or obligations of the Concessionaire under any of the Project Agreements, or (b) all or material part of the assets or undertaking of the Concessionaire except where such transfer in the reasonable opinion of DMRC does not affect the ability of the Concessionaire to perform, and the Concessionaire has the financial and technical capability to perform, its material obligations under the Project Agreements;

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(viii) A resolution is passed by the shareholders of the Concessionaire for the voluntary winding up of the Concessionaire;

(ix) The Concessionaire is adjudged bankrupt or insolvent or if a trustee or receiver is appointed for the Concessionaire or for any of its property that has a material bearing on the Project;

(x) Any petition for winding up of the Concessionaire is admitted by a court of competent jurisdiction or the Concessionaire is ordered to be wound up by Court except for the purpose of amalgamation or reconstruction provided that, as part of such amalgamation or reconstruction, the property, assets and undertaking of the Concessionaire are transferred to the amalgamated or reconstructed entity and that the amalgamated or reconstructed entity has unconditionally assumed the obligations of the Concessionaire under this Agreement and the Project Agreements, and provided that:

(a) the amalgamated or reconstructed entity has the technical capability and operating experience necessary for the performance of its obligations under this Agreement and the Project Agreements;

(b) the amalgamated or reconstructed entity has the financial standing to perform its obligations under this Agreement and the Project Agreements and has a credit worthiness at least as good as that of the Concessionaire as at the Financial Close; and

(c) each of the Project Agreements remains in full force and effect;

(xi) The Concessionaire is in Material Breach of this Agreement or any of the Project Agreements resulting in Concessionaire's incapacity to perform under this Concession Agreement to the satisfaction of DMRC;

(xii) An event of default of the Concessionaire under any of the Financing Documents has occurred or any of the Senior Lenders has recalled its loan under any of the Financing Documents;

(xiii) The Concessionaire abandons the operations of the Airport Metro Express Line for more than 15 (fifteen) consecutive days without the prior consent of DMRC, provided that the Concessionaire shall be deemed not to have abandoned such operation if such abandonment was (i) as a result of Force Majeure Event and is only for the period such Force Majeure is continuing, or (ii) is on account of a breach of its obligations by DMRC.

(xiv) The Concessionaire repudiates this Agreement or otherwise evidences an intention not to be bound by this Agreement;

(xv) The Concessionaire suffers an execution being levied on any of its assets/ equipment causing a Material Adverse Effect on the Project and allows it to be continued for a period of 15 (fifteen) days; or

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(xvi) The Concessionaire has delayed any payment that has fallen due under this Agreement if such delay exceeds 90 (ninety) days.

29.1.2 Save and except as otherwise provided in Sub-Article 29.2, and without prejudice to any other right or remedy which DMRC may have in respect thereof under this Agreement, upon the occurrence of any breach or default by the Concessionaire under this Agreement including any Concessionaire Event of Default, DMRC shall be entitled to terminate this Agreement by a communication in writing (the "Termination Notice") to the Concessionaire if the Concessionaire has failed to cure such breach or default within the period provided for the same in this Agreement provided that before issuing the Termination Notice, DMRC shall by a notice in writing inform the Concessionaire of its intention to issue the Termination Notice (the "Preliminary Notice") and grant 15 (fifteen) days time to the Concessionaire to make its representation, if any, against such intended Termination Notice and shall after the expiry of said 15 (fifteen) day period whether or not it is in receipt of such representation, in its sole discretion issue the Termination Notice.

29.1.3 Subject to Sub-Article 29.2, the following shall apply in respect of cure of any of the defaults and/or breaches of this Agreement.

(i) The Cure Period shall commence from the date on which a notice in writing is delivered by DMRC to the Concessionaire asking the latter to cure the breach or default specified in such notice.

(ii) The Cure Period provided in this Agreement shall not relieve the Concessionaire from liability for Damages caused by its breach or default;

(iii) The Cure Period shall not in any way be extended by any period of suspension under this Agreement;

(iv) If the cure of any breach by the Concessionaire requires any reasonable action by Concessionaire that must be approved by DMRC or the Consultant hereunder the applicable Cure Period (and any liability of the Concessionaire for damages incurred) shall be extended by the period taken by DMRC or the Consultant to accord their required approval.

29.2 Notwithstanding anything to the contrary contained in this Agreement, in the event of the Concessionaire being in default under any of the provisions hereof expressly providing for Termination under or in accordance with this Sub-Article 29.2, DMRC shall be entitled to terminate this Agreement forthwith by issuing a Termination Notice to the Concessionaire and upon issue of such Termination Notice by DMRC this Agreement shall stand terminated forthwith.

29.3 Notwithstanding anything to the contrary contained in this Agreement, in the event of a Termination Notice being issued by DMRC the Senior Lenders may exercise the rights of step-in or substitution as provided in the Substitution Agreement to be entered into among the Concessionaire, DMRC and Senior Lenders in the form set forth in Schedule 'U'. Provided, however, that in the event of such step-in or substitution, DMRC shall allow an additional Cure Period of 90 (ninety) days prior to Termination to enable the substituting entity to cure any breach or default subsisting on the day of such step-in or substitution. On the exercise of

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the rights substitution in accordance with the Substitution Agreement and with this Sub-Article 29.3, the entity substituting the Concessionaire shall thereafter be deemed to be the Concessionaire under this Agreement and shall enjoy all rights and be responsible for all obligations under this Agreement as if it were the Concessionaire

29.4 Upon Termination by DMRC on account of a Concessionaire's event of Default during the Operations Period, DMRC shall pay to the Concessionaire by way of Termination Payment an amount equal to 80% (eighty percent) of the Debt Due. For the avoidance of doubt, the Concessionaire hereby acknowledges that no Termination Payment shall be due or payable on account of a Concessionaire's Default occurring prior to COD.

29.5 Termination for DMRC Event of Default.

29.5.1 The Concessionaire may after giving 90 (ninety) days notice in writing to DMRC terminate this Agreement upon the occurrence and continuation of any of the following events (each a "DMRC Event of Default"), unless any such DMRC Event of Default has occurred as a result of Concessionaire Event of Default or due to a Force Majeure Event.

(i) DMRC is in breach of this Agreement and such breach has a Material Adverse Effect on the Concessionaire and DMRC has failed to cure such breach or take effective steps for curing such breach within 90 (ninety) days of receipt of notice in this behalf from the Concessionaire;

(ii) DMRC repudiates this Agreement or otherwise evidences an irrevocable intention not to be bound by this Agreement;

(iii) GoI or GNCTD or any Governmental Agency have by an act of commission or omission created circumstances that have a Material Adverse Effect on the performance of its obligations by the Concessionaire and have failed to cure the same within 90 (ninety) days of receipt of notice by DMRC in this behalf from the Concessionaire;

(iv) DMRC has delayed any payment that has fallen due under this Agreement if such delay exceeds 90 (ninety) days.

29.5.2 Upon Termination by the Concessionaire on account of DMRC Event of Default, DMRC shall pay to the Concessionaire, by way of Termination Payment, an amount equal to

a) Debt Due;

b) 130% of the Adjusted Equity; and

c) Depreciated Value of the Project Assets, if any, acquired and installed on the Project after the 10th anniversary of the COD.

29.5.3 Upon Termination on expiry of the Concession Period by efflux of time, no Termination Payment shall be due and payable to the Concessionaire what so ever, provided that in the event, any Project Asset is acquired and installed on the Project within five years of the cessation of the Concession by normal efflux of time, with prior written consent of DMRC, then a Termination Payment equal to the Depreciated Value of such Project Assets shall be made by DMRC to the Concessionaire.

29.6 Termination in Case of Persisting Force Majeure

If a Force Majeure Event subsists for a continuous period of 120 (one hundred and twenty) days or more, either Party may in its sole discretion terminate this Agreement by giving 30 (thirty) days Termination Notice in writing to the other Party without being liable in any manner whatsoever, save as provided in this sub-article.

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Upon Termination of this Agreement pursuant to this, DMRC shall pay to the Concessionaire as Termination Payment an amount equal to:

a) 100% of the Debt Due;

b) Depreciated Value of the Project Assets, if any, acquired and installed in the Project after the 10th anniversary of the COD.

29.7 Upon Termination of this Agreement for any reason whatsoever, DMRC shall:

(a) take possession and control of Airport Metro Express Line forthwith;

(b) take possession and control forthwith of any materials, construction plant, implements, stores etc. on or about the Site;

(c) restrain the Concessionaire and any person claiming through or under the Concessionaire from entering upon the Site or any part of the Airport Metro Express Line; and/or

(d) succeed upon election by DMRC without the necessity of any further action by the Concessionaire, to the interests of the Concessionaire under such of the Project Agreement as DMRC may in its discretion deem appropriate and shall upon such election be required to compensate such contractors only for compensation accruing and becoming due and payable to them under the terms of their respective Project Agreements from and after the date DMRC elects to succeed to the interests of the Concessionaire as aforesaid. All sums claimed by such Contractors as being due and owing for work and services performed or accruing on account of any act, omission or event prior to such date shall constitute debt between the Concessionaire and such Contractors and DMRC shall in no way or manner be liable or responsible for such sums.

29.8 Termination Payments: The Termination Payment pursuant to this Agreement shall become due and payable to the Concessionaire by DMRC within thirty days of a demand being made by the Concessionaire with the necessary particulars duly certified by the Statutory Auditors. If DMRC fails to disburse the full Termination Payment within 30 (thirty) days, the amount remaining unpaid shall be disbursed along with interest an annualised rate of SBI PLR plus two per cent for the period of delay on such amount.

29.9 Mode of Payment: Payment of compensation of costs by DMRC pursuant to this Article 29 shall be made by way of credit to the Escrow Account and such payment shall constitute valid discharge of DMRC's obligations for Termination Payment hereunder.

29.10 Notwithstanding anything to the contrary contained in this Agreement, any Termination pursuant to the provisions of this Agreement shall be without prejudice to accrued rights of either Party including its right to claim and recover money damages and other rights and remedies which it may have in law or contract. All rights and obligations of either Party under this Agreement, including without limitation Termination Payments and Divestment procedures, shall survive the Termination of this Agreement to the extent such survival is necessary for giving effect to such rights and obligations.

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ARTICLE 30
DIVESTMENT OF RIGHTS AND INTERESTS

30.1 Upon Termination of this Agreement, the Concessionaire shall comply with the following:

(a) notify to DMRC forthwith the location and particulars of all Project Assets;

(b) deliver forthwith actual or constructive possession of the Airport Metro Express Line free and clear of all Encumbrances and execute such deeds, writings and documents as may be required by the DMRC for fully and effectively divesting the Concessionaire of all of the rights, title and interest of the Concessionaire in the Airport Metro Express Line and conveying the Airport Metro Express Line free of any charge or cost to DMRC; and

(c) comply with the Divestment Requirements set out in Sub-Article 30.2.

30.2 Upon Termination of this Agreement, the Concessionaire shall comply and conform to the following Divestment Requirements in respect of the Airport Metro Express Line:

(a) all Project Assets including the track, structure and equipment shall have been cured of all defects and deficiencies as necessary so that the Airport Metro Express Line is compliant with the Specifications and Standards set forth in this Agreement;

(b) all instruments, controls and alarms shall be in working condition;

(c) the Concessionaire delivers relevant records and reports pertaining to the Airport Metro Express Line and its design, engineering, construction, operation, and maintenance including all operation and maintenance records and programmes and manuals pertaining thereto and complete as built drawings on the Divestment Date;

(d) the Concessionaire executes such deeds of conveyance, documents and other writings as the DMRC may reasonably require to convey, divest and assign all the rights, title and interest of the Concessionaire in the Airport Metro Express Line free from all Encumbrances absolutely and free of any charge or tax unto the DMRC or its Nominee; and

(e) the Concessionaire complies with all other requirements as may be prescribed under Applicable Laws to complete the divestment and assignment of all the rights, title and interest of the Concessionaire in the Airport Metro Express Line free from all Encumbrances absolutely and free of any charge or tax to DMRC or its nominee.

30.3 In order to assist DMRC, or a replacement to the Concessionaire appointed by the Senior Lenders in accordance with the Substitution Agreement, with assuming operations in the event that the Concessionaire ceases to operate and maintain the Airport Metro Express Line for whatever reason, the Concessionaire will be responsible for preparing and updating a Handover Package. The Handover Package must include details of all the matters listed in Schedule 'T'. The Concessionaire must update the Handover Package regularly and in the same manner as a competent provider of similar services would do and promptly provide an electronic and 2 hard copies of the updated Handover Package to DMRC. For each version of the Handover Package provided to DMRC, the Concessionaire must provide written confirmation to the DMRC that the Handover Packages contains the information required

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under Schedule 'T'. Where the Concessionaire decides that the Handover Package is not required to be updated in a 6 month period on the basis that it is already up to date, the Concessionaire must advise DMRC in writing within 20 Business Days after the end of each 6 month period that the Handover Package is up to date. The Concessionaire must also retain copies of the most recent version of the Handover Package and provide these to any new operator nominated by DMRC or appointed as the replacement by the Senior Lenders in accordance with the Substitution Agreement.

30.4 Not earlier than 3 (three) months before the expiry of the Concession Period but not later than 30 (thirty) days before such expiry, or in the event of earlier Termination of this Agreement, immediately upon but not later than 15 (fifteen) days from the date of issue of Termination Notice, DMRC shall verify, in the presence of a representative of the Concessionaire, compliance by the Concessionaire with the Divestment Requirements set forth in Sub-Article 30.2 in relation to the Airport Metro Express Line and, if required, cause appropriate tests to be carried out at the Concessionaire's cost for determining the compliance therewith. If any shortcomings in the Divestment Requirements are found by either Party, it shall notify the other of the same and the Concessionaire shall rectify the same at its cost. The provisions of Article 31 shall apply mutatis mutandis in relation to repair or curing of defects under this Article 30.

30.5 Upon the Concessionaire conforming to all Divestment Requirements and handing over actual or constructive possession of the Airport Metro Express Line to DMRC or a person nominated by DMRC in this regard, DMRC shall issue a certificate substantially in the form set forth in Schedule 'V' (the "Vesting Certificate") which will have the effect of constituting evidence of divestment of all rights, title and lien in the Airport Metro Express Line by the Concessionaire and their vesting in DMRC pursuant hereto. Issue of the Vesting Certificate shall not be unreasonably withheld by DMRC. The divestment of all rights, title and lien in the Airport Metro Express Line shall be deemed to be complete on the date when all the Divestment Requirements have been fulfilled or the Vesting Certificate has been issued, whichever is earlier, it being expressly agreed that any defect or deficiency in any Divestment Requirement shall not in any manner be construed or interpreted as restricting the exercise of any rights by DMRC or its nominee on or in respect of the Airport Metro Express Line on the footing as if all Divestment Requirements have been complied with by the Concessionaire.

30.6 Notwithstanding anything to the contrary contained in this Agreement, any Termination Payments made by DMRC into the Escrow Account shall not be withdrawn therefrom for any purpose whatsoever until the Vesting Certificate has been issued by DMRC under this Article.

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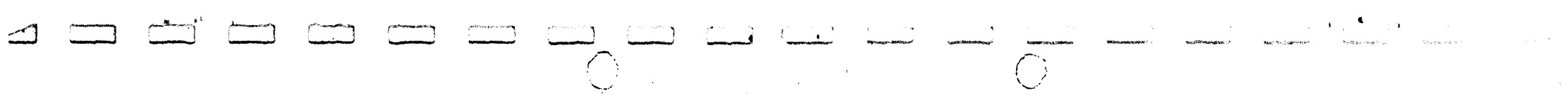

SECTION – VIII
MISCELLANEOUS

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ARTICLE 31
TRANSFER PROCEDURES ON EXPIRY OF THE CONCESSION

Not less than 30 months nor more than 36 months prior to the expiry of the Concession Period, the Concessionaire and DMRC shall conduct a joint inspection (the "Initial Inspection") of the Project.

31.1 Within 90 days after the completion of the Initial Inspection, the Concessionaire shall provide to DMRC a report on the condition of the Project and a notice setting out the Concessionaire's proposals as to the renewal works required to comply with the Divestment Requirements.

31.2 DMRC may, within 90 days after receipt of the notice from the Concessionaire in accordance with Sub-Article 31.2, by notice to the Concessionaire object to the proposals giving details of the grounds for such objection and shall give the Consultant's proposals in respect of the renewal works.

31.3 If no agreement is reached between the Concessionaire and DMRC within 30 days of receipt of such notice, then either the Concessionaire or DMRC may refer the matter to the Disputes Resolution Procedure.

31.4 Upon agreement, or determination in accordance with the Disputes Resolution Procedure as to what the scope of the renewal works shall be, the Concessionaire shall carry out the renewal works at its own cost.

31.5 Not less than 9 months nor more than 12 months prior to the expiry of the Concession Period, the Concessionaire and DMRC shall conduct a joint inspection (the "Second Inspection") of all elements of the Airport Metro Express Line (whether or not the Renewal Works have been carried out).

31.6 Within 30 days after the completion of the Second Inspection, the Concessionaire shall provide to DMRC a report on the condition of the Airport Metro Express Line and a notice setting out any revisions or additions to the renewal works required in order to ensure compliance with the Divestment Requirements.

31.7 DMRC may, within 30 days after receipt of the notice from the Concessionaire in accordance with Sub-Article 31.7, by notice to the Concessionaire object to the proposed revisions giving details of the grounds for such objection and shall give the Consultant proposals in respect of such matters.

31.8 If no agreement is reached between the Concessionaire and the Consultant within 30 days of receipt of such notice, then either the Concessionaire or the Consultant may refer the matter to the Dispute Resolution Procedure.

31.9 Upon agreement, or determination in accordance with the Disputes Resolution Procedure as to what the scope of remaining renewal works may be, the Concessionaire shall carry out the renewal works (as so revised) at its own cost.

31.10 From the date which is 2 years prior to the expiry of the Concession Period, a sum equal to the Fares realisable during the last two years of the Concession Period for a passenger

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31.11 volume equal to that actually recorded in the year immediately ended, or such higher sum estimated by DMRC as being the estimated cost for Renewal Works shall, notwithstanding anything to the contrary contained in this Agreement, be retained in the Escrow Account, provided that if a Bank Guarantee of an equivalent sum in the form and content acceptable to DMRC has been furnished by the Concessionaire to DMRC, no such retention shall be made.

31.12 If, following the Second Inspection, it is agreed or determined that no renewal works are required, then within 14 days of such agreement, 50% of the sums retained in accordance with Sub-Article 31.11 shall be released from the Escrow Account to the Concessionaire.

31.13 Within 14 days after the issue of the Vesting Certificate issued in accordance with Article 30 the sums retained in accordance with Sub-Article 31.11 shall be released from the Escrow Account to the Concessionaire.

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ARTICLE 32
ASSIGNMENTS AND CHARGES

32.1 Subject to Sub-Articles 32.3 and 32.4, this Agreement shall not be assigned by the Concessionaire save and except with prior consent in writing of DMRC, which consent DMRC shall be entitled to decline without assigning any reason whatsoever.

32.2 Subject to Sub-Article 32.3, the Concessionaire shall neither create nor permit to subsist any encumbrance over or otherwise transfer or dispose of all or any of its rights and benefits under this Agreement or any Project Agreements to which Concessionaire is a party except with prior consent in writing of DMRC, which consent DMRC shall be entitled to decline without assigning any reason whatsoever.

32.3 The restraint set forth in Sub-Articles 32.1 and 32.2 shall not apply to:

(a) liens arising by operation of law (or by an agreement evidencing the same) in the ordinary course of business of the Airport Metro Express Line;

(b) mortgages/pledges/hypothecation of goods/assets other than Project Assets, and those covered by the Substitution Agreement and their related documents of title arising or created in the ordinary course of business of the Airport Metro Express Line and as security only for indebtedness to the Senior Lenders under the Financing Documents and/or for working capital arrangements for the Airport Metro Express Line;

(c) assignment of rights, title and interest to or in favour of the Lenders pursuant to and in accordance with the Substitution Agreement in respect of financing by the Senior Lenders under the Financing Documents for the Project; and

(d) liens or encumbrances required by any Applicable Law.

32.4 Notwithstanding anything to the contrary contained in this Agreement DMRC may assign any of its rights and benefits and/or obligations under this Agreement pursuant to any direction of GOI or by operation of law or in the course of its own business.

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ARTICLE 33
CHANGE IN LAW

33.1 If as a result of Change in Law, the Concessionaire suffers an increase in costs or reduction in net after tax return or other financial burden, the aggregate financial effect of which exceeds Rs.10 million (Rupees ten million) in any Accounting Year, the Concessionaire may notify DMRC and propose amendments to this Agreement so as to put the Concessionaire in the same financial position as it would have occupied had there been no such Change in Law resulting in such cost increase, reduction in return or other financial burden as aforesaid. Upon notification by the Concessionaire as aforesaid, the Parties shall meet as soon as reasonably practicable but no later than 30 (thirty) days and either agree on amendments to this Agreement or on alternative arrangements to implement the foregoing.

33.2 If, as a result of Change in Law, the Concessionaire enjoys a reduction in costs or increase in net after tax return or other financial benefit, the aggregate financial effect of which exceeds Rs.10 million (Rupees ten million) in any Accounting Year, DMRC may so notify the Concessionaire and propose amendments to this Agreement so as to put the Concessionaire in the same financial position as it would have occupied had there been so such Change in Law resulting in such decreased cost, increase in return or other financial benefit as aforesaid. Upon notification by the DMRC as aforesaid, the Parties shall meet as soon as reasonably practicable, but no later than 30 (thirty) days and either agree on such amendments to this Agreement or on alternative arrangements to implement the foregoing.

Provided that if no agreement is reached as aforesaid by the Parties within 90 (ninety) days of the meeting pursuant to this Sub-Article 33.2, DMRC may by notice in writing require the Concessionaire to pay an amount that would put the Concessionaire in the same financial position it would have occupied had there been no such Change in Law resulting in such decreased cost, increase in return or other financial benefit as aforesaid. Such notice shall be accompanied by necessary particulars duly certified by the DMRC Representative. The Concessionaire shall make such payment within 15 (fifteen) days of receiving such notice or with interest an annualised rate of SBI PLR if the payment is delayed beyond such 15 (fifteen) days. If the Concessionaire shall dispute such claim of DMRC, the same shall be finally settled in accordance with the Dispute Resolution Procedure. The same will apply in case there is no agreement reached for payment delay by the Parties as stipulated above in case of any payment required to be made by DMRC to the Concessionaire regarding the change in law

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ARTICLE 34
LIABILITY AND INDEMNITY

34.1 **General Indemnity**

(a) The Concessionaire will indemnify, defend and hold DMRC harmless against any and all proceedings, actions and, third party claims (other than a claim by DMRC or GOI for loss, damage and expense of whatever kind and nature arising out of the design, engineering, construction, procurement, Operation and Maintenance of the Project or arising out of a breach by Concessionaire of any of its obligations under this Agreement except to the extent that any such claim has arisen due to DMRC Event of Default).

(b) DMRC will, indemnify, defend and hold harmless the Concessionaire against any and all proceedings, actions, third party claims for loss, damage and expense of whatever kind and nature arising out of defect in title and/or the rights of DMRC in the land comprised in the Site adversely affecting the performance of the Concessionaire's obligations under this Agreement and/or arising out of acts done in discharge of their lawful functions by DMRC, its officers, servants, agents, subsidiaries and contractors ("DMRC Indemnified Persons") including DMRC Events of Default except to the extent that any such claim has arisen due to a negligent act or omission, breach of contract or breach of statutory duty on the part of the Concessionaire, its Subsidiaries, Affiliates, contractors, servants or agents including due to Concessionaire Event of Default.

34.2 Without limiting the generality of Sub-Article 34.1 the Concessionaire shall fully indemnify, save harmless and defend DMRC including its officers, servants, agents and subsidiaries from and against any and all loss and damages arising out of or with respect to (a) failure of the Concessionaire to comply with Applicable Laws and Applicable Permits, (b) payments of taxes relating to the Concessionaire contractors, suppliers and representatives, income or other taxes required to be paid by the Concessionaire without reimbursement hereunder, or (c) non-payment of amounts due as a result of materials or services furnished to the Concessionaire or any of its Contractors which are payable by the Concessionaire or any of its contractors.

34.3 Without limiting the generality of the provisions of this Article 34, the Concessionaire shall fully indemnify, save harmless and defend the DMRC indemnified Person from and against any and all damages which the DMRC Indemnified Persons may hereafter suffer, or pay by reason of any demands, claims, suits or proceedings arising out of claims of infringement of any domestic or foreign patent rights, copyrights or other intellectual property, proprietary or confidentiality rights with respect to any materials, information , design or process used by the Concessionaire or by the Concessionaire's Contractors in performing the Concessionaire's obligations or in any way incorporated in or related to the Project. If in any such suit, claim or proceedings, a temporary restraint order or preliminary injunction is granted, the Concessionaire shall make every reasonable effort, by giving a satisfactory bond or otherwise, to secure the suspension of the injunction or restraint order. If, in any such suit claim or proceedings, the Concessionaire's Works, or any part, thereof or comprised therein is held to constitute an infringement and its use is permanently enjoined, the Concessionaire shall promptly make every reasonable effort to secure for DMRC a license, at no cost to DMRC, authoring continued use of the infringing work. If the Concessionaire is unable to

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secure such license within a reasonable time, the Concessionaire shall, at its own expense and without impairing the specifications and standards either replace the affected work, or part, or process thereof with non-infringing work or parts or process, or modify the same so that it becomes non-infringing.

34.4 In the event that either Party receives a claim from a third party in respect of which it is entitled to the benefit of an indemnity under this Article 34 (the "Indemnified Party") it shall notify the other Party ("Indemnifying Party") within 14 (fourteen) days of receipt of the claim and shall not settle or pay the claim without the prior approval of the Indemnifying Party, such approval not to be unreasonably withheld or delayed. In the event that the Indemnifying Party wishes to contest or dispute the claim it may conduct the proceedings in the name of the Indemnified Party subject the Indemnified Party being secured against any costs involved to its reasonable satisfaction.

34.5 **Defense of Claims**

34.5.1 The Indemnified Party shall have the right, but not the obligation, to contest, defend and litigate any claim, action, suit or proceeding by any third party alleged or asserted against such party in respect of, resulting from, related to or arising out of any matter for which it is entitled to be indemnified hereunder and their reasonable costs and expenses shall be indemnified by the Indemnifying Party. If the Indemnifying Party acknowledges in writing its obligation to indemnify the person indemnified in respect of loss to the full extent provided by this Article 34, the Indemnifying Party shall be entitled, at its option, to assume and control the defence of such claim, action, suit or proceeding liabilities, payments and obligations at its expense and through counsel of its choice provided it gives prompt notice of its intention to do so to the Indemnified Party and reimburses the Indemnified Party for the reasonable cost and expenses incurred by the Indemnified Party prior to the assumption by the Indemnifying Party of such defence. The Indemnifying Party shall not be entitled to settle or compromise any claim, action, suit or proceeding without the prior written consent of the Indemnified Party unless the Indemnifying Party provides such security to the Indemnified Party as shall be reasonably required by the Indemnified Party to secure, the loss to be indemnified hereunder to the extent so compromised or settled.

34.5.2 If the Indemnifying Party has exercised its rights under Sub-Article 34.4, the Indemnified Party shall not be entitled to settle or compromise any claim, action, suit or proceeding without the prior written consent of the Indemnifying Party (which consent shall not be unreasonably withheld or delayed).

34.5.3 If the Indemnifying Party exercises its rights under Sub-Article 34.4 then the Indemnified Party shall nevertheless have the right to employ its own counsel and such counsel may participate in such action, but the fees and expenses of such counsel shall be at the expense of such Indemnified Party, when and as incurred, unless:

(i) the employment of counsel by such party has been authorised in writing by the Indemnifying Party; or

(ii) the Indemnified Party shall have reasonably concluded that there may be a conflict of interest between the Indemnifying Party and the Indemnified Party in the conduct of the defence of such action; or

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(iii) the Indemnifying Party shall not in fact have employed independent counsel reasonably satisfactory to the Indemnified Party to assume the defence of such action and shall have been so notified by the Indemnified Party; or

(iv) the Indemnified Party shall have reasonably concluded and specifically notified the Indemnifying Party either:

(a) that there may be specific defences available to it which are different from or additional to those available to the Indemnifying Party; or

(b) that such claim, action, suit or proceeding involves or could have a material adverse effect upon it beyond the scope of this Agreement;

provided that if sub-Articles (ii), (iii) or (iv) shall be applicable, counsel for the Indemnified Party shall have the right to direct the defence of such claim, action, suit or proceeding on behalf of the Indemnified Party and the reasonable fees and disbursements of such counsel shall constitute legal or other expenses hereunder.

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ARTICLE 35
RIGHTS AND TITLE OVER THE SITE

35.1 The Concessionaire shall have exclusive rights to the use of the Site in accordance with the provisions of this Agreement and for this purpose it may regulate the entry and use of the Project by third parties.

35.2 The Concessionaire shall allow access to, and use of the Site for telegraph lines, electric lines or such other public purposes as DMRC may specify. Where such access or use causes any damage to the Project and consequent financial loss to the Concessionaire, it may seek compensation or damages from such user of the Site as per Applicable Laws.

35.3 For the purposes of the Concessionaire claiming tax depreciation, the property representing the capital investment made by DMRC shall be deemed to be acquired and owned by DMRC and not by the Concessionaire.

35.4 The Concessionaire shall not sublet the whole or any part of the Site save and except as may be expressly set forth in this Agreement provided however that nothing contained herein shall be construed or interpreted as restricting the right of the Concessionaire to appoint contractors for the performance of its obligations hereunder including for operation and maintenance of all or any part of the Project.

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ARTICLE 36
DISPUTE RESOLUTION

36.1 Amicable Resolution

(a) Save where expressly stated to the contrary in this Agreement, any dispute, difference or controversy of whatever nature howsoever arising under, out of or in relation to this Agreement including incompletion of the Project between the Parties and so notified in writing by either Party to the other (the "Dispute") in the first instance shall be attempted to be resolved amicably in accordance with the conciliation procedure set forth in Sub-Article (b) below.

(b) In the event of any Dispute between the Parties, either Party may call upon the Consultant to mediate and assist the Parties in arriving at an amicable settlement thereof. Failing mediation by the Consultant or without the intervention of the Consultant, either Party may require such Dispute to be referred to the Director, Airport Line as representative of DMRC and the Chairman of the Board of Directors as representative of the Concessionaire for amicable settlement. Upon such reference, the said two representatives shall meet not later than 7 (seven) days of the date of such request to discuss and attempt to amicably resolve the Dispute. If such meeting does not take place within the said period or the Dispute is not amicably settled within 15 (fifteen) days of such meeting between the said two representatives, either Party may refer the dispute to arbitration in accordance with the provisions of Sub-Article 36.2.

(c) If the Dispute is not resolved as evidenced by the signing of the written terms of settlement within 30 (thirty) working days of the aforesaid notice in writing or such longer period as may be mutually agreed by the Parties then the provisions of Sub-Article 36.2 shall apply.

36.2 Arbitration

36.2.1 Dispute Due For Arbitration

Disputes or differences shall be due for arbitration only if all the conditions in Sub-Article 36.1 are fulfilled.

36.2.2 Settlement of Disputes

Except where otherwise provided in the Contract, all disputes, whatsoever arising between the parties, arising out of touching or relating to construction, measuring, operation or effect of the Contract or the breach thereof, shall be settled by arbitration as detailed in Sub Article 36.2.3.

36.2.3 Nomination of Arbitrators / Sole Arbitrator

Matters to be arbitrated upon shall be referred to a sole Arbitrator where the total value of claims does not exceed Rs.1.50 millions. Beyond the claim limit of Rs.1.50 million, there shall be three arbitrators. For this purpose the DMRC will make out a panel of Engineers with the

ARTICLE 39
GOVERNING LAW AND JURISDICTION

39.1 This Agreement shall be construed and interpreted in accordance with and governed by the laws of India and the Courts at New Delhi, India shall have jurisdiction over all matters arising out of or relating to this Agreement.

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ARTICLE 40
MISCELLANEOUS

40.1 Video Recording

During the Construction Period, the Concessionaire shall provide a video recording to DMRC every calendar quarter which will be compiled into a 3 (three) hour cassette, covering the progress of the Concessionaire's Works in that quarter. Such video recording shall be provided no later than fifteen days after the close of each quarter.

40.2 Waiver

Waiver by either Party of any default by other Party in the observance and performance of any provision of or obligations of or under this Agreement.

(i) shall not operate or be construed as a waiver of any other or subsequent default hereof or of other provisions of or obligations under this Agreement;

(ii) shall not be effective unless it is in writing and executed by a duly authorised representative of the Party; and

(iii) shall not affect the validity or enforceability of this Agreement in any manner.

(a) Neither the failure by either Party to insist on any occasion upon the performance of the terms, conditions and provisions of this Agreement or any obligation thereunder nor time or other indulgence granted by a Party to the other Party shall be treated or deemed as waiver of such breach or acceptance of any variation or the relinquishment of any such right hereunder.

40.3 Survival

Termination of this Agreement (a) shall not relieve the Concessionaire or DMRC of any obligations hereunder which expressly or by implication survives Termination hereof, and (b) except as otherwise provided in any provision of this Agreement expressly limiting the liability of either Party, shall not relieve either Party of any obligations or liabilities for loss or damage to the other Party arising out of or caused by acts or omissions of such Party prior to the effectiveness of such Termination or arising out of such termination.

All obligations surviving the cancellation, expiration or Termination of this Agreement shall only survive for a period of 5 (five) years following the date of such Termination or expiry of this Agreement.

40.4 Entire Agreement:

This Agreement constitutes a complete and exclusive statement of the terms of the agreement between the Parties on the subject hereof and no amendment or modification hereto shall be valid and effective unless expressly previously approved in writing by DMRC and executed by the person expressly authorised by a resolution of DMRC in this behalf.

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40.5 Notices

Any notice or other communication to be given by Party to the other Party under, or in connection with the matters contemplated by this Agreement shall be in writing and shall:

(a) in the case of the Concessionaire, be given by letter delivered by hand to the address given and marked for the attention of the person set out opposite the corresponding signature below or to such other address marked for such other attention as the Concessionaire may from time to time designate by notice to DMRC, provided that notices or other communications to be given to an address outside New Delhi may (if they are subsequently confirmed by sending a copy thereof by first class registered airmail or by courier) be sent by facsimile to the number as the Concessionaire may from time to time designate by notice to DMRC; and

(b) in the case of DMRC, be given by letter delivered by hand and be addressed to the Managing Director, DMRC.

Copies of all notices shall also be sent by facsimile and by registered acknowledgement due pre-paid post or courier.

Copies of all notices shall also be sent to the DMRC Representative.

40.6 Severability

If for any reason whatever any provision of this Agreement is or becomes invalid, illegal or unenforceable or is declared by any court of competent jurisdiction or any other instrumentality to be invalid, illegal or unenforceable, the validity, legality or enforceability of the remaining provisions shall not be affected in any manner, and the Parties will negotiate in good faith with a view to agreeing one or more provisions which may be substituted for such invalid, unenforceable or illegal provisions, as nearly as is practicable to such invalid, illegal or unenforceable provision. Failure to agree upon any such provisions shall not be subject to dispute resolution under this Agreement or otherwise.

40.7 Corrupt and Fraudulent Practices

The Concessionaire warrants that no sums, in cash or kind, have been paid or will be paid by or on behalf of the Concessionaire, to any person by way of fees, commission or otherwise for securing the Concession or entering into this Agreement or for influencing or attempting to influence any officer or employee of DMRC, GOI or GNCTD in connection therewith.

40.8 Language

All notices required to be given by one Party to the other Party and all other communications, documentation and proceedings which are in any way relevant to this Agreement shall be in writing and in English language.

40.9 Confidentiality

Each Party shall keep in strict confidence any information and document received by it or on its behalf from the other Party in connection with the Project, and shall not disclose such information or document in any manner otherwise than as provided for in this sub-article.

Except and only to the extent as otherwise reasonably required in order to exercise any rights afforded under this Agreement, each Party shall keep in strict confidence any information and document received by it or on its behalf in connection with the Project, and shall not disclose such information or document in any manner, other than for the purpose of

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performing its obligations under this Agreement or as required under any Laws and Regulations, however the foregoing obligations of confidentiality shall not apply to:

(a) any information that is reasonably required by any Persons engaged in the fulfillment of the Concessionaire's or DMRC's obligations under this Agreement;

(b) any information which either Party can demonstrate is already generally available and in the public domain otherwise than as a result of a breach of this sub-article;

(c) any information which is reasonably required to enable a determination to be made under Article 36 (Dispute Resolution);

(d) any information the disclosure of which is required by any Applicable Laws or other regulations (including any order of a court of competent jurisdiction), or by any Governmental Agency; and

(e) any information required by the Senior Lenders or the Lender's Representative or by insurance advisers or insurers, but only to such extent necessary to enable their decisions to be taken.

(f) Concessionaire shall not recruit or attempt to recruit any DMRC Employee.

40.10 Exclusion of Implied Warranties etc.

This Agreement expressly excludes any warranty, condition or other undertaking implied at law or by custom or otherwise arising out of any other agreement between the Parties or any representation by either Party not contained in a binding legal agreement executed by both Parties.

40.11 Counterparts

This Agreement may be executed in two counterparts, each of which when executed and delivered shall constitute an original of this Agreement.

Delhi Metro Rail Corporation Ltd.

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दिल्ली मेट्रो रेल कॉरपोरेशन लिमिटेड
DELHI METRO RAIL CORPORATION LTD.

AIRPORT METRO EXPRESS LINE

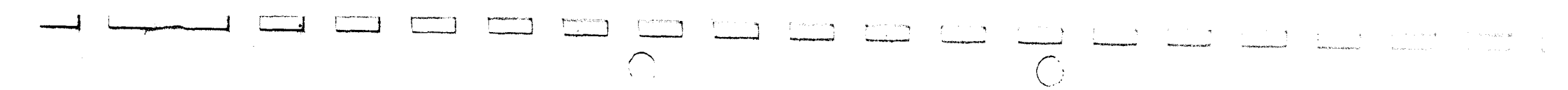
CONCESSION CONTRACT NO. AMEL-P1

DESIGN, INSTALLATION, COMMISSIONING, OPERATION AND MAINTENANCE OF AIRPORT METRO EXPRESS LINE NEW DELHI - INDIRA GANDHI INTERNATIONAL AIRPORT - DWARKA SEC. 21

PART II

CONCESSION AGREEMENT

Delhi Metro Rail Corporation Limited
NBCC Place,
Bhishma Pitamah Marg,
Pragati Vihar,
New Delhi –110 003
India



दिल्ली मेट्रो रेल कॉरपोरेशन लिमिटेड
DELHI METRO RAIL CORPORATION LTD.

AIRPORT METRO EXPRESS LINE

CONCESSION CONTRACT NO. AMEL-P1

DESIGN, INSTALLATION, COMMISSIONING, OPERATION AND MAINTENANCE OF AIRPORT METRO EXPRESS LINE NEW DELHI - INDIRA GANDHI INTERNATIONAL AIRPORT - DWARKA SEC. 21

CONCESSIONAIRE AGREEMENT

Volume III

Delhi Metro Rail Corporation Limited
NBCC Place,
Bhishma Pitamah Marg,
Pragati Vihar,
New Delhi –110 003
India

Delhi Airport Metro Express Pvt. Ltd. New Delhi

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DESIGN, INSTALLATION, COMMISSIONING, OPERATION AND MAINTENANCE OF AIRPORT METRO EXPRESS LINE - NEW DELHI-INDIRA GANDHI INTERNATIONAL AIRPORT - DWARKA SECTOR 21

TABLE OF SCHEDULES

Note; (*) The Bidders to procure this publication from DMRC separately. This will be part of the Concession Agreement

SCHEDULE-A

SITE OF THE PROJECT

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SCHEDULE-A
SITE OF THE PROJECT

1.0 General

1.1 The site of this Project is located at New Delhi, India's National Capital, which is a not only a commercial and trading hub of the country but is a major educational, tourist and Information Technology destination. During the last five years, Delhi Metro has commissioned approx. 65 Kms of Phase I and is likely to complete another 105 Km of Phase II before the forthcoming Commonwealth Games which are slated to start from 03 Oct 2010. As part of its 20 year development plan, Airport Authority of India has also entrusted Delhi International Airport Limited (DIAL) to carry out a major up gradation of the Airport infrastructure before the Commonwealth Games which will serve both the International as well as the domestic passengers.

1.2 At present the mode of transport between the Airport and the City/satellite towns is primarily by taxis and private cars, which is both time consuming, costly and tiring. Though an express-way with toll is likely to be opened soon on NH-8 between Dhaula-Kuan and Gurgaon with a link to the new Airport terminal, the situation is likely to aggravate further during the next few years, as traveling time which is presently about one hour, is likely to increase due to additional number of taxis and cars. The projected passenger load can be served by Rail based Mass Rapid Transport System, which is affordable, convenient and fast.

2.0 Access to Site and Right of Way

2.1 The site of the Airport Metro Rail system shall include land, buildings, structures, road works etc. as described herein. The Concessionaire and representative of DMRC shall jointly prepare an Inventory of the Site including the land, buildings, structures, road works, trees, utilities and other immovable properties on, or attached to the Site. In Part One, an inventory of the Site exclusively required by the Concessionaire for undertaking the work in Depot area will be prepared. Such Inventory shall become part of the Concession Agreement as per a Memorandum of the Agreement. In Part One of such memorandum shall have appended thereto an appendix (the "Appendix') specifying in reasonable details, those parts of the Site to which vacant access and Right of Way has not been granted to the Concessionaire. In Part Two, inventory of remaining Site shall be prepared, based on the Access dates for equipment rooms, guide-way, stations, ancillary/other buildings, roads and services etc. Signing of the Memorandum by the authorized representatives of both the Parties shall constitute a valid license and Right of Way to the Concessionaire for free and unencumbered use during the period of construction and the Concession Period in accordance with the provisions of this Agreement and for no other purpose, whatsoever.

2.2 Any additional land required for construction of works specified in Change of Scope Order shall be acquired. This shall be recorded in Part Three in accordance with the provisions of this Agreement as and when the situation arises.

2.3 Notwithstanding anything contained in the foregoing paragraphs, the Site shall remain the property of the DMRC, except that the concessionaire shall be entitled to exercise rights thereon as per this Agreement during the Concession Period.

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3.0 Description of Site

3.1 The site for Airport Metro Express Line will have a length of approx. 22.694 Kms from New Delhi Railway Station to Dwarka Sector 21, via IGI Airport and passes through Rajiv Chowk, Baba Kharak Singh Marg, GoI Dak Khana, Willingdon/Mother Terresa Crescent, SP Marg, Dhaula Kuan, NH-8, Palam, IGI Airport and Dwarka Sector 21. DMRC shall hand over to the Concessionaire, the Site as per Access dates given in the Schedule of Implementation (see Schedule 'H'). This Site will include all basic civil structures constructed by the Contractors engaged by DMRC such as the structures of one elevated station and Five Underground stations along-with the ancillary buildings, underground tunnels, viaducts and ramps etc. as shown on the drawings. The vacant Site for construction of all Depot infrastructure/services including Operation Control Center, also the Railway Sub-stations will be handed over as per Schedule H.

3.2 The preliminary make-up lengths of the revenue line site, including stations are, as follows :-

3.2.1	Total Length of underground section	: *15.081* Km
3.2.2	Total Length of at-grade section	: *0.893* Km
3.2.3	Total Length of elevated section	: *6.720* Km

3.3 The provisional lengths and description of the various Civil Contract sections are as follows:-

3.3.1 AMEL-C1

Underground section (New Delhi to Talkatora Garden – 0 Km to 3.861Km) involving twin bored tunnels, cut and cover tunnels and New Delhi and Shivaji Stadium underground stations.

3.3.2 AMEL-C6

Underground section (Talkatora Garden to Buddha Jayanti Park – 3.861 Km to 6.473 Km) involving single NATM tunnel with dividing wall and a ramp.

3.3.3 AMEL-C 2

At-grade, ramps' and elevated section (Buddha Jayanti Smaarak Park to Palam Depot - 6.473 Km to 13.691 Km involving twin track at-grade formation, viaducts', ramps' and an elevated station at Dhaula Kuan.

3.3.4 AMEL-C3

Underground section (Palam Depot to Mahipalpur – 13.691 Km to 17.301 Km) involving Cut and Cover tunnels, ramps' and an underground station at National Highway No. 8

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3.3.5 AMEL-C 4

Underground section (Mahipalpur to IGI Airport Station – 17.301 Km to 19.561 Km), involving Cut and Cover tunnels, and an underground station at IGI Airport.

3.3.6 AMEL-C 5

Underground section (IGI Airport Station to Dwarka 21 Station -19.561 Km to 21.941 Km) involving twin bored and Cut and Cover tunnels and ramps.

3.3.7 AMEL- C7

Underground section (Dwarka 21 Station – 21.941 Km to 22.694 Km) involving the interchange station, cut and cover tunnels for the station over-run tracks, connection to AMEL – C5 section and Dwarka Depot. Also, Civil and Structural work for DMRC Line 3 Extension Dwarka Sectors 9 to 21

3.3 The Preliminary location and type of stations are as follows:

Station	Km	Type	CAT facilities
New Delhi	0.155	Underground	Check-in and Baggage handling
Shivaji Stadium	2.143	Underground	Check-in and Baggage handling
Dhaula Kuan	8.971	Elevated	Check-in
NH8	15.936	Underground	None
IGI Airport	19.387	Underground	Outbound Baggage Handling
Dwarka 21	22.534	Underground	None

Only the civil structure work shall be provided by DMRC for the stations along with the guide way structures (tunnel and viaduct)

3.5 Two Railway Sub-stations (RSS) for power supply shall be provided, RSS1 near Kendriya Bus Terminal in Church Street and RSS2 at IGI Airport complex.

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SCHEDULE - B

DMRC WORKS

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SCHEDULE B

DMRC WORKS

1 Introduction

For the Airport Metro Express Line between New Delhi and Indira Gandhi Airport DMRC shall provide station and guide-way structures as per the following contract packages:

1.2 AMEL-C1 From New Delhi to Talkatora Garden. This includes structures for two underground stations at New Delhi and Shivaji Stadium, along with entry and exit structures, together with twin bored and Cut and Cover tunnels.

1.3 AMEL-C2- From Buddha Jayanti Smaarak Park to Palam Siding. This includes one elevated station at Dhaula Kuan along with entry-exit structures and viaduct for two tracks (elevated guide-way).

1.4 AMEL-C3 From Palam Siding to Mahipalpur. This includes Cut & Cover tunnel along with entry-exit structures.

1.5 AMEL-C4; From Mahalipar to IGI Airport. This consists of twin trackway Cut & Cover tunnel and IGI underground station, along with entry and exit structures.

1.6 AMEL-C5- This consists of twin bored tunnels between IGI Airport Station (exclusive) and Dwarka Sector 21 Station (exclusive) and Dwarka Sector 21 Station (Exclusive)

1.7 AMEL-C6 From Talkatora Garden to Buddha Jayanti Smaarak Park. This consists of a single NATM tunnel with dividing wall separating each track and a ramp to ground level.

1.8 AMEL –C7 this consists of Dwarka 21 underground station structure, with interchange for the DMRC Network, along with entry and exit structures and Cut &Cover tunnels connecting to AMEL-C5 works and Dwarka Depot.

DMRC Shall provide the architectural finishes and Building Services for all areas of the station; and Line 3 E&M and Systems engineering.

[Note: The locations given are tentative and may undergo changes during the Detailed Design stage. Also please refer Schedule I and Schedule A]

2 Civil Works

The Permanent Works to be undertaken by various Contractors on behalf of DMRC are as follows:

(a) Design and Construction of following Works and services including waterproofing complete except Items to be undertaken by Concessionaire as per Schedule C.

(b) Structural part of all underground stations/elevated stations, including running tunnels, and associated structures such as Entry/ Exit structures, Utilities galleries, plant rooms, pump houses, water tanks and other enclosures.

(c) Tunnel between the stations by TBM and cut and cover methods including connections with the Stations.

(d) Viaducts/Elevated Structures including connections with the Stations.

(e) Construction of Drains based on site conditions.

(f) All permanent embedded/buried drainage and water supply system except supply of pumps.

(g) Making provisions in the structures for all the E&M equipment and systems requirements, including fixing points, openings/cut outs and so on as per the interface with the Concessionaire.

3 **Interfacing between Civil Contractor and Concessionaire**. Concessionaire shall coordinate with the Civil Contractors all interface requirements at design stage, during construction, installation, commissioning and integrated testing activities of various items in the Scope of works of the Concessionaire, refer to Diagram B 1.4.

4 **The DMRC will:**

(a) Provide approximately 8.0 Hectare of land for the Dwarka Depot.

(b) Provide approximately 2.27 Hectare of land for the permanent Palam Siding, access roads and ancillary facilities.

(c) Arrange Concessionaire rental of upto 11 Hectare of land at Palam for a temporary construction site, at Department of Defence rental rates/m^2

(b) Identify site for disposal of surplus materials unsuitable for backfilling within a radius of 25 km.

5 ***Power Supply***

DMRC Designated Contractor(s) will provide High Voltage sub-stations with supplies for the Airport Metro Express Line: 33kV 3 phase Auxiliary Supplies and 25kV single phase Traction Power supplies near Kendriya Bus Terminal Church Street and IGI Airport complex. The day to day maintenance and operational control of the sub stations will rest with the Concessionaire.

A temporary connection for 33 kV 3 phase Auxiliary Supply and 25 kV single phase Traction Power supply shall be provided at DMRC Dwarka Sub-station, pending installation of the AMEL permanent HV supply connections

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SCHEDULE - C

CONCESSIONAIRE SCOPE OF WORKS

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SCHEDULE-C

CONCESSIONAIRES WORKS

1.0 Concessionaire Scope of Works

1.1 The Concessionaire shall undertake a Transportation Planning study for the AMEL and forecast the passenger usage of the facilities for the 30 year period, 2010 until 2040. 2040 shall be the Design Year for engineering the railway systems and City Airport Terminal facilities.

1.2 The Concessionaire shall Operate and Maintain the AMEL infrastructure and equipment provided by others, as follows:

- All Civil Works and Structures provided by DMRC contractors AMEL-C1, C2, C3 C4, C5, C6 and C7 works for Dwarka 21 Station, as per Schedule B.
- High Voltage cable connections between TRANSCO switch station with the AMEL Railway Sub-station, RSS structure and HV transformers and associated switchgear and protection equipment, cables, provided by DMRC Designated contractor.

1.3 For the AMEL area of Dwarka Station, the Concessionaire shall provide, Operate and Maintain the Station E&M and System-wide equipment required for the Operation & Maintenance of Railway System, similar to other AMEL stations(also refer Schedule L).

1.4 The Concessionaire shall finance, design, install & construct, supply, commission, test, operate and maintain the Items and equipment, as the case may be, as follows but not limited to:

1) Station, Tunnel, and Guideway structures
   a. Architectural Works including architectural finishes for internal and external walls, ceilings and floors to the Civil Structures at each station including circulating areas and shall include all non-structural building works in stations for the Operating Staff, passengers and equipment housing,.
   b. Emergency Walkways
   c. Drainage/sump pumps.
   d. Approach roads to the depot
   e. Station Plaza including circulating area
2) Landscaping of each Station environs
3) Signage at each station and station environs;
4) Track work System
5) Rolling Stock, Passenger trains and maintenance vehicles
6) Signalling and Train Control System
7) High Voltage Electric Power System for the Auxiliary supplies to Stations, Depot and On-line equipment rooms, and Traction Power OHLE including catenary, poles and fixtures.
8) Operation and maintenance of the substations constructed by DMRC designated contractors
9) Communication Systems, as follows:
   - Data Transmission System;
   - Clock System;
   - Telephone Systems;

- CCTV Systems;
- Public Address System;
- Radio System;
- Station Management System;
- Passenger Information System;
- Train-borne Communications Systems; and
- Office Administration and IT systems.

10) Automatic Fare Collection System, including Clearing House;

11) Platform Screen Doors;

12) Tunnel Ventilation System Including station Over Track Exhaust;

13) Building Services for Stations, Guideway, Depot, Siding and On-line equipment rooms, as follows:

- Low Voltage systems – Lighting, power outlets, UPS, Generators, Lightning Protection and Earthing equipment;
- HVAC system including OTE ducts;
- Fire detection and suppression systems;
- Elevators;
- Escalators;
- Utility supplies for water and foul water disposal;
- Water supply including Deep Tube Wells at each station and Depot, complete in all respects and storage tanks.
- Installation testing and maintenance of Pumps and pipes for drainage/sewerage system.

14) At Dwarka Depot and Palam Siding , as required, and as follows:

- Site leveling, sub-ballasting, access road and fencing;
- Civil Works and Structures including all services;
- Architectural works/finishes;
- Landscaping;
- Fabricated buildings
- Workshop plant, tools and equipment train maintenance
- Train Inspection and Stabling facilities
- Automatic Wash Plant and Train cleaning Systems
- Trackwork for the Depot and Link Line;
- Depot Signalling System
- Depot Auxiliary Power System
- Depot Traction Power system;
- Depot Communications systems

- Operation and Depot control center
- Asset Maintenance facilities

15) City Airport Check-in facilities shall be provided at New Delhi Station, Shivaji Stadium Station and Dhaula Kuan Station. The facilities to be provided by the Concessionaire at various stations are tabulated below:

Station	Check-in counters	Baggage handling system	Oversize baggage handling system	Type of Station
New Delhi	Yes	Yes	Yes	Terminal
Shivaji Stadium	Yes	Yes	Yes	Intermediate
Dhaula Kuan	Yes	No	No	Intermediate
IGI Airport	No	Yes	Yes	Intermediate
Dwarka-Sector 21	No	No	No	Terminal

16) At the City Airport Terminal facilities, as follows:

- New Delhi Station, the check-in desks, scales and baggage handling system equipment, electronic hardware and software for the Common Use Terminal Equipment (CUTE) and Airport Information Management System (AIMS) and Flight Information Display System (FIDS);
- Shivaji Terminal Station, the check-in desks, scales and baggage handling system equipment, electronic hardware and software for CUTE and AIMS and FIDS; and
- Dhuala Kuan Station, Check-in desks, electronic hardware and software for the CUTE and AIMS and FIDS.

IGI Airport Station, Baggage Handling System equipment and transportation for bags to the IGI Airport baggage hall.

The Concessionaire shall liaise with the Airport Authority of India Designated Contractor's to ensure seamless inter-operation of the CAT system's with those of the IGI Airport systems'.

17) A dedicated Data Transmission System including DTS terminal equipment at each Station between IGI Airport Station and each CAT equipment room. This DTS shall use a diversely routed fibre ring.

18) A suitable means for transfer of baggage and/or baggage containers form IGI Airport Station to the designated baggage injection point at the airport terminal building

19) At IGI Airport Station trolley's assisting passengers to convey their baggage between the Station and Airport Terminal (T3) building shall be provided by the IGI Airport Handling Agent. The Concessionaire shall co-ordinate the management requirements of trolleys within the IGI Airport Station, with the IGI Airport Handling Agent.

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20) Operations Control Centre- in Depot area:

- Civil Works and Structures-including all services
- Architectural finishes
- Furniture and Fittings
- Work Stations
- Mimic panels
- Power supply equipment
- Control System complete in all respects.

[Note: The above list is not exhaustive and any work necessary over and above the Civil works (Sch. B) shall be Concessionaire's responsibility.]

21) The Concessionaire shall provide all door frames and doors for tunnel cross passage ways and entrances to ventilation shafts.

1.5 Interfacing between Concessionaire and Civil Contractors

The Concessionaire shall coordinate with the Civil Contractors' for all interface requirements at the design stage, during construction, installation, commissioning and integrated testing activities of various items in the Scope of works of the Concessionaire Refer to Diagram B 1.4.

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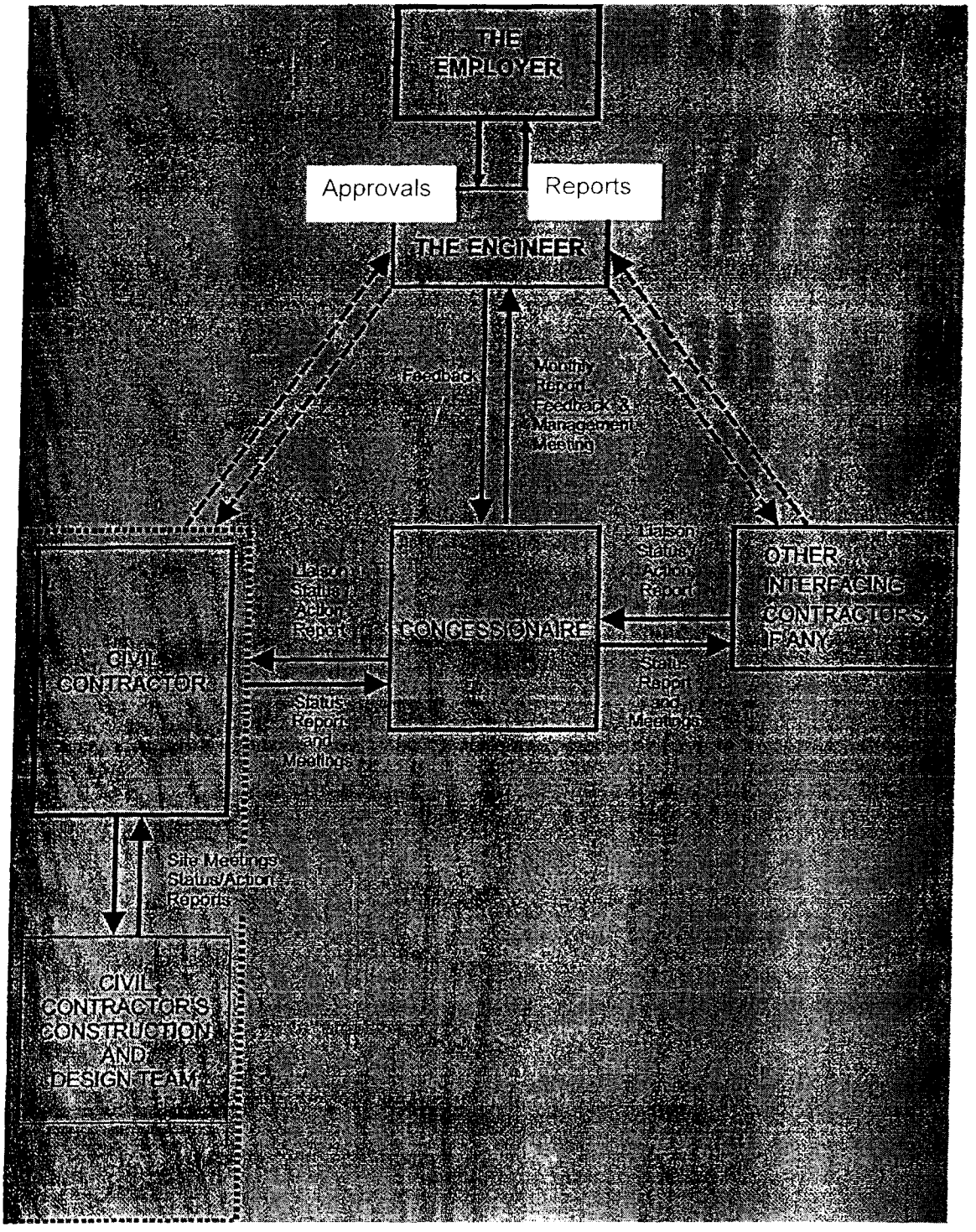

PROJECT COORDINATION MODEL

Diagram 8.1.4

SCHEDULE-D

SPECIFICATION FOR THE CONCESSIONAIRE'S WORKS

PART I

SCHEDULE D

PART I

CHAPTER 1

ABBREVIATIONS

1 Introduction

This document provides Abbreviations which may be used in the Specifications for the Airport Metro Express Line (AMEL).

Abbreviation	Full Name
AC	Alternating Current
AMEL	Airport Metro Express Line
AFC	Automatic Fare Collection
AFTC	Audio Frequency Track Circuits
AHU	Air Handling Unit
AIMS	Airport Information Management System
ASS	Auxiliary Sub-Station
BHA	Baggage Handling Area
BHS	Baggage Handling System
BS	British Standards
CAT	City Airport Terminal
CCH	Central Clearing House
CCTV	Closed Circuit Television
CER	Communications Equipment Room
CS	Control Superintendent
CUTE	Common Use Terminal Equipment
CVRS	Central Voice Recording System
DB	Distribution Board
DC	Direct Current
DG	Diesel Generator
DID	Direct Inward Dial
DLP	Defects Liability Period
DLT	Direct Line Telephone
DOD	Direct Outward Dial
DTS	Data Transmission System
E&M	Electrical and Mechanical
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
FAT	Factory Acceptance Tests
FIDS	Flight Information Display System
GPS	Global Positioning Satellite

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HV	High Voltage (over 1000 V)
IGIA	Indira Gandhi International Airport
ISO	International Organisation for Standardisation
IT	Information Technology
ITU-T	International Telecommunications Union – Telecommunication Standardization Sector
LAN	Local Area Network
LC	Local Controller
LCD	Liquid Crystal Display
LCP	Local Control Panel
LCX	Leaky Coaxial
LED	Light Emitting Diode
LV	Low voltage (below 1000 V)
M&E	Mechanical and Electrical
MCB	Miniature Circuit Breaker
MIS	Management Information System
MMI	Man Machine Interface
MTBF	Mean Time Between Failures
MTTR	Mean Time To Restore
N/A	Not Applicable
NFPA	National Fire Protection Association
NMS	Network Management System
O&M	Operation and Maintenance
OCC	Operations Control Centre
OCS	Overhead Centenary System
OHLE	Overhead Line Equipment
OOG	Out of Gauge
PABX	Private Automatic Branch Exchange
PAS	Public Address System
PC	Personal Computer
PIDS	Passenger Information Display System
PSD	Platform Screen Door
PTO	Passenger Train Operator
PTZ	Pan/Tilt/Zoom
RAMS	Reliability, Availability, Maintainability & Safety
RMDT	Reliability, Maintainability Demonstration Testing
RASTI	Rapid Speech Transmission Index
RF	Radio Frequency
RSS	Railway Sub-station
S&T	Signalling and Telecommunications
SAT	Site Acceptance Tests
SC	Station Controller
SCADA	Supervisory Control and Data Acquisition
SCR	Station Control Room
SDH	Synchronous Digital Hierarchy
SER	Signalling Equipment Room

SMS	Station Management System
SS	Sub Station
TC	Traffic Controller
TER	Telecommunications Equipment Room
TSS	Traction Sub-station
TVF	Tunnel Ventilation Fan
TVS	Tunnel Ventilation System,
UPS	Uninterruptible Power Supply
VAC	Ventilation and Air Conditioning
VDU	Visual Display Unit
WAN	Wide Area Network

End of Chapter 1

SCHEDULE D

PART I

CHAPTER 2

CODES AND STANDARDS

1 List of Codes and Standards

Standards indicated in this document are provided solely for the guidance of Contractors. Standards shall be International Standards or National Standards of those countries listed in Schedule D, Part III Chapter 1 Clause 1.2.

National and international Standards listed, which may serve as a basis for the Contractors engineering, are as follows:

2 INTERNATIONAL ELECTROTECHNICAL COMMISSIONS (IEC)

IEC 60296	Specification for unused mineral insulating oils for transformers and switchgear
IEC60034	Rotating electrical machines
IEC60038	IEC standard voltages
IEC60050	International electromechanical vocabulary
IEC60051	Direct acting indicating analogue electrical-measuring instruments and their accessories
IEC60056	High-voltage alternating current circuit breakers
IEC60060	High-voltage test techniques
IEC60071	Insulation Co-ordination
IEC60076	Power transformers
IEC60077	Rules for electric traction equipment
IEC60085	Thermal evaluation and classification of electrical insulation
IEC60099-4	Surge arresters – Part 4: Metal oxide surge arresters without gaps for ac systems
IEC60129	Alternating current disconnections (isolators) and earthing switches
IEC60137	Insulating Bushings for alternating voltages above 1000V
IEC60146	Semiconductor converters
IEC60156	Insulating liquids – Determination of break down voltage at power frequency – Test Method
IEC60185	Current Transformer
IEC60214	On-load taps changers
IEC60228	Conductors of insulated cables
IEC60230	Impulse test on cables and their accessories
IEC60255	Electrical relays
IEC60258	Direct acting recording electrical measuring instruments and their accessories
IEC60265	High voltage switches
IEC60269	Low-voltage fuses

IEC60287	Electric cables - Calculation of the current rating of cables (100% load factor)
IEC60298	AC metal-enclosed switchgear and control gear for rated voltages above 1kV and up to and including 52kV
IEC60332	Tests on electric cables under fire conditions
IEC60354	Loading guide for oil-immersed power transformers
IEC60376	Specification and acceptance of new sulphur hexafluoride
IEC60420	High voltage alternating current switch fuse combinations
IEC60439	Low-voltage switchgear and control gear assemblies
IEC60502	Power cables with extruded insulation and their accessories for rated voltages from 1kv up to 30 kV
IEC60517	Gas insulated metal enclosed switchgear for rated voltages of 72.5kV and above.
IEC60521	Class 0.5, 1 and 2 alternating-current watt-hour meters
IEC60529	Degrees of protection provided by enclosures (IP code)
IEC60542	Application guide for on-load tap changers
IEC60551	Determination of transformer and reactor sound levels
IEC60664	Insulation co-ordination for equipment within low-voltage systems
IEC60694	Common specifications for high-voltage switchgear and control gear standards
IEC60722	Guide to the lightning impulse and switching impulse testing of power transformers and reactors
IEC60726	Dry type Power Transformer
IEC60754	Test on gases evolved during combustion of electric cables
IEC60811	Common test method for insulating and sheathing materials of electric cables
IEC60859	Cable connections for gas-insulated metal-enclosed switchgear for rated voltages of 72.5kV and above
IEC60871-1	Shunt capacitors for ac power systems having a rated voltage up to and including 1000V
IEC60947	Low-voltage switchgear and control gear.
IEC60831	Shunt power capacitors of the self-healing type for ac systems having a rated voltage up to and including 1000V
IEC61034	Measurement of smoke density of electric cables burning under defined conditions
IEC61133	Electric traction – Rolling stock – test method for electric and thermal/electric rolling on completion of construction and before entry into service
IEC 285	Alkaline Secondary Cells and Batteries - Sealed Nickel Cadmium Cylindrical Rechargeable Single Cells
IEC 331	Tests for electric cables under fire conditions
IEC 408	Low Voltage Air Break Switches
IEC 439	Low Voltage switchgear and controlgear assemblies
IEC 473	Electrical installations of buildings
IEC 529.8	IP Ratings Specifications
IEC 801	Acoustics and electroacoustics

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IEC 898	Miniature Circuit Breakers
IEC 890	A method of temperature rise assesment by exrrapolation for partially type tested assemblies of low voltage switchgear and controlgear
IEC 947	Low Voltage Switchgear and Control Gear
IEC 76:	Power Transformers (Parts 1-8);
IEC 255:	Electrical Relays.
IEC 297:	Dimensions of mechanical structures of the 482.6mm (19inch) series racks.
IEC 332:	Tests on Electric Cables under Fire Conditions;
IEC 571:	Electronic equipment used on rail vehicles;
IEC 742	Isolating Transformers and Safety Isolating Transformers;
IEC 285	Alkaline Secondary Cells and Batteries - Sealed Nickel Cadmium Cylindrical Rechargeable Single Cells
IEC 331	Tests for electric cables under fire conditions
IEC 408	Low Voltage Air Break Switches
IEC 439	Low Voltage switchgear and controlgear assemblies
IEC 473	Electrical installations of buildings
IEC 529.8	IP Ratings Specifications
IEC 801	Acoustics and electroacoustics
IEC 898	Miniature Circuit Breakers
IEC 947	Low Voltage Switchgear and Control Gear

2 AMERICAN STANDARDS

IEEE 48	IEEE Standard test procedures and requirements for high-voltage alternating current cable terminations.
IEEE 383	Standard for type-test of Class E electrical cables, field splices and connections for nuclear power generating stations.
IEEE 404	Cable and joints for use with extruded dielectric cable rated 5000 to 13800 V and cable joints for use with laminated dielectric cable rated 2500 V to 50,000 V (50kV)
IEEE S 1100:	Recommended Practice for Powering and Grounding of Sensitive Electronic Equipment;
IEEE S 80	Guide for Safety in AC Substation Grounding - 1986'
IEEE S 519	Recommended Practices and Requirements for Harmonic Control in Electric Power Systems

IEEE S 85	Standard Test Procedure for Airborne Sound Measurements on Rotating Electric Machinery
IEEE S 112	Test Procedure for Polyphase Induction Motors and Generators.
IEEE S 80	Guide for Safety in AC Substation Grounding
MIL-STD-880C	Military standard system safety program requirements (VSA)
NFPA 70	National electrical code
NFPA 70 E	Standard for electrical safety requirements for employee workplaces
NFPA 130	Standard for fixed guide way transit systems
NFPA 258	Standard research test method for determining smoke generation of solid materials
SS 299	Specification for fire resistant cables
ANSI C3716	Relays and low voltage power circuit breakers and AC power circuit protectors
ASTM D 2863	Method for measuring the minimum oxygen concentration to support candle like combustion of plastic (oxygen index)
ASTM B 173-64	Specification for rope lay-stranded copper conductors having concentric members, for electrical conductors

3 BRITISH STANDARDS

BS 88	Cartridge Fuses
BS 787	Flameproof Air Circuit Breakers
BS 799/2594	Fuel Storage Tanks
BS 2633	Specification for Class 1 arc welding of ferritic steel pipework for carrying fluid
BS 2757/IEC 85	determining the thermal classification of electrical insulation
BS 2869	Fuel oil for non-marine use
BS 2971	Specification for Class 2 arc welding of carbon steel pipework for carrying fluid
BS 3535	Isolating Transformers
BS 4190	ISO metric black hexagon bolts, screws and nuts
BS 4485	Water Cooling towers
BS 4552	IC Engine Fuel Filters
BS 4548	Drive Belts
BS 5000	Rotating Electrical Machines for Miscellaneous Applications

BS 5150	Specification for cast iron gate valves
BS 5153	Specification for cast iron check valves for general purposes
BS 5155	Household refrigerating appliances
BS 5266	Code of Practice for Emergency Lighting
BS 5306	Part 1 Fire extinguishing Installations and Equipment on Premises – Hydrant systems, Hose Reel and Foam Inlets
BS 5306	Part 2 – Fire extinguishing Installations and Equipment on Premises – Sprinkler Systems.
BS 5486	Miniature Circuit Breakers
BS 5489	Road Lighting
BS 5512	Equipment Life Rating
BS 5514	Engine Power Performance
BS 6007	Heat Resisting Cables
BS 6206	Impact Performance Requirements for Flat Glass and Safety Plastics for use in Buildings
BS 6290	Sealed Lead Acid Rechargeable Single Cells
BS 6346	Armoured Cables
BS 6387	Specification for performance requirements for cables required to maintain circuit integrity under fire conditions.
BS 6651	Code of Practice for protection of Structures against Lightning
BS 6708	Flexible Cables for Mines
BS 6500	Flexible Cables for Office Appliances and Equipment
BS 6667	Obsolescence management
BS 6853	Code of Practice for Protection of Structures against Lightning
BS 7375	Code of Practice for Distribution of Electricity on Construction Sites
BS 7430	Code of Practice for Earthing
BS 7655	Insulating and Sheathing Materials for Cables
BS 7671	Wiring Regulations for Electrical Installations in Buildings.
BS 7698	Internal Combustion Engines for AC Generators
BS 8206	Lighting for Buildings
BS 8301	Building Drainage Station Drainage

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BS 60146	Semiconductor Converters
BS EN 81	Safety Rules for Construction and Installation of Lifts
BS EN 115	Safety Rules for Construction and Installation of Escalators and Passenger Conveyors
BE EN 287	Approval testing of welders for fusion welding
BS EN 545	Ductile iron pipes, fittings, accessories and their joints for water pipelines
BS EN 752	Drains and Sewer Systems outside Buildings
BS EN 1092	Flanges and their joints
BS EN 1461	Hot dip galvanised coatings on fabricated iron and steel articles
BS EN 1435	Non destructive examination of welds
BS EN 2379	Hot Dip Galvanising Coatings – Specifications and Test Methods
BS EN 13201	Road lighting
BS EN 50081	Electromagnetic Compatibility for Industrial Applications
BS EN 50082	Electromagnetic Compatibility for Industrial Applications
BS EN 50121	Electromagnetic Compatibility for Railway Applications
BS EN 50122	Protective Provisions relating to Electrical Safety and Stray Currents
BS EN 55014	Radio Interference Limits
BS EN 60034-22	AC Generators
BS EN 60051	Electrical Indicating Instrument
BS EN 60076	Power Transformers
BS EN 60255/6	Electrical Protective Relays
BS EN 60309	Plugs, Socket Outlets and Couplers for Industrial Purposes
BS EN 60439	Low Voltage Switchgear and Control Gear Assemblies
BS EN 60529	Specification for degrees of protection provided by enclosures (IP Codes)
BS EN 60598	Luminaires
BS EN 60898	Circuit Breakers for Overcurrent Protection
BS EN 60947	Low Voltage Switchgear and Control Gear Assemblies
BS EN 61000	Electromagnetic Capacity
BS 4575	Fluid power transmission and control systems;

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BS 6234	Polyethylene Insulation and Sheath of Electric Cables;
BS 6274	Specification for armoured cables for electricity supply having thermosetting insulation with low emission of smoke and corrosive gases when affected by fire.
BS 6469	Insulation and Sheathing Materials.
BS 6853	Code of Practice for Fire Performance of Materials Used in Rolling Stock Vehicles.
EN 50125	Railway Applications: Environmental conditions for equipment. Equipment on board Rolling Stock, and Part 2: Railway Applications: Environmental conditions for fixed electrical installations;
EN 50128	Railway applications- communications, signalling and processing systems- software for railway control and protection system;
EN 50119	Railway Applications: Overhead contact lines
EN 50121	Railway Applications: Electromagnetic compatibility
EN 50122	Railway Applications: Protective provisions for electrical safety and earthing and against the effects of stray currents
EN 50123	Railway Applications: dc switchgear and control gear
EN 50124	Railway Applications: Insulation co-ordination
EN 50126	Railway Applications: The specification and demonstration of reliability, availability, maintainability and safety (RAMS)
EN 50128	Railway Applications: SCADA
EN 50149	Railway Applications: Copper and copper alloy grooved contact wires
EN 50152	Railway Applications: ac switchgear
EN 50163	Railway Applications: Supply voltages of traction systems
EN 60076	Power Transformers
EN 60146	Semi-conductor converters
EN 60255	Electrical Relays
EN 60298	ac switchgear and control gear
EN 60694	HV switchgear and control gear

4 INDIAN STANDARDS

IS 14665	Electric traction lifts
IS 15330	Installation and maintenance of lifts for handicapped persons

IS 7759	Lift doors, locking devices and contacts
IS 1860	Code of Practice for Installation, Operation and Maintenance of Electric Passenger and Goods Lifts

5 OTHER STANDARDS

ISO 1459	Metallic Coatings-Protection against corrosion by hot dip galvanizing – Guiding principles
ISO 1460	Metallic Coatings-Hot dip galvanized coatings of ferrous materials –Gravimetric determination of the mass per unit area.
ISO 1461	Hot dip Galvanized Coating on fabricated ferrous products – specification
ISO 2064	Metallic and other non-organic coatings definitions and conventions concern the measurement of thickness.
ISO 2177	Metallic Coatings measurements of coating thickness - coulometric method by anodic dissolution.
ISO 2178	Non-magnetic on magnetic substrates – measurements of coating thickness – magnetic method
ISO 2859	Sampling procedures and tables for inspection by attributes.
UL 94	Tests for flammability of plastic materials for parts in devices and appliances
UL 508	Industrial control equipment
UL 746C	Polymeric materials used in electrical equipment evaluations
VDE 0115 P1	Traction systems general construction and safety

EMC International Standards

BS EN 50082	Electromagnetic compatibility _ Generic immunity standard
DD ENV 50121	Railway applications _ Electromagnetic compatibility
EN 50155	Railway applications - Electronic equipment used on rolling stock
IEC 571	Electronic equipment used on rail vehicles
IEC 61000-1	Electromagnetic compatibility Part 1: General
IEC 61000-2	Electromagnetic compatibility Part 2: Environment
IEC 61000-3	Electromagnetic compatibility Part 3: Limits
IEC 61000-4	Electromagnetic Compatibility Part 4: Testing and measuring techniques
IEC 61000-5	Electromagnetic compatibility Part 5: Installation and mitigation guidelines

End of Chapter 2

PART II

Chapter 1

STATION FINISHES

Introduction

The purpose of this section is to specify basic requirements and criteria established for the finish of public areas within the System. While convenience, comfort, and attractiveness will be considered in the selection and application of these finishes, the contractor shall assure that the goals of safety, durability, and economy are achieved.

Basic Goals

A. Safety

1. Fire Resistance and Smoke Generation

Reduce hazard from fire by using materials with minimum burning rates, smoke generation, and toxicity characteristics for station finishes, consistent with requirements of Fire/Life Safety requirements.

2. Attachment

Eliminate hazard from dislodgment due to temperature change, vibration, wind, seismic forces, aging, or other causes, by using proper attachments and adequate bond strength.

3. Slip-resistant walking surfaces

Increase pedestrian safety, in compliance with accessibility requirements by using floor materials with slip-resistant qualities. Entrances, stairways, platform edge strips, and areas around equipment should have high slip-resistant properties.

The following static coefficients of friction shall be provided as a minimum :

Coefficient Of Friction

• Public horizontal surfaces	0.6
• Non-public horizontal surfaces, exterior	0.6
• Non-public horizontal surfaces, interior	0.5
• Platform edge strips	Textured visually-contrasting material
• Stairs, ramps, sloping sidewalks	0.8
• Area around equipment	0.5

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B. Durability

Provide for long and economical service by using materials with wear, strength, and weathering qualities consistent with their initial and replacement costs, and their location in the station. The materials must maintain their good appearance throughout their useful life. Materials should be colorfast.

C. Ease of Maintenance

1. Cleaning

Reduce cleaning costs by using materials which do not soil or stain easily, which have surfaces that are easy to clean in a single operation, and on which minor soiling is not apparent. Materials shall be cleanable with standard equipment and cleaning agents.

2. Repair or Replacement

Reduce maintenance costs by using materials which, if damaged, are easily repaired or replaced without undue interference with the operation of the System. Spare materials shall be provided for tile and other unit materials in a quantity of approximately two percent of the total used.

D. Resistance to Vandalism

Provide materials and details that do not encourage vandalism, that are difficult to deface, damage or remove.

All surfaces exposed to the public are to be finished in such a manner that the results of casual vandalism can be readily removed with normal maintenance techniques. The Contractor is required to describe procedures for removal of more serious defacement for each finish in public areas and within 3 meters of the floor surface, as part of the Maintenance Manual.

E. Aesthetic Qualities

Create feeling of warmth, attractiveness, quality, and to instill civic pride in the facility.

General Criteria

Certain general criteria for finish materials are indicated to achieve the goals outlined above as well as those, which would result in a high level of illumination, good cleanliness levels, and the appearance of high cleanliness.

A. Surface

Applied materials shall be hard, dense, non-porous, non-staining, acid and alkali resistant, for long life and low maintenance. Surfaces within reach of the public, up to 3 meters above the floor level may be finished with applied materials.

B. Color

Colors shall aid maintaining high illumination levels, with sufficient contrasts and accents to provide visual interest and warmth and to conceal minor soiling.

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To provide uniform contrast ratio in all Stations a 100 mm wide yellow warning strip shall be placed adjacent to the 500 mm at Platform Edge paver.

C. Texture

Smooth surfaces are preferred over rough ones for ease in cleaning and because they are less prone to catch settling dust. Rough surfaces are desirable where a slip-resistant feature is important, and are acceptable where surfaces are difficult to reach and are therefore unlikely to be cleaned very frequently. A rough surface may hold dust without being visually apparent.

A distinctive texture shall be provided at the platform edge when open or operable to the tracking. This shall enable the blind to sense the presence of the platform edge.

D. Unit Size

Unit should be large enough to reduce the number of joints yet small enough to conceal minor soiling and scratches and to facilitate replacement if damaged. Monolithic materials may be used if they have inherent soil hiding characteristics that can be easily repaired without the repair being noticeable.

E. Joints

Since joints are a major source of maintenance problems, joints should be small, flush limited in number and the best possible materials. Horizontal joints should not be raked but should be flush or tooled concave. Monolithic materials should have adequate control joints and expansion joints at the proper spacing in order to prevent surface cracking.

F. Cost

Materials shall be selected for long life, low maintenance, replacement considerations and overall aesthetic and functional qualities.

G. Availability

Materials should be selected which are readily available. Domestic products shall be selected unless the product is not available within the country.

H. Nonproprietary Materials

In order to obtain competitive bids, proprietary items should only be used where it is established that no other materials would meet the particular design requirements.

I. Installation Standards

Materials shall be detailed and specified to be installed in accordance with industry standards and manufacturer's printed directions.

J. Flammability

Interior finishes including door/ windows shall meet requirements of the Code and the Fire/Life Safety Requirement.

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1. Finishes for all protected exitways shall be Class A as defined by NFPA 101. In underground stations, platforms, mezzanines, corridors, stairways, and vestibules shall be considered exitways.

2. Finishes in all other areas shall be Class B as defined by NFPA 101.

3. Combustible adhesives and sealants may be used when they meet the requirements stated above.

List of Finished Materials

The list will apply to all public area entrances. For the use of items listed as "Acceptable," installation is subject to location and environmental considerations.

A. Floor Materials - Finish to Provide Slip-Resistant Surface

1. Acceptable

(a) *Monolithic Materials*

1. Concrete - with appropriate finish to provide slip-resistant surface in ancillary areas.

   Hardened finish where shown
2. Acid-resistant applied coating - for application in Battery Rooms.

(b) Unit Materials

1. Natural granite.
2. Vitrified Tile
3. Paver brick - dense, hard
4. Unglazed ceramic tile
5. Cement Terrazzo (special/hard aggregates, *abrasive*
   aggregates and installation control); thick set
   installation.

2. Not Acceptable

(a) Monolithic Materials

1. Bituminous toppings
2. Synthetic resin toppings
3. Resinous Terrazzo Tile

(b) Unit Materials

1. Resilient tile and sheet products - in public areas
2. Wood products
3. Marble
4. Mosaic tile.
5. Glazed Ceramic tile.

B. Wall Materials

1. Acceptable

(a) Monolithic Materials

1. Concrete with sealers (with sufficient surface texture to conceal minor soiling and damage without complicating maintenance procedures, or constituting a hazard to clothing or skin of patrons).

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(b) Unit Materials

1. Unglazed and unglazed ceramic mosaic tile
2. Ceramic facing veneers
3. Glazed and unglazed brick
4. Vitrified Tile
5. Natural Granite
6. Porcelain enamel steel panel - noncombustible assembly
7. Crystallized glass panels
8. Concrete masonry units - nonpublic areas only in underground stations.
9. Reinforced cast-in-place concrete shall be used for underground tunnel walls because of air pressure build-up and for exterior walls of shafts and all bearing walls.
10. Structural glaze faced concrete masonry units

(c) Surface Applied Finishes

1. Clear sealer - on concrete surfaces or concrete masonry units.

2. Acceptable for use over 3 meters above floor (Underground Station)
   (a) Rough or textured concrete
   (b) Acoustic panels - in passageway areas only.

3. Not Acceptable
   (a) Monolithic Materials
      1. Rough concrete (within 3 m of floor immediately adjacent to public circulation and flow areas)
      2. Plaster
      3. Exposed steel
      4. Glass (only acceptable at elevator housing walls and other special conditions as required for safety and security and approved by Employer
      5. Curtain wall assemblies.

   (b) Unit Materials
      1. Gypsum board (acceptable for 2-hour rated enclosure at smoke exhaust duct where passing through ancillary space)
      2. Plastics
      3. Wood
      4. Glass

   (c) Surface-Applied Finishes
      1. Vinyl wall covering
      2. Paint
      3. Special epoxy coatings.

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C. Ceiling Materials

1. Acceptable

(a) Monolithic Materials

1. Smooth concrete
2. Acoustic Materials (vermiculite plaster, etc.) sprayed onto mechanically fastened expanded metal lath.

(b) Unit Materials

1. Non-corrosive linear metal panels with applied coating or natural brushed finish with wrapped acoustical material
2. Non-corrosive metal panels with applied coating or natural brushed finish with large perforations with wrapped acoustical material
3. Rigid, cellular glass blocks.

2. Not Acceptable

(a) Surface-Applied Materials

1. Gypsum plaster.

(b) Unit Materials

1. Acoustic tile (ceramic and mineral, glass and wood fiber)
2. Gypsum board
3. Suspended plaster systems
4. Wood

D. Door Materials

1. Acceptable

(a) Flush hollow metal doors and frames:

1. Public areas - alkyd enamel finish
2. Nonpublic areas - alkyd enamel finish.

(b) Wire glass at doors with vision panels

(c) Laminated safety glass at elevator, glazed doors and hoistways

(d) Stainless steel overhead rolling grilles.

(e) Stainless steel service gates.

(f) Stainless steel doors.

2. Not Acceptable

(a) Fluoropolymer finished doors and frames

(b) PVC doors

(c) Wooden, particle board doors

E. Smoke exhaust duct cladding

1. Acceptable

(a) Non-corrosive metal - natural brushed finish

(b) Non-corrosive metal with applied coating.

2. Unacceptable

(a) High polished stainless steel ceiling or smoke exhaust duct cladding.

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F. Canopy Materials

1. Acceptable

(a) Steel deck, factory-finished baked enamel

(b) Non-corrosive metal-natural brushed finish

(c) Silicone or Teflon-coated fiberglass (where out of reach of vandals).

(d) Steel, factory finished aliphatic polyurethane coated.

2. Not acceptable

(a) Ordinary glass

(b) Uncoated fabric

(c) Ordinary plastics

G. Handrails

1. Acceptable

(a) Underground Station

1. Stainless Steel - public areas

2. Painted galvanized steel - Ancillary areas

(b) Aboveground Station

1. Steel with factory finished aliphatic polyurethane coasts

2. Staincess steel, public areas

3. Painted galvanized steel

2. Not Accepted

(a) Aluminum

(b) Uncoated steel

(c) Uncoated galvanized steel

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Suggested materials are listed in the following table.

Room Name	Finishes			
	Floor	Skirting	Wall	Ceiling
Station Entrance	F-11	S-4	W-8, 19, 18	C-1
Stair Hall	F-11	S-4	W-25	C-2
Access Stair	F-11	S-4	W-25	C-2
Passageways	F-11	S-4	W-25,19	C-8
Concourses	F-11	S-4	W-18, 13	C-3
Retail Area	F-11	S-4	W-7, 9	C-3
Concession Kiosks	F-15	S-4	W7, 9	C-1
Public Area	F-11	S-4	W-18,20	C-3
Ticket Hall Supervisor Office	F-8	S-3	W-11	C-3
Ticket Office / Cash Room	F-8	S-3	W-10, 11	C-9
Ticket and Cash Trolley Store	F-3	S-3	W-11	C-6
Station Control Room	F-8	S-3	W-13	C-3
Public Toilet	F-13	S-2	W-14	C-3
Staff Room	F-7	S-3	W-11	C-3
Staff WC. / Showers	F-7	S-2	W-14	C-3
Staff Lockers	F-7	S-2	W-14	C-3
Staff Dormitory	F-7	S-3	W-17	C-9
ECS Control Room	F-7	S-3	W-13	C-6
Refuse Store	F-3	S-5	W-11	C-6
Store	F-3	S-5	W-11	C-6
Permanent Way Store	F-2	S-5	W-11	C-6
Maintenance Office/ Store	F-7	S-3	W-11	C-12
First Aid/Stretcher Store	F-7	S-3	W-17,25	C-6
First Aid Room	F-7	S-3	W-14	C-3
Cleaner	F-7	S-2	W-11	C-2
Driver, Toilet	F-7	S-2	W-14	C-3
Communications	F-3	S-5	W-13	C-6
Electrical Sub-station	F-9	S-5	W-13	C-6
Draught Relief	F-2	S-5	W-11	C-6
Emergency Fan Room	F-9	S-5	W-13	C-6
Escape Stair	F-2	S-5	W-11	C-6
Fan Room	F-9	S-5	W-13	C-6
A/C Plant Area	F-9	S-5	W-11	C-6

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Fire Water Tank	F-2	N/A	W-2	C-6
Pump Room, Sump Control + Sewage	F-9	S-5	W-11	C-6
Interlock Room	F-9	S-5	W-11	C-6
Hydraulic Pump Room	F-9	S-5	W-11	C-6
Relay Room	F-9	S-5	W-11	C-6
UPS Room	F-9	S-5	W-11	C-6
Tunnel Air Relief	F-2	S-5	W-1	C-6
UPE. + Station Air Exhaust	F-2	S-5	W-1	C-6
Station / Retail Air Intake	F-9	-	W-1	C-6
Intervention Shaft	F-9	-	W-1	C-6
CAT Check-in area	F-11	F-4	W-18, 13	C-3

Note: a)Check-in desks and furnishing at CAT shall be similar in fit, form and finishes to those of the new IGI Airport Terminal.

b) Kiosks and furnishings shall be similar in fit, form and finishes to those of the new IGI Airport Terminal

List of Material

Key	Description	Remarks
Floor		
F-1	Concrete with color Mixture,	Steel trowel finish
F-2	Concrete	Steel trowel finish
F-3	Concrete with Floor Color Hardener	
F-4	Concrete with Waterproof	
F-5	200 x 200 mm Ceramic Floor Tile	
F-6	300 x 600 x 25 mm Precast Terrazzo Tile	
F-7	Ceremic Tile (200 x 200 mm)	
F-8	Computer Raised Floor	
F-9	Granilithic Floor	Steel trowel finish
F-10	Granilithic Screed Floor	
F-11	300 x 300 mm Granite	
F-12	300 x 300 mm Unpolished Artificial Granite Floor Tiles	
F-13	300 x 300 mm Ceremic Floor Tiles	
F-14	Polished Cement Finish	
F-15	600 x 600 mm Granite Floor Tiles	
F-16	Precast Terrazzo Tile	
Wall		
W-1	Concrete	
W-2	Concrete Smooth Surface	Exposed
W-3	Cement Plaster	
W-4	70 mm. Concrete Block	
W-5	195 mm. Concrete Block	
W-6	Secondary Wall Lining	
W-7	Glass Mosaic	
W-8	Glass Wall	
W-9	Vitreous Enamel Panels	
W-10	Clear Toughended Glass	
W-11	Colored Epoxy Paint	
W-12	Colored Epoxy Paint with Glass in Stainless Frames	
W-13	Colored Epoxy Paint + Acoustic Board	
W-14	Glazed Ceremic Tile	
W-15	Spray-on Textures Acrylic	Solvent Base
W-16	Aluminum Cladding 3 mm. Thickness	
W-17	Interior Acrylic Emulsion Paint	

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W-18	0.60 x 0.60 x 0.20 m. Polished Granite	flamed
W-19	0.30 x 0.30 Granite Tile	
W-20	Plastered brick wall	
W-21	Off-Formed R.C. Wall	
W-22	Precast Concrete Panel	
W-23	0.30 x 0.15 m. Ceremic Wall Tile	
W-24	P.C. linear Wall	
W-25	200 x 200 mm. Ceramic Wall Tile	
W-26	100 x 300 x 10 mm. Precast Terrazzo Tile	
Skirting		
S-1	Rasin-based Terrazzo	
S-2	Ceramic Tile	
S-3	Vitrified tile	
S-4	Granite	
S-5	Colour Enamel Paint	
Ceiling		
C-1	Aluminum Panels	
C-2	Folded, Perforated Aluminum	
C-3	Folded, Perforated Aluminum	
C-4	Clear Toughened Glass	
C-5	Clear Toughened Glass	
C-6	Gypsum Board Ceiling	
C-7	Extruded Aluminum Ceiling	
C-8	Grid Aluminum Ceiling	
C-9	Acoustic Mineral Fiber Board Ceiling	
C-10	Off-formed R.C. slab with smooth surface	
C-11	Fairfaced Concrete	
C-12	Metal Ceiling Panels	
C-13	Feature Ceiling Panels	
C-14	Continuous Aluminum Ventilation Grill	
C-15	Glass Reinforced Concrete Panel	
C-16	12 mm. Gypsum	

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PART III

CHAPTER 1

GENERAL TECHNICAL REQUIREMENTS

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1.0 General

1.1 Scope of Document

1.1.1 This Specification for the Metro Railway Electrical & Mechanical engineering sets out the general requirements applicable to each System for quality in workmanship and material, and the reliability and safety of the engineering to be provided by the Concessionaire. The General Technical Specification shall be read in conjunction with Part III, Chapters' 2 to 12, inclusive.

1.2 Standards and Codes of Practice

1.2.1 The design of the Airport Metro Express Line (AMEL) Fixed E&M Systems and Rolling Stock and their Operation and Maintenance shall, in general, comply with the recommendations of NFPA-130 -- 'Standard For Fixed Guideway - Transit and Passenger Rail Systems'

1.2.2 Throughout the Specifications, reference is made to Codes and Standards which establish the quality of workmanship and materials, and which establish methods for testing and reporting on the pertinent characteristics. Where a specific Standard or Code is quoted in the Specifications it may be substituted with an equivalent Standard or Code when accepted by the DMRC.

1.2.3 Where India Government Regulations, local Ordinances, Codes and Standards affect the choice of plant, materials or equipment, the plant materials or equipment supplied shall comply with all relevant sections of such regulations even though no particular reference may be mentioned in this Specification.

1.2.4 The Concessionaire shall design and operate the AMEL in compliance with the DMRC "Conditions of Contract on Safety, Health and Environment" (Schedule S).

1.2.5 It is the Concessionaires responsibility to provide new materials and workmanship which meet or exceed Standards' or Codes' which are approved by the DMRC.

1.2.6 Standards indicated in the Specifications are provided solely for the guidance of the Concessionaire. Other National or International Standards may be proposed by the Concessionaire, for review and acceptance by the DMRC, from countries with a significant railway industry, such as:

European Norm (EN);

International Electro Technical Committee Standards (IEC);

International Standards Organisation (ISO)

Japanese Industrial Standard (JIS);

United States of America (AIS, AAR).

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1.3 Definitions

Table 1.3.1 Definitions

Term	Definition
Commissioner	The Commissioner of the Metro Railway Safety, as appointed in accordance with the Delhi Metro Railway O&M Act, 2002
O&M Act	The Delhi Metro Railway (Operation and Maintenance) Act, 2002 and Amendments issued by an Act of the Central Government.
The Works	All labour, materials and equipment to be fitted into the stations and tunnel structures constructed by the DMRCs' C&S Contractor by the Concessionaire, necessary to implement the AMEL Operations and Maintenance Requirements.

1.4 Requirements

1.4.1 The DMRC requires that the Airport Metro Express Line will provide and continuously operate safely, efficiently, reliably and trouble free. To this end, the DMRC shall review the Concessionaires proposed engineering and equipment for assurances for Reliability, Availability, Maintainability and Safety.

1.4.2 The Concessionaire shall develop his own detailed engineering to meet the Operations and Maintenance Requirements (Schedule L) and the DMRC requirements outlined in the Contract for the Safe and Reliable Operation of rail passenger services. The Concessionaire shall retain an Independent Railway RAMS Assessor to supervise all of the Concessionaires RAMS activities. The scope of work shall be proposed by the Concessionaire and Approved by the DMRC.

1.4.3 The Concessionaire shall be responsible for the engineering services of the Metro Railway System and shall satisfy himself that the sizes, ratings and quantities of equipment meet the functional and Operating and Maintenance requirements as specified in the Contract. The Concessionaire shall conduct simulations to ensure that the Systems engineering meet the DMRC requirements in terms of operating Line Capacity and reliability.

1.4.4 All systems and equipment to be used for the Metro System and CAT shall be designed for operation, taking into account the local climatic conditions.

1.4.5 The Concessionaire shall be responsible to develop and coordinate the Interface Management Plan as specified in the Contract. The Concessionaire shall make all necessary provisions to define and develop compatible interfaces between the DMRC Contractor for Civil and Structural Works for the Airport Metro Express Line and the IGI Airport Project Management Consultants, Airlines and Airline Agents, National and Local Government Agencies, Utility Companies and the like.

1.4.6 Where the Concessionaire identifies conflicts between any element of the Civil Works and System Works, which may result in safety hazards, poor access, equipment interference, routing problems, poor maintenance provisions or general bad practice the Concessionaire shall issue proposals to the DMRC for approval to overcome the conflict

1.4.7 The Concessionaire shall submit his engineering design for review and/or approval of the DMRC in progressive stages. The Engineering Process shall consist of three submittals, Initial, Intermediate and Final as described in the Contract. The Concessionaire shall

demonstrate the integration of all systems by test.

1.4.8 In addition to the engineering design submittals, the Concessionaire shall submit all drawings, specifications, simulation reports, calculations and assumptions, and the like, which represent the final constructed works. The As-Built drawings shall be dimensioned and sufficiently detailed to support any modifications to the constructed Works, extensions to the AMEL, and the investigation of abnormal or unsafe incidents.

All original copies of test documents shall be submitted to the DMRC for his records.

1.4.9 In accordance with The Delhi Metro Railway (Operations and Maintenance) Act 2002 and amendments, the Concessionaire is required to certify his engineering is fit for operation and safe for passenger use. The Central Government appointed Commissioner of Metro Railway Safety shall inspect and test the AMEL engineering design, equipment and installation and recommend the Central Government to sanction the AMEL to commence passenger rail services. The Central Government approval is necessary for the Concessionaire to commence revenue Operations.

The Concessionaire shall fully cooperate with the Commissionaire of Metro Railway Safety, New Delhi Emergency Services (police, fire and ambulance services), Central and Local Government Agencies Utility Companies, and the like, in the pursuance of the certification necessary to commence Operations.

1.4.10 The Design of the E&M Systems and Rolling Stock shall enable compliance with DMRC, Conditions of Contract on Safety, Health and Environment.

1.5 Engineering Philosophy and Requirements

1.5.1 Systems designs and equipment shall be having proven in service design.

(1) The Concessionaire shall develop the engineering based on the specifications and drawings and with proven and reliable engineering practices. The engineering with all technical data and calculations shall be submitted to the DMRC for his review of the quality of equipment to be supplied and reliability in service.

(2) The Sub-systems and equipment proposed by the Concessionaire shall have been in revenue service with at least two Metro Railway Systems and shall have established performance reliability over a minimum period of two years, during past ten years.

(3) Adequate margin shall be built into the engineering to protect against the high ambient temperatures, the seasonal humidity, the corrosive conditions, and the effects of lightning strikes, etc. prevailing in New Delhi

1.5.2 Design drawings and documents

(1) The Concessionaire shall submit his proposals for the engineering systems design the equipment in three stages for the review by the DMRC, as follows:

(i) The Initial Engineering submission shall include the Design Submission Programme; each system outlines design and equipment specifications. Also, Standards, Interface Management Plan, Quality Assurance Plans, Systems Assurance Plans, EMC Plan, RAMS management plan,

simulation tools, calculations and assumptions, software programmes and listing, third party co-ordination arrangements, and the like, necessary for the Works, to enable the DMRC to have a complete understanding of the equipment and system arrangement to be provided.

(ii) The Intermediate Engineering submission shall include the detail design drawings and software programmes for each System engineering and coordinated interface requirements, to enable the DMRC to have a complete understanding of the detail design of the system arrangements.

(iii) The Final Engineering submission shall include the systems detail design documents, including the integration of all interfaces, all engineering management plans, manufacturing and installation programmes

The testing and commissioning specifications, plans and procedures are to designed to verify that the Airport Metro Express Line railway is fit for passenger use. During Test and Trial Running the O&M Specification requirements shall be demonstrated and simulated emergency scenarios conducted in conjunction with the New Delhi emergency service authorities. RAM demonstration tests shall be undertaken during the initial year of revenue service.

1.5.3 As-Built Drawings

(1) The Concessionaire shall produce as-built drawings to show the final installed arrangements of all elements of the systems, sub-systems and equipment and shall contain sufficient detail and information to allow maintenance work and any future alteration or repair work to be undertaken without the need for any other drawings or Design Data.

(2) The original copy of all test records shall be endorsed by the testing engineer and returned to the DMRC for his keeping.

END OF SECTION 1

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2. Quality Assurance, Software Assurance and System Assurance

2.1 General

2.1.1 A Quality Assurance Program Plan shall be developed and implemented by the Concessionaire as a means of determining compliance with the DMRC objectives. This Plan shall comply with the requirements as set out in ISO 9000 series of Quality Control Standards. The Program shall include, but not be limited to, the procedures necessary to ensure that all equipment, materials, systems and sub-systems are properly specified, engineered, purchased, recorded, inspected, installed and tested at all appropriate stages. The procedure shall also ensure that handling, storage and delivery arrangements are satisfactory.

2.2 Quality Assurance Program

2.2.1 The Quality Assurance Program shall include as a minimum, the following functions:-

(1) Record System: Data and records essential to the operation of the Quality Assurance Plan shall be maintained by the Concessionaire and made available to the DMRC upon request. These records shall include, design checking, inspection and testing observations and the number and type of deficiencies found. In addition, records shall be maintained for monitoring work performance, inspection and testing which indicate the acceptability of work or products and the remedial action taken in connection with deficiencies.

(2) Design Checking System: Engineering design shall only be undertaken by appropriately qualified and experienced persons in the field. A procedure for checking calculations, assumptions and drawing shall be instituted. All engineering documents shall be signed by the author and the checking person(s).

The Concessionaire shall submit checklists to demonstrate compliance with all applicable standards.

(3) Inspection Record System: A documentation system to record the processes of the Quality Assurance Plan.

(4) Calibration System: A system for periodic calibration and control of the accuracy of precision instrumentation and gauges employed by the Concessionaire.

(5) Supplier Control System: A system for ensuring that all supplies and services procured from suppliers (sub-contractors and vendors) conform to the requirements of the Contract. The records system shall enable components to be traced, from their manufacture to sub-assembly and equipment and final installation at site.

(6) Manufacturing Control System: A system for providing necessary control over manufacturing operations to ensure that the final product conforms to all requirements of the specifications. This system shall include controls for the following:

a) Materials: Suppliers' materials and products shall be subject to inspection to demonstrate conformance with the technical requirements.

b) Production Process and Fabrication: The Concessionaires Quality Assurance Programme shall ensure that all machinery, wiring, batching, shaping and basic production operations (of any type) together with all processing and fabricating are accomplished through documented work instructions. These instructions shall be the criteria for acceptable workmanship.

c) Completed Item Inspection and Testing: The Quality Assurance Plan and

programme shall ensure that there is a system for final inspection and testing of completed products. Such testing shall provide a measure of the overall quality of the completed product and be performed so that it simulates, to a sufficient degree, product end use and functioning.

d) Statistical Quality Control and Analysis: Statistical methods may be utilised for planning, analysis, tests and quality control whenever such procedures are suitable for maintaining the required control of quality. Sampling plans shall be subject to the acceptance of the DMRC prior to use

e) Traceability and Indication of Inspection Status: The Concessionaire shall maintain a positive system for identifying the origin and inspection status of products and materials. Identification may be accomplished by means of permanent stamps, tags, routing cards, move tickets or other control devices acceptable to the DMRC.

(7) Installation Control System: A system providing necessary control, monitoring, inspection of the progress, quality of work and protection of equipment, to ensure that the equipment is installed according to the requirements of the contract.

2.2.2 The Quality Assurance Plan shall include but not be limited to the following, which shall be subject to the acceptance of the DMRC prior to use:

(1) Design Specifications, Drawings and Software: All design documentation and electronic programmes required for the Electrical and Mechanical equipment necessary for the Operation and Maintenance of the AMEL

(2) Shop Drawings: All layout and shop drawings giving detailed layout of equipment, structural cut-outs, supports, openings, all dimensions, tolerances setting, etc

(3) Assembly Procedures and Drawings: These shall show details of all equipment assembly and factory testing, site installation procedures, including inspections and tests to be undertaken.

(4) Inspection Checklist: Checklists giving all items to be checked and inspected with tolerances setting, etc.

(5) Certification

Certification shall be provided as applicable for:

a) The DMRC

b) Commissioner of Railways, as defined by the DMRC (O&M) Act 2002 and Amendments;

c) Electrical Inspector of the Government of India

d) Power and Telecommunications Consultative Committee;

e) TRANSCO and DISCOM (Electricity Authorities);

f) Delhi Fire Department;

g) Delhi Police Department; and

h) Delhi Ambulance Department.

(6) Quality Assurance programmes to be implemented during the Operation Period.

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2.3 Software Assurance

2.3.1 General

Where software is a deliverable, the Concessionaire shall comply with the requirements in this Section for the management and assurance of the development of the software. The Concessionaire shall ensure that only licensed software is provided. All software delivered shall be copied to the DMRC.

2.3.2 Definition

(1) The term "software" used within the scope of this Specification shall cover software and firmware.

(2) "Safety Related Software" is any program operating a Programmable Electronic System whose function is to give assurance of safety for human life or the environment.

2.3.3 Software Quality Standards

(1) The Concessionaire shall comply with the requirements of ISO/IEC 9001:2004 "Software engineering - Guidelines for the application of ISO 9001:2000 to computer software" to establish and maintain the quality assurance framework for the development of software.

(2) For any software deliverable which is justified as Safety Related Software, the Concessionaire shall further comply with the requirements of the EN50128 1997 for the development of the software and EN 50129 for the review and Approval of DMRC.

2.3.4 Software Quality Document

The Concessionaire shall submit a Software Quality Assurance Plan to the DMRC for review. The Software Quality Assurance Plan shall comply with the requirements of EN50128:1997 and shall be specific for the software system to be developed.

2.3.5 Software Quality Audit

The DMRC may conduct software quality audits on software development activities at the Concessionaires premises. The Concessionaire and his sub-contractor's shall co-operate with the audit team and provide timely and reasonable access to all personnel, activities, software, source code, documentation, procedures and records in connection with the software development activities. At least fourteen days of advance notice will be given to the Concessionaire for each audit.

2.3.6 Software Engineering

(1) The Concessionaire shall develop a lifecycle model detailing the development processes of each software product. The lifecycle model shall clearly define, but not be limited to, input documents, output documents, review process, Verification and Validation activities throughout the lifecycle of the software development.

(2) The Concessionaire shall use systematic analysis and design methods in conducting software requirements analysis and design. Software documentation structure shall be clearly defined. Appropriate Verification tools such as cross reference tables shall be produced to support traceability of the software requirements in all software documents such as design documents and testing documents.

(3) Where new software is to be developed or existing software is to be modified, the Concessionaire shall establish and implement procedures to cover the production, collation and analysis of software metrics. The metrics shall be conducted as part of

the software test. The metrics and the acceptance criteria shall be appropriate to the development methods and the software to be produced and shall be submitted to the DMRC for review.

2.3.7 Software Assurance

(1) System operating software shall have been independently validated and proven in service, with a Metro Authority recognized by the DMRC, for a period of at least 5 years. All modifications undertaken to the proposed programs during the qualification period, together with the Metro Authorities test reports shall be advised to the DMRC.

(2) Applications software shall be verified by a qualified organization and proven during test.

(3) The Concessionaire shall provide justifications for his determination of the Safety Integrity Level (SIL) of any software components prior to the software requirement phase in accordance with the functional safety of programmable electronic Systems, in accordance with IEC 61508: 2002, as follows:

Degree 4 - to prevent train collision and derailment;

Degree 3 – to identify integrity and characteristics of trains;

Degree 2 – to manage rail traffic;

Degree 1 – to inform passengers; and

Degree 0 – to manage the railway.

All software components within a system or subsystem shall by default have the same SIL of the system or subsystem. However, SIL of the software components may be altered with further justifications. All justifications shall be submitted to the DMRC for review without objection.

(4) Where existing software is to be reused, the Concessionaire shall provide full justification to the DMRC. The justifications shall demonstrate that the SIL of the existing software is suitable for the application.

2.3.8 Sub-contractor Management

The Concessionaire shall establish a management framework and procedures to ascertain the quality of software produced by sub-contractor(s) of any tier. The procedures shall cover but not be limited to:

(1) Monitoring and audit of sub-contractor's software quality assurance system;
(2) Integration management of the software sub-systems;
(3) Requirement management of the software sub-systems; and
(4) Configuration management of the software sub-systems.

2.4 Systems Assurance

2.4.1 Management

The Concessionaire shall retain the services of an Independent RAMS Assessor organization to manage the RAMS procedures and the preparation of RAMS documents for review by the DMRC.

In the event that DMRC retains the services of an additional Independent RAMS Assessor, the Concessionaire and his retained Independent Assessor shall coordinate with DMRC appointed Independent and provide all documentation requested.

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2.4.2 General

The Concessionaire shall submit a compliance matrix with all phases and tasks to be performed, as detailed in the Systems Assurance Plan and Program.

(1) The Concessionaire shall develop and implement the requirements for the Systems Assurance Plan and Programme. These requirements shall also be applied to sub-contractors and suppliers and shall be carried out during the engineering, manufacture, installation, testing and commissioning phases of the Works and its operation.

(2) The Concessionaire shall prepare and submit for review and acceptance by the DMRC a Systems Assurance Plan.

(3) The System Assurance Plan shall be based on IEC 62278 (September 2002) Railway Applications – Specification and Demonstration of Reliability, Availability, Maintainability & Safety (RAMS)

(4) The System Assurance Plan shall define the Concessionaire's approach, procedures and schedules for conducting the Reliability Engineering, Availability Engineering, Maintainability Engineering and Safety Engineering, Human Factors Engineering is an integral part of Systems Assurance and shall be considered and reflected within the Systems Assurance Plan.

(5) The Concessionaire shall pro-actively engineer the systems to meet the Safety, Availability, Reliability and Maintainability performance requirements specified for the Metro Systems and demonstrate that the requirements have been met by the system installed.

(6) In the process the potential hazards to Safety, Availability, Reliability and Maintainability performance should be further minimised where design options permit.

(7) The Systems Assurance Plan (Clause 2.4.3) shall provide the DMRC with a sound basis for acceptance of the safety, availability, reliability and maintainability performance; progress information; confidence that the engineering is proceeding with a low risk of failing to meet the performance requirements information that will aid the planning of work schedules; and part of the foundation of the safety case for operation of the line.

2.4.3 Systems Assurance Plan

(1) The Systems Assurance Plan shall be developed specifically for the Systems described in this Specification and shall address in particular the following items:

(a) Safety engineering which shall provide analyses for the minimization of the magnitude and seriousness of those events or malfunctions which could result in injury to passengers or staff and damage to equipment or property; and

(b) Reliability, Availability and Maintainability engineering analysis, which shall ensure a high degree of failure-free operation and minimise down time during revenue service operations, preventative and corrective maintenance.

(2) The Concessionaire shall formulate and document criteria to achieve Availability for the AMEL Systems Engineering of 99.94% for the whole of the Works. Safety and operationally critical Systems engineering shall comply with the requirements specified.

(3) The Concessionaire shall produce a Systems Assurance Plan that integrates the systems assurance elements in all phases of the Works and incorporates a disciplined approach to evaluate the system design. The Concessionaire shall prepare hazard identification, assessment and resolution; prediction of unreliability; and determination of degree of maintainability. As a minimum, this shall include:

(a) Organising the Systems Assurance Plan to include specific sections for the disciplines of Safety, Reliability, Availability and Maintainability engineering;

(b) Describing the procedures to perform the specific tasks necessary to meet Safety, Reliability, Availability and Maintainability requirements;

(c) Clearly defining the responsibilities of personnel directly associated with systems assurance policies and implementation of the programme;

(d) Describing the systems assurance organisation; and

(e) Identifying the authority dedicated to the systems assurance organisation and the relationship between the assurance organisation and other organisational components.

(4) The Concessionaire shall co-ordinate results of Systems Assurance analysis with each engineering discipline, particularly as the results affect engineering and hardware development. The Concessionaire shall make recommendations for re-engineering or modifications necessary to assure compliance with specified requirements including redundancy, utilisation of high reliability components, built-in self diagnostics and "self healing"; utilisation of in-service status displays to enhance fault isolation and test; easy accessibility and quick disconnect connectors; and, the use of mechanical keying to reduce errors during installation and repair.

(5) The Concessionaire shall document instances where evaluations or analyses indicate an unresolved problem area and formulate appropriate recommendations as well as maintain records, which show that follow-up action has been taken to resolve the problem.

(6) The Concessionaire shall ensure participation of his Systems Assurance organisation in all engineering reviews.

(7) The Concessionaire shall maintain documentation of Systems Assurance throughout the engineering and make it available to the DMRC for examination.

(8) During consideration of precedence in the control of system hazards, the Concessionaire shall take account of human limitations as an engineering constraint. The Concessionaire shall take actions to satisfy requirements in the following order of precedence:

(a) Incorporation of fail-safe or vital features which would allow the system to transfer from a high loss or risk mode to a lower loss or risk mode upon the occurrence of a critical failure; and

(b) Reduction of the probability of occurrence of a failure by increased component reliability or by provision of supervised redundant components.

(9) The Concessionaire shall use safety devices to reduce the magnitude of the loss or risk once a hazardous mode has been entered; and ensures that the safety device does not introduce an additional hazard or system malfunction.

(10) The Concessionaire shall use warning devices and systems which are audio/visual portion of a vital system in which the human is the responder. The Concessionaire shall recommend special equipment operating procedures to reduce the probability of a hazardous event.

(11) A Hazard Log shall be established as a basis for on-going risk management. The

hazard Log shall be updated with each event identified and mitigated. Residual Risk shall be carried forward and rules and procedures proposed to the DMRC for the Management of such Residual Risk.

2.4.4 Safety Engineering

(1) The qualitative measures of hazard severity defined in Standard IEC 61508; 2002, are as follows:

Hazard Category 4 - Catastrophic: Operating conditions such that personnel error, environment, design deficiencies, subsystem or component failure or procedural deficiencies may cause death or system loss.

Hazard Category 3 - Critical: Operating conditions such that personnel error, environment, design deficiencies, subsystem or component failure or procedural deficiencies may cause severe injury to personnel, severe occupational illness or major system damage.

Hazard Category 2 - Marginal: Operating conditions such that personnel error, environment, design deficiencies, subsystem or component failure or procedural deficiencies may cause minor injury to personnel, minor occupational illness or minor system damage. Acceptable with adequate control and agreement of the DMRC.

Hazard Category 1 - Negligible: Operating conditions such that personnel error, environment, design deficiencies, subsystem or component failure or procedural deficiencies will not result in injury to personnel, occupational illness or damage to the system.

(2) Risk acceptance shall be based on the principles of "As Low as Reasonably Practicable" (ALARP) and as follows:

Category 4 hazards shall be not greater than one unsafe incident in one-hundred years (1:100 years).

Category 3 hazards shall not be greater than one unsafe incident in one-hundred years or only be accepted when the risk reduction is impractical and with the agreement of the DMRC

Category 2 hazards shall only be permitted if a desired benefit is demonstrated as generally acceptable within accepted levels for the international railway industry and in agreement with the DMRC.

Category 1 hazards shall only be permitted if assured that the risk will remain at that level and any residual risk shall be mitigated by Operating Rules and Procedures.

(3) The Concessionaires safety engineering shall employ hazard analysis tools, as follows:

(a) Subsystem Hazard Analysis (SSHA)

(b) Interface Hazard Analysis (IHA)

(c) Operating and Support Hazard Analysis (O&SHA)

(d) Quantitative Fault Tree Analysis (QFTA)

(e) Failure Modes, Effects and Criticality Analysis (FMECA)

(f) Quality Assurance Requirements (EN 29001)

(4) The Concessionaire shall fully develop a Safety Critical Items List (SCIL) which shall be

updated as required and carried forward throughout implementation until final resolution of identified hazards is achieved. The SCIL shall include the following areas:

(a) Protection of the transit system from illegal intrusion;

(b) Clearance from trains for people;

(c) Identification of safe refuges in the infrastructure for staff;

(d) The track system shall provide safe guidance and support for trains;

(e) Clearance between adjacent tracks for trains and fixed structures;

(f) Structures supporting the track and train loads;

(g) Earthworks above and structures adjacent to tunnels;

(h) Tunnels and enclosed spaces should provide a safe environment for people and safe evacuation;

(i) Stations should provide for free and safe movement of people;

(j) Platforms should allow for the safe occupancy by people and boarding or alighting trains;

(k) Where stations have terminal tracks, arrangements should be provided to stop a train and protect people and the infrastructure from the effects of a train over-run

(l) Facilities should be provided for the safe control of the transit system during all operations;

(m) Stations and the guide-way should allow for safe evacuation in an emergency;

(n) Buildings, including stations and tunnels should have fire and fume prevention and control measures commensurate with the fire risk and evacuation arrangements;

(o) The Metro System should provide for the safe stabling, shunting and maintenance of trains;

(p) The electric traction system should not present safety hazards for people, and shall prevent climbing of OHL poles by children or animals;

(q) The electric traction system should provide for its safe management and operation;

(r) The electric traction system should not give rise or be subject to dangerous interactions within the transit system or with other systems

(s) The signalling and train control system should provide for safe routing, separation and control of trains;

(t) In the Depot, where people and vehicles may cross the track level, warning arrangements should be provided;

(u) The structural integrity of trains should be maintained in normal operations and afford protection to people in the event of an accident;

(v) The interior of trains should provide a safe environment for people;

(w) Trains should have a safe means of access, egress and of people;

(x) There should be effective means of communicating safety messages to, from

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and within a train;

(y) The electric and other powered systems and equipment on-board trains should not endanger other systems or people;

(z) The speed regulation system of trains should meet the operational requirements of the transit system without endangering people;

(aa) The running gear should guide trains safely along the track;

(bb) The trains should be compatible with the signalling system;

(cc) The trains should be dimensionally compatible with the infrastructure;

(dd) Public and DMRC safety including all systems required for evacuation and warning information;

(ee) Trains should be compatible with the power supply and electric traction system; and

(ff) Trains shall have an emergency egress facility and be ventilated.

(5) The Concessionaire shall develop and submit for the DMRC and Independent RAMS Assessor review, the following:

(a) RAMS policy and criteria and Management Plan;

(b) Hazard Log;

(c) Reports, as follows:

i) Evaluation of the specified RAMS policy and criteria;

ii) Identification of hazards and analysis;

iii) Mitigation of risk and assessment of residual risk;

iv) Management of residual risk;

v) RAM's analysis and calculation and apportionment for sub-systems

vi) Demonstration of achievement of specified RAMS criteria; and

vii) Documentation and co-ordination with the Operating Concessionaire

(6) Further, the information presented by the Concessionaire shall be supported by the history of tests conducted and by approved test certificates from accredited laboratories which attest to the engineering program characteristics and behaviour.

2.4.5 Reliability and Maintainability Engineering

(1) Reliability and Maintainability requirements and goals shall be developed in terms of Mean Time Between Service Affecting Failures (MTBSAF) and Mean Time to Restore (MTTR) failure

(2) Final Reliability and Maintainability predictions shall be verified by testing after the System's engineering has been completed

(3) The sub-systems and equipment shall be engineered to maximise System Availability during traffic hours, to minimise the amount of maintenance required and to ensure that any maintenance can be easily and quickly carried out, and at minimum cost.

(4) The Concessionaire shall perform Reliability and Maintainability analyses of each System, up to the point of interface with other systems.

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(5) Reliability block diagrams shall be developed which show each equipment element that is essential to the performance of the system, including element interrelationships. Block diagrams shall be revised to keep current with design iterations.

(6) The Concessionaire shall develop a Reliability model consisting of Reliability block diagrams and probability of success equations. The model shall show the relationships required for system success. The Concessionaire shall revise the model to keep current with design iterations

(7) The Concessionaire shall provide Reliability prediction and apportionment in accordance with established techniques or standard or properly documented and verifiable field failure data for identical or similar equipment. The standards used or the source of field data shall be identified.

(a) Quantitative Maintainability assessments to all significant functional levels of the system, subsystems or equipment shall be allocated. Maintainability analyses during engineering, development and testing shall be used to evaluate the degree of achievement of the maintainability requirements. The Concessionaire shall identify the standards by which these allocations are made.

(b) The Concessionaire shall develop predictions to judge the adequacy of the proposed engineering to meet quantitative Maintainability requirements and shall identify design features requiring corrective action during early stages of engineering and development.

(c) The Concessionaire may submit existing analyses which are properly documented and verifiable for equipment and applications which are identical or manifestly similar. Existing data need not conform to the agreed format but shall contain the same data presented in a neat, concise and logical manner.

(8) In all Maintainability calculations the following access times shall be assumed:

(a) 30 minutes for train-borne equipment;

(b) 30 minutes for equipment located in equipment rooms that are accessible during traffic hours; and

(c) 20 hours for trackside equipment or equipment located such that it is only accessible during non-traffic hours.

2.4.6 Mean Time to Restore (MTTR)

(1) MTTR calculations shall not include the access times assumed in this Particular Specification

(2) The required MTTR shall be achieved for failures of the whole System or any part of the System, whether service affecting or not.

(3) The following MTTR shall be achieved:

(a) 15 minutes for train-borne equipment;

(b) 15 minutes for train detection equipment;

(c) 30 minutes for other trackside equipment; and

(d) 15 minutes for equipment located in equipment rooms or control rooms.

(4) The measurement of MTTR shall include on site diagnostics and rectification of the failure (including software re-boot) up to the point that the System is restored to full

functionality. In the event that the failure cannot be rectified, this time measurement shall include the time necessary to remove the failed piece of equipment from the System and replace it with a functioning one.

(5) The Maintainability requirements of the transit system shall be demonstrated by the Concessionaire. The Demonstration specifications shall be proposed by Concessionaire, for Approval of the DMRC.

2.4.7 Reliability, Maintainability, Demonstration, Testing

(1) The Reliability, Maintainability, Demonstration, Testing (RMDT) shall be carried out after the Systems commissioning tests. All equipment shall be included in the RMDT and shall be fully operational. The Concessionaire shall perform failure/incident data analyses, component analyses and provide the remedial engineering and associated tests. The Concessionaire shall submit weekly status reports, which shall include as a minimum a statement of failures, status of failure dispositions and achieved MTBSAF for each subsystem.

(2) The Reliability, Maintainability, Demonstration, Testing (RMDT) shall be conducted on all Systems, subsystems and their interfaces. The DMRC reserves the right to determine the level of Reliability achieved for the AMEL before authorizing Revenue Service.

2.4.8 Availability Demonstration

(1) Availability shall be calculated as follows:

$$\text{Availability} = \frac{\text{MTBSAF} \times 100}{\text{MTBSAF} + \text{MDT}} \quad \%$$

Where MDT = Mean Down Time of service affecting equipment.

(2) The demonstration test measure for Availability shall consider the performance of the Concessionaires installed equipment, operator staff competence, and the effectiveness of operating rules and procedures.

(3) During the Trial-Running period and the initial 12 months of revenue service, the Concessionaire shall demonstrate the Availability performance in progressive stages; the Concessionaire may elect the period for each demonstration, within the specified period for each stage. In the event of failure to achieve the specified Availability criteria during each demonstration, the Concessionaire shall promptly remedy the items that fail to provide the required performance levels.

Stage 1:

During Trial Running and prior to issue of the Central Government authorisation of revenue service, the Availability shall be demonstrated during four trials, within a four week period, as follows:

(a) During a demonstration period of 4 consecutive days of operating an "initial service", 98% of Trips shall be complete within +/-15 minutes of the schedule time;

(b) During a demonstration period of 4 consecutive days of operating an "initial service", 98% of Trips shall be complete within +/-10 minutes of the schedule time;

(c) During a demonstration period of 3 consecutive days of operating an "initial service", 98% of Trips shall be complete within +/-5 minutes of the schedule time; and

(d) During a demonstration period of 3 consecutive days of operating an "initial service", 98% of Trips shall be complete within +/-2 minutes of the schedule time.

Stage 2:

Not less than 3 months after the Central Government authorisation to commence revenue services, and within a four week period the Stage 2 Availability shall be demonstrated during four consecutive trial, as follows:

(a) During a demonstration period of 4 consecutive days of operation, 99% of Trips shall be complete within +/-15 minutes of the schedule time;

(b) During a demonstration period of 4 consecutive days of operation, 99% of Trips shall be complete within +/-10 minutes of the schedule time;

(c) During a demonstration period of 3 consecutive days of operation, 99% of Trips shall be complete within +/-5 minutes of the schedule time; and

(d) During a demonstration period of 3 consecutive days of operation, 99% of Trips shall be complete within +/-2 minutes of the schedule time.

Stage 3:

On completion of any remedial work consequent on Stage 2 Availability demonstrations, but not less than six months after issue of the Central Government authorization to commence revenue service and within a four-week period, Stage 3 Availability shall be demonstrated during 4 consecutive trials, as follows:

(a) During a demonstration period of 4 consecutive days of operation, 99.5% of Trips shall be complete within +/- 15 minutes of the schedule time;

(b) During a demonstration period of 4 consecutive days of operation, 99.5% of Trips shall be complete within +/-10 minutes of the schedule time;

(c) During a demonstration period of 5 consecutive days of operation, 99.5% of Trips shall be complete within +/- 5 minutes of the schedule time; and

(d) During a demonstration period of 5 consecutive days of operation, 99.5% of Trips shall be complete within +/-2 minutes of the schedule time.

Stage 4:

On completion of any remedial work consequent on Stage 3 Availability demonstrations, but not less than nine months after issue of the Central Government authorisation to commence revenue service and within a four-week period, Availability shall be demonstrated during 3 consecutive trials, as follows:

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(a) During a demonstration period of 10 consecutive days of operation, 99% of Trips shall be complete within +/-5 minutes of the schedule time;

(b) During a demonstration period of 10 consecutive days of operation, 99% of Trips shall be complete within +/- 2 minutes of the schedule time;

(c) During a demonstration period of 4 consecutive days of operation, 99% of Trips shall be complete within +/- 1 minutes of the schedule time.

(3) In addition to the service Availability demonstrations, the following major events shall be demonstrated during the first 9 months of revenue service:

(a) Failure of a train to be Available for revenue service at a scheduled time shall be limited to one each month;

(b) Closure of any station to passengers shall be limited to one during the first 12 months of revenue service; and

(c) Severe disruption resulting in services being disrupted for more than one hour shall be limited to two during the first 3 months and one during each of the subsequent three months.

2.4.9 Submissions

(1) Quality Assurance Plan & Software Assurance Plan

(2) The Systems Assurance Plan for each system.

(3) The Preliminary Systems Assurance Report for each system shall be submitted for review.

(4) The Final Systems Assurance Report for each system shall be submitted for acceptance as part of the engineering submission.

(5) The Reliability, Availability, Maintainability and Safety Demonstration Test Plans shall be submitted for each system for acceptance as part of the Final Engineering submission.

(6) Reliability, Availability, Maintainability and Safety demonstration test results for each system shall be submitted for acceptance 30 days after completion of the demonstrations.

END OF SECTION 2

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3. Electromagnetic Compatibility (EMC) Assurances

3.1 EMC Management Plan

3.1.1 The Concessionaire shall prepare and submit for review by the DMRC, an EMC Management Plan which shall be based upon a top-down approach. A top down approach shall allow for high level plans to be developed based upon specified performance goals without precluding the submission of subsequent detail plans as required or directed by the DMRC. The EMC Management Plan shall define the EMC philosophy, activities, and means of control for the engineering processes and EMC submissions, to be supplied to demonstrate compliance with the Contract.

3.1.2 The EMC Management Plan shall:

(1) Identify a comprehensive list of specifications, standards, method statements and procedures to be submitted to the DMRC for review.

(2) Include a programme that shall identify the dates for EMC submissions.

(3) Identify all internal and external generators and suspected equipment of Electromagnetic Interference (EMI) and the interfaces.

(4) Model the induced and coupled Electromagnetic Interference between the OHLE contact wire in bored tunnels and external cables. Screening arrangements shall be provided for compliance with the Power and Telecom Consultation Committee.

(5) Include measures to reduce conducted, induced, and radiated emissions, especially the levels of harmonics, to acceptable values as specified by the relevant international standards or by the concerned statutory authority.

(6) Include a definition and description of the process and methods used for Verification and Validation that the Works will achieve the required EMC parameters in all respects.

(7) Include an initial list of engineering documentation, test specifications and test reports with a single paragraph functional description of each document to indicate compliance with the Contract

3.2 EMC Co-ordination

3.2.1 The Concessionaire shall co-ordinate the levels of interference emissions and susceptibility of all equipment that are to be engineered, manufactured, supplied and installed by the Concessionaire and his sub-contractors and suppliers.

3.2.2 The Concessionaire shall liaise and co-ordinate with all manufacturers/suppliers and external agencies (police, military and governmental) in the exchange of EMC data and related equipment performance characteristics. A copy of all EMC related information exchanges shall be sent to the DMRC for review.

3.3 EMC Engineering

3.3.1 The Concessionaire shall ensure that all electrical and electronic apparatus are engineered and constructed to operate without degradation of quality, performance or loss of function and data in the electromagnetic environment of the Project.

3.3.2 The Concessionaire shall comply with the requirements of the international standards EN 50121-1/-/5 Railway Applications – Electromagnetic Compatibility, 2003 and related standards and the IEC 61000 series for Electromagnetic Compatibility, or equivalent Standards Approved by the DMRC. EMC considerations shall be incorporated in the Concessionaires procedures for functional Safety and Engineering Verification.

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3.3.3 The engineering shall ensure that any electromagnetic interference emissions introduced into the environment do not exceed that determined for the EMC Plan. The Concessionaire shall ensure that the electromagnetic emissions and susceptor equipment requirements do not cause or suffer unsafe or unreliable interferences between equipment, under normal and abnormal traffic working scenarios'. Any shortcomings in achieving EMC shall be made known to the DMRC immediately and recommendations for corrective action formulated.

3.3.4 In respect of engineering documentation, the Concessionaire shall demonstrate by theoretical analysis and related tests that the engineering of the electrical and electronic systems is fully compliant with the EMC requirements identified in The EMC Plan. The Concessionaire shall state clearly in the documentation, all the assumptions made and parameters used in the analysis.

3.3.5 Where theoretical analysis is deemed necessary, the Concessionaire shall detail the process and methods used for Verification and Validation of any simulation models used in support of the analysis. The Concessionaire shall prepare and submit to the DMRC for review, reports of the Verification and Validation of the models.

3.3.6 In the circuit analysis, calculations shall be made for all component tolerance effects due to manufacture, environment, ageing, and all possible component Failure Modes. If any component can exist in a Dormant Failure Mode, the analysis shall assume that the component has failed. The Concessionaire shall identify all component Failure Modes and produce evidence that any component failure shall not cause an unsafe operation.

3.4 EMC Testing

3.4.1 EMC type testing shall be carried out on all equipment identified in the engineering stage which requires attention regarding EMC. These shall include all EMC tests to be completed. Tests to be conducted shall include but not be limited to satisfying the requirements of the standards listed.

3.4.2 The Concessionaire shall identify all components to be tested, specify the interval between routine tests, define the test procedure and provide Verification levels and pass marks which must be achieved. The Concessionaire shall carry out proof testing of circuit components.

3.4.3 The Concessionaire shall supply documentation showing how system Safety and Reliability is ensured. It shall include Failure Modes, system failures, the effect of human intervention and how equipment thresholds have been set in order to keep them significantly above worst-case interference levels, and how allowance has been made for equipment tolerances and other characteristics in the equipment specification.

3.5 EMC Audits and Corrective Action

3.5.1 The DMRC may conduct an independent EMC audit for the System, sub-systems and component parts and shall therefore require access to all the relevant engineering and production information. The Concessionaire shall provide assistance to the DMRC in conducting his tests.

3.5.2 The DMRC may request that tests be carried out to simulate the Failure Mode of any critical hardware/software component that is considered to have a significantly detrimental effect.

3.5.3 The Concessionaire shall implement corrective actions to rectify any EMC problems identified during engineering, on-site testing and when the whole system is in operational service

3.5.4 The Concessionaire shall be fully aware of the EMC requirements and any modifications to systems and equipment carried out by the Concessionaire during the Defects Liability Period

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shall not cause the immunity or emission levels of the installed system and equipment to exceed such values. Detailed EMC documentation on all modifications carried out shall be submitted to the DMRC for review. Modification work shall not commence until the respective submission has been reviewed by the DMRC.

3.6 Environmental EMC

3.6.1 The Concessionaire shall ensure that radiated emissions from the equipment are maintained at an internationally acceptable level.

3.6.2 The Concessionaire shall also ensure that the equipment is protected from RF radiation in accordance with the relevant International Standards.

3.6.3 The Concessionaire shall be responsible for mitigation of disturbances to susceptible equipment, located adjacent to the AMEL corridor, which is attributed to EMI generated by the Systems equipment.

3.7 Installation and Mitigation Guidelines

A consistent series of guidelines, such as the IEC61000 series, shall be observed wherever applicable.

3.7.1 Earthing

An Earthing system should be engineered to assure personnel safety and protection of installations against damage in accordance with EN 50122-1, IEEE 80 and IS 3043. It should also serve as a common voltage reference and to contribute to the mitigation of disturbances.

To achieve the primary goal of assuring personnel safety and damage control, a low impedance path shall be made available to large currents generated due to lightning or power system fault. The potential differences (touch and step voltages) between any two points shall be as low as possible. Safety considerations also require the chassis or enclosure to be earthed to minimize shock hazards to passengers and the maintenance staff.

To achieve the secondary goal of providing protection for sensitive and interconnected electronic and electrical systems, Earthing should be engineered to minimize the noise voltage generated by currents from two or more circuits flowing through common earth impedance and to avoid creating earth loops susceptible to magnetic fields and differences in earth potentials.

Earthing shall also be designed to accomplish the following minimum requirements:

(1) Protect personnel and equipment from electrical hazards, including lightning, where practical.

(2) Reduce hazardous touch voltages relative to Earth.

(3) Reduce or eliminate the effects of electrostatic interference and electromagnetic interference arising from within the system.

(4) Provide a single-point Earthing method for all equipment enclosures, cabinets, drawers, assemblies and sub-assemblies.

(5) Provide a clean zero-volt reference point for signals in computer and related equipment.

3.7.2 Bonding

Bonding all exposed metallic parts of all equipment and connecting them to the Earthing network shall meet the safety requirements and minimize noise voltages due to potential differences.

Direct bonding should be used wherever practical. Where indirect bonding via bonding strap is used to connect two isolated items, the bond must satisfy the following minimum requirements and prevailing international standards, for example, IEC61000.

(1) Low bonding resistance from 0Hz to at least 2 GHz.

(2) Low bonding inductance from 0Hz to at least 2 GHz.

(3) Proper bonding procedure, including appropriate surface treatment before and after the bonding process is adopted.

(4) Proper use of bond material to reduce electrolytic corrosion.

END OF SECTION 3

4. Materials and Workmanship Requirements

4.1 Materials and Equipment, General

4.1.1 Materials and components to be used in the execution of the Works shall be new, free from imperfection and proven to be reliable in service with a recognised Metro System, comparable to the AMEL. These requirements shall be the minimum requirements for general purposes and they shall not relieve the Concessionaire from ensuring that the engineering is fit for purpose, and that all materials and components incorporated in the Works are new and suitable for their intended purpose, environment and function.

4.1.2 All material used shall be of current production and well-proven application for the design and intended use.

4.1.3 The names of the manufacturers of materials and equipment proposed for incorporation in the Works together with performance, capacities, certified test reports, approval letters and other significant information pertaining to the same, shall be furnished when requested by the DMRC, who shall have the power to reject any parts which in his opinion are unsatisfactory in meeting the objectives. Such parts shall be replaced by the Concessionaire with neither cost nor programme implications to the DMRC.

4.1.4 Samples of equipment submitted for the DMRC consent shall not be incorporated into the Works without the DMRC permission in writing.

4.1.5 All similar items of equipment and their component parts shall be completely interchangeable. Spare parts shall be manufactured from the same materials as used for the originals and shall fit all similar items or plant. Where machining may be needed before fitting renewable parts, the machining fits with their tolerances shall be shown on the drawings accompanying the instruction manuals.

4.1.6 All parts and equipment, which are subject to wear or damage by dust or moisture in the environment they are installed, shall be totally enclosed in housings with the appropriate degree of protection.

4.2 Workmanship General

4.2.1 Workmanship and general finishes shall be of best quality and in accordance with best practice.

4.2.2 The Concessionaire shall ensure that appropriately skilled staff is employed in the manufacture and construction of the Works.

4.3.3 The DMRC will inspect the quality and workmanship of the first installation for each configuration of the Works. The installation, if consented, will establish the minimum acceptable standards for the Concessionaire's Works

END OF SECTION 4

CHAPTER 2

ALIGNMENT AND TRACKWORK SPECIFICATION

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1 General

1.1 Scope of Specification

1.1.1 This Specification stipulates the performance requirements for the Alignment Design Criteria and Track System to be designed, constructed, commissioned and operated by the Concessionaire for the Airport Metro Express Line (AMEL).

1.1.2 The definition 'track work' covers the track system that provides support and guidance to the Rolling Stock, including the rails, rail bearers, ties and track foundations, and rail fastenings. It also includes under-track crossings constructed within the track-form for the protection of electrical, control systems and communications cabling, and drainage. In detail, the following sub-systems are described:

- rails including fishplates, drilling and welding;
- rail fastenings including base plates, bolts, rail pads and insulators;
- sleepers and rail bearers including non-ballasted track systems;
- track foundations including ballast and any associated drainage and capping layers;
- 'special' track work including turnouts and crossovers;
- derailment containment mechanisms where required;
- measures to mitigate noise and vibration;
- ducts laid beneath the track to accommodate railway control and communications equipment wiring;
- stray current collection system where provided within the track form;
- traction system track and cross bonding; and
- Track permanent markers.

1.2 Definitions

Compound (curve)	A curve consisting of juxtaposed horizontal curves of differing radii. Compound curves may be separated by a transition to reduce the effects of lurch
Crossing	The part of a crossover or turnout that enables a wheel travelling along a given rail to pass through the rail of a track which crosses its path
Crossover	A junction arrangement consisting of two turnouts and by means of which juxtaposed tracks are connected
Exemplary Vehicle	Hypothetical passenger train car with dimensions to be employed as Design Criteria for the Static Vehicle Profile and Swept Envelop

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Horizontal curve	Track which is curved in plan. Curves may have uniform radius, or may be *Compound* (i.e. consisting of juxtaposed curves of different radii), or else may be *Transitioned*
Kinematic Envelope	The Static Vehicle Profile enlarged to allow for the permitted tolerances in track gauge, alignment, level and cross-level and the dynamic and static effects of track wear. The Kinematic Envelope takes into account the vehicle suspension characteristics and the dynamic effects of the vehicle maintenance tolerances, particularly of the wheel. The effects of *end-throw* and *centre-throw* of vehicles on curved track are not included, and are disregarded in the development of the Kinematic Envelope.
Noise Mitigation	Process of reducing the noise output of (in this case) railway tracks. Mitigation is considered in the context of radiated noise (i.e. noise emitted by the wheels and rails to air) and re-radiated noise (i.e low-frequency noise caused when ground-borne vibrations encounter a building)
Right of Way	The corridor reserved for the transit system alignment including an allowance for equipment, safety walkways etc.
Static vehicle profile	The *static vehicle profile* defines the maximum permitted cross-sectional dimensions of the vehicle when stationary on straight and level track. It includes manufacturing tolerances and the effects of worst-case load distribution
Structure gauge	The boundary enclosing the clearances required outside the *swept envelope* to enable the railway to be operated in safety. The structure gauge should include provision for staff safety, where staff are permitted on the railway whilst trains are in operation
Super elevation	The amount by which the outer rail of a *horizontal curve* is raised above the level of the inner rail to counter the effects curving forces (cf. 'cant' and 'dever' (Fr.)
Swept envelope	The *kinematic envelope* enlarged to allow for the effects of vertical and horizontal curvature, including end and centre throw of vehicles, and the *super elevation* applied to the track. This represents the bounds that a vehicle can 'sweep' through whilst traversing a particular section of the track. The swept envelope may be defined separately for each structure or for sections of the route and should take account of all railway vehicles using the line.
Swept path	The space 'swept' out by the vehicle in plan. The two-dimensional/planar equivalent of the *swept envelope*

Throw	The (generally horizontal) displacement of a vehicle on a curve. Centre-throw is the displacement of the central part of the vehicle towards the inside of the curve. End-throw is the displacement of the ends of the vehicle towards the outside of the curve
Tolerances	*Installation tolerances* are prescribed for the track which define the maximum amount by which the track can deviate from the designed alignment during construction. *Maintenance tolerances* are prescribed which define the maximum amount by which the track can deviate from the designed (or accepted) alignment during operation before a maintenance response becomes necessary to correct the alignment
Top of Rail	Rail head running surface
Track geometry	Generic term for the geometric/topographical characteristics of railway track
Track System	Generic term for the assemblage of components from which the track is constructed
Track-form	The formation of the track (Rails, rail bearers, rail retention, sleepers/tracked, crossing ducts, drains, etc) comprising the Track System
Track work	Generic term for all railway track
Transition curve	Colloidal curve connection sections of track of different geometry
Turnouts	A simple junction arrangement by means of which a railway vehicle can be switched onto either of two possible routes
Vertical curve	Vertical curves are provided to ensure a smooth transition between different gradients.
Vignole	Type of rail which is symmetrical about the y-axis, has a flat base flange and a profiled 'head'

1.3 Requirement

1.3.1 Alignment Design Criteria shall safely support the optimum Line speed and passenger comfort.

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1.3.2 Noise and vibration emitted by rail vehicles during service shall at no time exceed the levels prescribed in the DMRC "Conditions of Contract on Safety, Health and Environment".

1.3.3 The swept path shall be calculated from a consideration of the Alignment Design Criteria in this specification for the Exemplary Vehicle dimensions and rolling characteristics, track geometry, installation and wear tolerances.

1.3.4 The Track System shall be engineered to support commuter traffic working of some 50 million gross tones of traffic per annum and shall enable a superior level of passenger comfort to be achieved, throughout the useful life of the System.

1.3.5 The Concessionaire shall provide a risk assessment to establish the value of providing derailment containment throughout the revenue line, or at sections of the revenue line. In the event that a unsafe situation may occur at less than 1 in 100 years, then The Concessionaire shall provide Derailment Containment facilities.

1.3.6 The Track Form shall be designed and supplied for a Design Life of 60 years and rails for 25 years

END OF SECTION 1

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2 Design Criteria

2.1 System Assurance

2.1.1 The Alignment and Track System is considered to be a Safety Critical system and shall be engineered for the RAMS criteria as specified, as a minimum.

2.1.2 Noise and Vibration

Mitigation measures shall be employed to limit the noise and vibration transmitted to adjacent buildings, environment and the rail vehicle. Mitigation measures may be provided by a variety of measures, some of which impact on the track design. In the event the Concessionaire includes noise and vibration measures in the track system design, they shall be compatible with the required track form performance and compliant with Standard DD ENV 13481-6.
Noise conducted or radiated to adjacent buildings or the environment, shall not exceed the prescribed limits specified in DMRC "Conditions of Contract on Safety, Health and Environment".

Vibration conducted to adjacent structures shall not exceed the limits of Particle Velocities as indicated in Table 2.1.2. The Concessionaire shall coordinate with the Civil Contractors in the study of transmitted vibration and mitigation measures.

Existing adjacent structure	*Peak particle velocity, mm/sec*
Most structures in "good" condition	25
Most structures in "fair" condition	12
Most structures in "poor" condition	5
Water supply structures	5
Heritage/bridge structures	5

Table 2.1.2 Limits for Peak Particle velocities at existing structures from AMEL generated vibration.

2.1.3. Reliability Requirements

(1) The Track work System for the revenue line shall be engineered for a minimum useful life of 25 years, based on the equipment being continuously in operation, and shall achieve an MTBSAF of no less than 5000 hours between any failures affecting the revenue train service.

(2) The Depot Track work System shall be engineered for a minimum useful life of 40 years, based on the equipment being continuously in operation, and shall achieve an MTBF of not less than 3000 hours where no fault is recorded.

2.1.4 Availability Requirements

(1) The System shall be engineered for a minimum useful life of 25 years, based on equipment being continuously in use, and achieving a minimum Operating Availability of 99.98%.

2.1.5 Maintainability Requirements

The Maintainability measure for the Track System shall be Mean Time To Restore (MTTR) and shall not be greater than specified in Schedule D Part III Chapter 1

2.1.6 Safety Requirements

(1) The System shall provide for the safe separation of train movements.

The Concessionaire shall undertake a Risk Analysis for the Track System and mitigate the potential Hazards as low as reasonably practical, in accordance with IEC 62278 Standard, or equivalent international standard.

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The System safety sub-systems shall be engineered for a Safety Integrity Level 4 (SIL 4), as defined in IEC 61508 Standard, or equivalent international standard. Hazardous events shall not occur with a greater frequency than 1 in 10^4 years.

2.1 Operating Requirements

2.1.1 Design Speed

The Concessionaire shall construct the track system to be compatible with the operating speeds, as specified in the Alignment Design Criteria.

2.1.2 Noise and Vibration

Noise mitigation measures shall be employed to ensure that the prescribed noise limits within neighbouring buildings and rail vehicles are not exceeded. Mitigation may be provided by a variety of measures, some of which impact on the track design. In the event that the Concessionaire includes noise mitigation measures into the track design, he shall demonstrate that they are compatible with the track form performance requirements prescribed elsewhere in this Specification.

Vibration-attenuating track will need to be provided in locations where the levels of low frequency ground borne and re-radiated noise in structures adjacent to the railway would otherwise exceed the limits prescribed in the DMRC "Conditions of Contract on Safety, Health and Environment". The design of vibration-attenuating track forms shall be in accordance with DD ENV 13481-6.

2.2 Structure Gauge

2.2.1 The design shall be carried out based on the DMRC Structure Gauge (Schedule I Drawings). Tunnels, major structures and other permanent features that will become part of the Railway System will be designed to accommodate the latter.

The Swept Envelope shall be developed from the DMRC Structure gauge and the Exemplary Vehicle data, indicated in Table 4.7

2.2.2 Vehicle Swept Path

The Swept Path of the Exemplary Vehicle shall be developed for the AMEL As-built Alignment. The Concessionaire shall describe his approach to the calculation of the Swept Path in his Initial Design Submission for the review of the DMRC.

2.2.3 Track Positional Tolerances

The Concessionaire shall review the DMRC Reference installation and maintenance tolerances for the track alignment, indicated in Table 2.2.2, and propose improvements where appropriate for his Track System. This information shall be included in the Concessionaire's Initial Design Submission.

The installation tolerances shall be the tolerances to which the track shall be constructed relative to the designed alignment, and to which the track shall be restored following any significant maintenance intervention.

The maintenance tolerances shall define the amount by which the track may deviate from the designed alignment in service before triggering the need for maintenance intervention. Where the track alignment falls outside the installation tolerances it will be said to be in a 'degraded condition'.

The Concessionaire shall install the tracks in the underground sections of the AMEL to tolerances that reflect the rolling characteristics of metro-type rolling stock but which are consistent with the vehicle that will be deployed.

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Table 2.2 2 DMRC Reference track installation and maintenance Tolerances

Tolerance	Installation[1]		Maintenance[2]	
	Absolute value	Relative value	Absolute value	Relative value
Track gauge	1435±2 mm	max. variation in 3 metres of track: 2 mm	1435± 5mm	max. variation in 3 metres of track: 4 mm
Horizontal alignment	max variation from designed alignment: ±5 mm	on 10 metre chord: 1.5 mm; on 5 metre chord: 1 mm	±5 mm	on 10 metre chord: 3 mm; on 5 metre chord: 2 mm
Vertical alignment	±4 mm	Max. variation on 30 metre base: 3 mm	+10, -20mm generally; ±5 mm at stops	Max. variation on 30 metre base: ±5 mm
Super-elevation	Max. divergence from design value: ±2 mm	-	Max. divergence from design value: ±5 mm	-
Twist	on a 3 metre base: 0.1%	on super elevation transitions, combined effect of super elevation gradient and twist not to exceed 0.2%	on a 3 metre base: 0.2%	on super elevation transitions, combined effect of super elevation gradient and twist not to exceed 0.25%
Versine		±2mm for ballast less track on 20 m chord (half over lapping) ±4 mm for ballasted track on 20,m chord (half over lapping)		Can be ±4mm & ±6mm for ballast less and ballasted track respectively
Rail Joint Square ness across the Track	±6mm		±6mm	
Deviation in versine in curves of Switches-measured on 6m chord (half over lapping)	±2mm		±2mm	

[1] The installation tolerances are the tolerances to which the track should be constructed, relative to the designed alignment. Following installation, the as-built alignment will be the 'reference alignment' for the track. The Concessionaire shall reinstate the track to the reference alignment following replacement of the rails or rail bearers, or any other significant maintenance activity.

[2] The maintenance tolerances are the tolerances within which the track shall be reinstated following any routine maintenance activity. These tolerances describe the maximum extent to which the track alignment shall be allowed to deteriorate before triggering a maintenance response.

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2.3 Electrical Insulation

The running rails will be an integral part of the traction current supply system and will be the means by which the traction current will be transmitted to the trains from the traction current sub-stations. Accordingly, the rails shall be electrically insulated from Earth.

The Concessionaire shall design the track system affected track components for compatibility with the Traction Power System. The overall track system shall be designed and constructed so as to ensure that the electrical resistance of traction system return is as low as reasonably practicable.

The minimum resistance of the track with respect to earth within each electrical section shall not be less than the following:

- 100 Ohm.km as a standard commissioned value;
- an absolute minimum service value of 20 Ohm.km

The Concessionaire shall provide adequate levels of cross bonding and electrical insulation resistance for the correct functioning of the signalling and control systems and the traction power distribution system and shall comply with the requirements of EN 50122-1 railway Applications- Fixed Installations. Part 1 Protective Provisions Relating to Electrical Safety and Earthling.

END OF SECTION 2

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3 Performance Requirements

3.1 Design Requirements

The track form design shall be based on proven track technology and all materials and components used shall have been proven in service on other transit system installations. Track form components shall have a minimum service life consistent with those tabulated in Schedule L, Operations and Maintenance Functional Specification, of the Contract Documents.

In the event that the Concessionaire offers systems and components that do not have a proven service life, he shall carry out all necessary testing and modelling to demonstrate that the systems and components meet the requirements of this Specification before they are used in the construction.

In particular, the Concessionaire shall arrange for the testing of the proposed track form to demonstrate suitability to the DMRC. The Concessionaire shall state the worst-case traffic loading conditions to be simulated by tests to verify the suitability and shall agree these with the DMRC. Testing may be waived at the discretion of the DMRC where proven track systems are proposed, and where documentary evidence on the track form's maintenance history is presented showing that no significant maintenance intervention will be necessary for a period of 25 years.

Principal objectives of the track work design shall be to satisfy the performance requirements prescribed in this Specification and in particular to:

(1) focus on the wheel/rail interface, ensuring that the track is compatible with the proposed train vehicle wheel profile that shall be used for alignment as described in this Specification. (the Concessionaire shall describe his philosophy for ensuring wheel/rail compatibility in his Initial Design Submission);

(2) produce tracks that can be easily inspected and maintained during the times when the railway is closed to revenue-earning traffic;

(3) ensure a long trouble-free life before replacement of the components becomes necessary;

(4) minimise the costs of carrying out maintenance;

(5) ensure the long term availability of materials and components for future replacement;

(6) limit the number of different materials and components to be held in stock as spares;

3.1.1 Alignment Characteristics

Subject to the constraints imposed on him by the proposed Railway System alignment as prescribed in this Specification, the Concessionaire shall maximise the following:

- horizontal curve radii;
- vertical curve radii (subject also to maintainability, e.g. in ballasted track); and
- transition curve lengths;

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The following shall be minimised:

- track gradient (subject to local topographical constraints);
- super elevation (particularly in platforms); and
- super elevation deficiency.

The track spacing and the positioning of line side structures shall be developed from the swept path of the Exemplary Vehicle indicated in the DMRC Alignment Design Criteria.

3.1.2 Track Foundations

The foundations of tracks shall be formed in reinforced concrete and shall be an integrated part of the tunnel and viaduct design. Generally, the tunnel and track design including detailed alignment calculations shall be considered together. The Concessionaire shall describe how he intends managing the track/tunnel interface in his Initial Design Submission for review by the DMRC.

At-grade track foundation shall be reinforced concrete slabs suitable for direct fixation of the track system or other established track system, Approved by DMRC.

Any reinforcement used in the track form shall not form closed conducting loops that are likely to interfere with or distort the signals emitted by track-side or train mounted control equipment that may be installed to facilitate metro operations.

3.1.3 Depot and Siding Track-form

The Concessionaire may provide ballasted track system for Dwarka Depot and Palam Siding. The sub-ballast shall comply with UIC Leaflet 719 R for Earthworks and track-bed layers for railway lines.

3.1.4 Cable Ducts and Under-track crossings

Cable ducts and /or stub-walls shall be provided parallel to the track to accommodate high and low voltage cables. The Concessionaire shall calculate the minimum number of cable routes to accommodate the electrical power and communications cables required for the operation of the Railway System and shall provide an additional 50% as spare capacity to accommodate renewals.

Cast- in under-track crossings shall be provided as necessary to protect electrical cables routed from one side of the track to the other shall be non-metallic PVC/unplasticised PVC to BS4660, BS3506 or equivalent Approved specification.

The Concessionaire shall provide a schedule of the locations where he proposes to construct under-track crossings as part of the Interface Management Plan.

3.1.5 Rail Supports

The rails shall be discretely supported on base plates and subject to the design and performance criteria prescribed in this Specification. The track bed shall be a concrete or other approved material track bed founded on the foundation prepared by the DMRC Civil Works contractor.

The Concessionaire shall state the concrete to be supplied and methodology for production of all mass and reinforced concrete elements used to construct the track form as part of his Detailed Design Submission. The construction techniques that will be employed which ensure that the track alignment tolerances are maintained shall be specified by the Concessionaire in the Initial Design Submission.

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3.1.6 Rails

Rails shall be a standard vignole type with dimensions commensurate with the loads supported by the rail, taking into account any deterioration in service as a consequence of contact wear or corrosion.

Rail shall in accordance with UIC Standard section and manufactured in accordance with UIC 860.

3.1.7 Rail Retention

The Concessionaire shall describe the means by which the rails will be fastened or secured to the rail supports, including all fastenings, pads, spacer blocks, filler pieces and fillers supplied in liquid form.

The rail retention/fastening system shall be designed to electrically insulate the rails from the supporting structure and from Earth as prescribed in this Specification.

3.1.8 Derailment Containment

The Concessionaire shall provide appropriate mitigation measures against the consequences of derailment throughout the AMEL. Appropriate mitigation will be determined by the application of a suitable risk assessment protocol such as that described in EN50126 and required as part of the Concessionaires System Assurance program prescribed in the Contract.

Locations where derailments may carry a high risk include tunnels, covered ways, viaducts and other areas where access may be difficult or where the proximity of structures, turnouts and other junction layouts might compound the effects of the derailment.

Where, following risk assessment, derailment containment measures are deemed to be necessary, these shall be designed to re-rail derailed rail vehicles or to prevent derailed vehicles from deviating from the track to the extent that they collide with any adjacent structures. Where derailment containment mechanisms are provided, they shall be an integral part of the track form.

The Concessionaire shall describe his derailment containment philosophy and shall identify the locations where derailment containment is to be provided in his Initial Design Submission and submit this to the DMRC for review.

3.1.9 Common Elements of Track System

(1) Rail Welding

(a) All rail joints, including special trackwork, shall be welded to provide a smooth transition from one rail to the next and to reduce the numbers of individual track components that need to be maintained.

The Concessionaire shall submit his methodology for welding and de-stressing rails with his Initial Design Submission.

Preference shall be given to flash-butt welding the rails using a static or mobile welding plant. The Concessionaire is at liberty to specify alumino-thermic welding techniques but must provide details of the process and quality control systems he will deploy to ensure that the completed welds have an intrinsic reliability equivalent to that of flash-butt welds for the design life of the rail.

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Welds shall conform to the requirements, regardless of the welding method adopted, as follows:

(i) of the welding mix for moisture content and chemical composition weld metal shall have a similar hardness to that of the rails;

(ii) adjacent welded rail joints in plain line shall not be staggered and shall not be out of square by more than 150 mm;

(iii) the minimum distance between adjacent welds in the same rail shall not be less than 4,500 mm;

(iv) all welds shall be made by competent operatives and shall carry the operative's identification mark; and

(v) the Concessionaire shall keep a record of all welding.

(b) In addition, alumino-thermic welds shall be subject to inspection/testing requirements, as follows:

Testing of samples;

(i) mechanical testing of rail samples not less than 1,000 mm long including the weld. The test regime include the Brinell Hardness Test and bending of the rail with the bottom flange in tension;

(ii) Visual inspection of homogeneity;

(iii) Inspection of weld geometry; and

(iv) Ultrasonic inspection .

(c) All welds in the permanent works shall have:

(i) An alignment checks to within 0.1 mm using a 1,000 mm long straight edge. The line and level of the welded rails shall not deviate by more than 0.3 mm. The weld height variation measured from any 200 mm portion of straight edge shall not exceed 0.2 mm;

(ii) A visual check for porosity, lack of fusion, coarse grains, slag and sand inclusions and hot tears. If one or more of these defects is found, the weld shall be rejected;

(iii) Ultrasonic testing for lack of fusion between weld and parent metal.

(iv) The procedure& Tolerances for welds shall, however be

Controlled by provision of IRS&UIC Codes.

(2) Turnouts

(a) Turnouts may be selected from the UIC Standard arrangements, to suit the design alignment as follows:

1:7 radius 140 (absolute minimum) in Depot areas

1:9 radius 190m

1:9 radius 300m

1:12 radius 500m

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The turnout geometry shall be a function of the operational speed for the section of the route under consideration. Metro-standard turnouts and crossovers shall be provided in areas which are to be up-graded to metro as prescribed above, and shall be compatible with the Concessionaire's chosen passenger train wheel profile.

(b) The Concessionaire shall submit a schedule of the turnouts with his Initial Design Submission for the DMRC review, listing their principal dimensions and operating speeds. He shall also address and highlight in his Submission, any wheel-rail design issues to emerge from the proposal to operate passenger trains over metro-standard turnouts.

Generally, turnouts shall be sited adjacent to Stations to enable staff to safely attend O&M activities. With the exception of infrequently used turnouts within the Depot all turnouts shall be operated by electrically powered point machines. Junctions within the depot that serve infrequently used workshop areas may be hand-lever operated.

(c) Junctions shall be assembled from components that are robust and inherently reliable. Preference shall be given to layouts based on all-welded or cast austenitic manganese steel (AMS) crossings (cf. Frogs) or other hard-wearing components.

(d) The geometry of junction rails shall be compatible with the passenger train wheel profile and shall under no circumstances result in an increased derailment risk when in a worn or otherwise degraded condition. The Concessionaire shall address wheel-rail design issues under the interfaces section of his Initial Design Submission.

(3) Buffer Stops

Buffer stops shall be of the sliding friction type, adjusted to absorb the impact force of a train loaded at AW3 and travelling at the maximum permitted line speed. The buffer stop shall progressively apply restraining forces to the train, up to maximum deceleration rate of 1.5m/sec^2 until the train is brought to a stand-still, without damage or derailment.

(4) Vibration-attenuating Track

Re-radiated noise from the operation of the railway measured in any adjacent property shall not exceed the levels given in the DMRC "Conditions of Contract on Safety, Health and Environment".

Where there is a risk that re-radiated noise levels might exceed the specified limits, the Concessionaire shall specify suitable vibration-attenuating track forms.

The Concessionaire shall describe his strategy for minimising re-radiated noise in the locations indicated and provide a schedule in his Intermediate Design Submission, of all the locations where a vibration-attenuating track form will be required.

(5) Emergency Walkways

In tunnel sections, the Preliminary Engineering provides for evacuation of passengers from a train front-end bridge down to the track level, then along the track, and an elevated walkway for maintenance staff. The Concessionaire may elect evacuate passengers from train saloon side doors, providing it is demonstrated that a walkway compliant to NFPA 130 Guidelines can be accommodated throughout all of the tunnel sections, as specified.

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3.1.10 PERMANENT MARKERS

1) As the track is completed permanent markers shall be provided and installed as follow:-

(a) Kilometre markers,

(b) Change of gradient markers,

(c) Curve reference markers,

(d) LWR/CWR reference markers,

(e) Fouling point markers,

(f) Turnout markers,

2) All permanent marker plates/boards including colour scheme and fixation arrangement proposed to be used shall have prior approval of Engineer.

3) All information to be marked on the markers shall be submitted by the contractor for engineer's approval.

4) All markers are required to be painted on rail for curves and turnouts etc, shall be paint marked by concessionaire for Engineer's approval.

3.2 Testing and Commissioning

3.2.1 The Concessionaire shall submit a schedule with his Intermediate Design Submission, listing the inspections and tests he intends carrying out to meet his obligations with respect to the quality control requirements described in the Contract. In particular, the Concessionaire shall:

(1) Check, inspect and test the track alignment using appropriate instruments and measuring equipment to ensure compliance with the installation tolerances;

(2) Check the integrity of all components and materials used to construct the track to ensure that they have been installed in accordance with the suppliers' instructions;

(3) Check the track system electrical insulation value; and

(4) Describe the proposed testing regimes and test equipment he intends using.

END OF SECTION 3

4 Alignment Design Criteria

4.1 Principles

The Concessionaire shall review DMRC Preliminary Engineering alignment and any proposed alignment amendments by DMRC Civil Contractors, and develop an alignment design for the AMEL; alterations to the authorised corridor should be avoided. The coordinated alignment design shall be submitted to DMRC for their Approval.

The alignment shall safely support the optimum line speed without compromising passenger comfort.

The Concessionaire may change the Preliminary Engineering track layout to suit his preferred operations, providing they are within the defined area for construction of the AMEL.

4.2 Design Statement

The Concessionaire shall submit a design philosophy statement during Initial Design Submission. It shall identify the Concessionaire's design methods and shall as a minimum include calculation methods, threshold values, clearances, cross sections and description of software and interfaces used.

The Detailed Design of the Concessionaire shall at least identify all horizontal and vertical radii, super elevation and permissible speeds, individually of each track for any line section and depot. It shall furthermore identify all transitions curve and special track work design parameters, show swept path, elevation, clearances, and positions and dimensions of all of the Railway System installations, including the support poles of the Overhead Contact System.

4.3 Operating Speeds

The maximum design speed of the revenue line shall be 135 kph and maximum operating speed 120kph. Where the track and special track work radii require lower speeds, the Concessionaire shall identify these areas in the alignment for permanent speed restrictions.

The depot speed limit shall be 25kph.

4.4 Alignment Design

1.1.1 4.4.1 Exemplary Vehicle

A reference metro vehicle shall be used for the design, with the following parameters:

train length, excluding driver cab	150 m
body width,	3.00 m
floor height	1.10 m
vehicle body length	24 m
Vehicle length over couplers	25.0 m
pivot distance	16.1 m
bogie wheelbase	2.5 m

The Static and Kinematic Envelops and Structure Gauge of the Exemplary Vehicle shall be based on the DMRC Structure Gauge, modified by the Concessionaire for Standard Gauge Track and shall be submitted to the DMRC during Initial Design Submission, for review and Approval.

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4.4.2 Lateral Acceleration

Alignment shall allow for a slight positive acceleration a_q = 0.2 m/s² in uniformly curved track. For comfort reasons, a_q shall not exceed 0.65 m/s².

4.4.3 Transition Curves

The difference in lateral acceleration Δa_q resulting in a lateral jerk (lurch) shall not exceed c_{max} = 0.30 m/s³.

The length and position of a transition curve shall be identical with the length and position of the corresponding super elevation ramp.

Station platform paid areas shall not be infringed by vehicle displacements due to curves, including transition curves.

4.4.4 Super elevation

Super elevation shall correspond with the operating speed of the location. For the mean value of the spread of this speed, an uncompensated lateral acceleration of a_q = 0.2 m/s² shall be achieved.

Achieving high design speeds shall have precedence over minimising lateral acceleration without compromising the safety principles.

Super elevation of revenue tracks shall not exceed 150 mm. Track in stations shall not have super elevation.

4.4.5 Super elevation Ramps

At the interface between track sections with different super elevation, a ramp with a constant inclination shall be provided.

Super elevation ramps shall have the lowest possible inclination. Maximum inclination shall not exceed 1 : 400.

Station platform paid areas shall not be infringed by vehicle displacements due to super elevation ramps.

4.4.6 Vertical Curves

Vertical curves shall have of a minimum radius of 2500m.

Reliable operation of special track work in vertical curves, if any, shall not be compromised.

4.5 Swept Envelope

4.5.1 The DMRC Structure Gauge (SG) is to be adopted by the Concessionaire for the establishing the Swept Envelope.

(1) The static vehicle profile shall be the Exemplary vehicle.

(2) The Kinematic Envelope shall be as indicated in Schedule I Drawings, Section 1

(3) The Structure gauge = KE + 100mm for Tunnel

(4) The Structure gauge = KE + 150mm for Elevated

4.5.2 Horizontal and vertical throw in curves and lateral displacement due to super elevation shall not be less than for the Exemplary Vehicle. Mid Throw shall be calculated as:

$$MT = 150*C^2 / R,$$

where MT = KE- SE; C = cant and R = Radius

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4.6 Cross-Sections

4.6.1 Safe Distances

Sufficient distances shall be provided to ensure safe separation of any adjacent tracks, and between any track and adjacent structures and installations, under worst case operation and wear and tear conditions. They shall facilitate evacuation and recovery after failures / accidents.

4.6.2 Safety Walkways

For the evacuation of passengers from tunnels to Station platforms, cross passage or intermediate escape shafts, a safety path in accordance with NFA 130 shall be provided within the track form.

4.6.3 Structure Gauge

Provision shall be made for re-railment of trains at any section of the line, without contact between the vehicle body or the fully retracted pantograph and the overhead contact wire.

Provision shall also be made to enable later modification of super elevation.

4.6.4 Platforms

Platform height above rail level shall be in accordance with the Alignment Design Criteria.

Vehicle / platform interfaces shall be in conformity with the The Persons with Disabilities (Equal Opportunities, Protection of Rights and Full Participation) Act, 2006

Track at platforms shall be level and minimum radius of 1000m.

The paid area of a platform shall be fitted with Platform Screen Doors as specified in the Contract.

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Summary of Alignment Design Criteria

Table 4.7 Alignment design criteria

Dimension		Metro
Exemplary Vehicle Data		
Maximum vehicle length over couplers Maximum train length over couplers		25 m 154 m
Vehicle width maximum		3.00 m
Floor height in entrance area		up to 1.10 m [1)]
Horizontal distance between vehicle entrance and platform edge		Horizontal +/- 50mm Vertical +/- 50mm
Vehicle height (retracted pantograph)		4 m
Maximum axle load		up to 16 t
Pivot distance		up to 16.1 m
Bogie wheel base		up to 2.5 m
Station Data		
Platform length (paid + unpaid area)		160 m
Platform paid area minimum width	side platforms island platforms	≥ 4.5 m [1)] ≥ 12 m [1)]
Track curvature	Horizontal	1000m radius
	Vertical	level
Maximum gradient		level
Track Alignment Data		
Track gauge		1435 mm
Maximum design speed[2)]		135 kph
Maximum operation speed[3)]		120 kph
Minimum horizontal curve radius: revenue track		800 m
Minimum horizontal curve radius: critical areas and non-revenue track		190 m
Minimum vertical curve radius except for special track work		0.4 * v² [v = km/h] ≥ 650 m
Maximum gradient		3 %
Recommended energy hump station approach and departure	Gradient length	+ 0 % / - 2 % 300 m adjacent to a station
Maximum super elevation		150 mm

[1)] larger platform width to be determined by highest passenger load

[2)] 0.65 m/s² lateral acceleration must not be exceeded

[3)] excluding sections constrained by the civil design

END OF SECTION 4

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CHAPTER 3

ROLLING STOCK SPECIFICATION

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1 General

1.1 Specification

This Specification stipulates the performance requirements for the Rolling Stock to be designed, constructed, commissioned and operated by the Concessionaire for the Airport Metro Express Line (AMEL)

1.2 Definitions

The following defined terms shall have the meanings indicated in Table 1.2

Table 1.2 Definitions

Abnormal Operation	The situation where the Train Control and Signalling System operates in an unscheduled situation.
AW O	Average tare weight of a car;
AW 1	Average weight of a car with all seats and luggage racks occupied
AW 2	Average weight of a car with all seats and luggage racks occupied and normal standing at 4 persons per square meter;
AW 3	Average weight of a car with all seats and luggage racks occupied and crush load standing at 6 persons per square meter;
AW 4	Average weight of a car with all seats and luggage racks occupied and Design Load standing at 8 persons per square meter;
Correct Stopping Position	The point at which the train is required to stop in a station platform
Delay	Delay is caused when a train is unable to move or its speed is reduced due to failures in the System.
DMC	Drive Motor Car
DMLC	Drive Motor Luggage Car
Failure	An event which causes loss of functions or performance within any part of the Rolling Stock and requires a maintenance intervention to restore full functionality and performance
Revenue Service	Operation service with fare paying services.
Safety-Critical	Failure of the system, sub-system or equipment that will directly lead to a situation with the potential to cause harm, injury, damage to property, plant or equipment, the environment, or economic loss.
Service	When the railway is available for fare paying passengers.
Service Affecting Failure	A failure which causes a Delay.
Vital	That which is necessary for the safe operation of the Railway.

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1.3 Requirements

1.3.1 The passenger train selected by the Concessionaire shall fit within the Swept Path described along the AMEL Alignment, by the Exemplary Vehicle specified in the Part III, Chapter 2, Track work and Alignment Specification.

1.3.2 Rolling Stock operating passenger services shall be fitted with Continuous Automatic Train Control System. Non-revenue vehicles required to operate amongst revenue service trains shall be fitted with Automatic Train Protection and wheel slip-slide protection.

1.3.3 The furnishings and fittings of the passenger trains shall be of superior quality, matching that of the IGI Airport

1.3.4 The passenger train major components shall be designed and supplied for a Design Life of 30 years, being routinely maintained and in revenue service other times.

1.4 Systems Assurance

1.4.1 General

1.4.1 Rolling Stock systems shall be planned and engineered in accordance with the requirements specified in Schedule D Part III Chapter 1, General Technical Specification.

1.4.2 Reliability Requirements

The Rolling Stock fleet operating the revenue services shall be engineered for a minimum useful life of 30 years, based on the equipment being continuously in operation, and shall achieve an MTBSAF of not less than 10000 hours between any failures affecting the revenue train service.

Non-revenue trains required to operate during revenue service shall achieve an MTBSAF of not less than 10000 hours between any failures affecting the revenue train service.

1.4.3 Availability Requirements

Availability shall be recorded as the Mean Down-time Between Service-Affecting Failures (MDTBSAF), in minutes of time.

The Rolling Stock shall be engineered for a minimum useful life of 30 years, based on equipment being continuously in use, and achieving a minimum fleet Availability of 99.98%.

1.4.4 Maintainability Requirements

The Rolling Stock shall be engineered to maximise Availability during traffic hours and ensure that the preventive and corrective maintenance activities can be carried out during non-revenue hours.

The Maintainability measure for the Rolling Stock which fails on the revenue line shall be Mean Time to Restore (MTTR) and shall not be greater than specified in Schedule D Part III Chapter

1.4.5 Safety Requirements

The safety of the Rolling Stock shall be demonstrated by the Concessionaire before commencement of revenue service. The demonstration methodology shall be defined by the Concessionaire and approved by the DMRC.

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1.4.6 Risk Assessment.

The Concessionaire shall undertake a Risk Analysis for the System and mitigate the potential Hazards as Low as Reasonably Practical (ALARP) in accordance with IEC 62278 Standard. The Concessionaire shall establish and maintain a Hazard Log throughout the Concessionaire Period, recording the hazards identified and mitigation measures provided; residual risk management procedures shall be proposed to the DMRC for Consent.

The Rolling Stock safety systems shall be engineered for a Safety Integrity Level 4 (SIL 4), as defined in IEC 61508 Standard. Hazardous events shall not occur with a greater frequency than 1 in 100 years.

As part of the Systems Assurance Program, the Concessionaire shall conduct a Risk Assessment in order to establish the measures needed to eliminate risks from the identified Hazards; the Concessionaire shall propose how to manage residual risks.

END OF SECTION 1

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2 DESIGN CRITERIA

2.1 Car Body

2.1.1 The car body should be lightweight, conforming to EN 12663:2000 – railway application – 'Structural Requirements of Railway Vehicle Bodies'. The car strength shall comply with UIC 566 –'Loading of car bodies and their components'. However, the compressive load shall be 1200 kiloNewtons..

2.1.2 The car body may be of Austenitic stainless steel or aluminium. Combinations of materials should be avoided, however where the Concessionaire has dissimilar metals, measures shall be provided to mitigate corrosion in the vehicle structure due to electrolytic action.

2.1.3 All couplers shall have crash worthiness features;

2.1.4 Anti-climbing devices shall be provided on headstock of all vehicles and shall remain fully engaged and operational under the action of vertical shear loads (upwards or downwards) equal to half the AW4 vehicle weight. During an engagement of anti-climbing devices, the resultant damages shall be restricted to couplers and anti-climbing devices;

2.1.5 Each passenger car shall be provided with minimum of 4 bi-parting slide type doors, 2 on either side of the car. The doors shall have an adequate opening for quick detraining and entraining of passengers during short dwell period at the stations. The number of doors to be provided on the baggage cars shall be determined by the Concessionaire

2.1.6 The door mechanism shall have safety provision that the train cannot start unless all doors have been closed and electrically locked. The doors shall have following additional safety features:

a) Obstacle detection;

b) Internal and external release;

c) Audible door closing warning for the saloon interior and platform;

d) Visual door closing indication for the saloon interior and platform;

e) Door status indication on the Train Operators console; and

f) Door sensing facilities shall detect an obstruction and inhibit train movement.

2.1.7 Each cab front end shall include a bridge doorway to evacuate passengers from a train to the track level, during an Emergency

2.1.8 As the car is to be provided with air-conditioning, all windows shall be sealed, flush with the exterior of the car and shall be provided with safety glass to the appropriate standard.

2.1.9 The car shall have a wide gangway connecting to the adjoining car to allow passengers with luggage to move between cars. The gangways shall be completely weather proof and draft proof.

2.1.10 Each cab front end shall include a bridge doorway to evacuate passengers from a train to the track level during an emergency. Self-closing, self-locking doors shall be provided between the Train Operator's cab and the baggage car and between the baggage car and passenger saloon and it shall normally be possible only to open these doors from the cab and baggage car respectively. For opening the door from the passenger saloon to the baggage car, a special key shall be provided; the key shall be accessed by a break-glass cover fixed to the door. During an evacuation scenario, passengers may access the baggage car and Train Operator cab to exit via the bridge doorway, via the normally locked doors.

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2.1.11 Floor of the car shall be at same level as the platform.

2.1.12 The gap between the car door sill and the Platform Screen Door (PSD) sill, shall not be greater than:

a) 50mm horizontally, and

b) +/- 50 mm vertically.

2.2 Car Interior.

2.2.1 The passenger saloon shall have comfortable transverse seating and the gangway shall be wide enough and without obstructions to accommodate passengers moving along with luggage or physically handicapped persons with mobility aids

2.2.2 Each DMC and DMLC shall have space near the door for one wheel chair. Grab rails and wheel chair clamps shall be provided in the space to secure and assist the mobility impaired persons. The train door associated with the reserved space shall include external signage.

2.2.3 Interior fittings shall include luggage racks, grab rails and partitions;

2.2.4 Passenger Communication Systems' shall include audio and visual facilities as specified in Part III Chapter 6;

2.2.5 Modern System map showing the AMEL system.

2.2.6 Safety signage shall be prominently displayed.

2.2.7 Advertising displays shall not impede safety signage.

2.2.8 All permanent notices, warnings etc. shall be displayed at 4 locations inside the car. These shall be of vandalism proof design;

2.2.9 The interior lighting of the car shall provide an average illumination at 1000mm above the floor of the car of at least 200 lux.

2.2.10 Emergency lights from standby batteries shall be provided to maintain minimum illumination in the event of the failure of the main electric power;

2.2.11 Headlight and side marker lights in Driving Motor Car shall conform to latest world Standards. In the event of failure of main power supply these also shall be powered from standby batteries.

Note: Items 2.2.9/-/11 shall conform to EN 13272:2001 – Railway application – Electrical lighting for rolling stock in public transport systems' as applicable to urban rail transport systems.

2.2.12 The car interior shall have very good resistance to fire and conform to NFPA-130 -- 'Standard For Fixed Guide way - Transit and Passenger Rail Systems'. Each car shall be provided with two dry powder type fire extinguishers located near the gangways. These shall be installed in a niche so that it will not cause injury to passengers;

2.2.13 The total fire load above and below the floor shall be appropriate for a train with seating and luggage.

2.2.14 The baggage **Air-conditioning**

2.3.1 Each car shall be air-conditioned. At least two air-conditioning units shall be provided in each car. In the Driving Motor Car, there shall be a separate air-conditioning unit for the cab. Air-conditioning in vehicles shall conform to EN 14750-1:2006 'Railway Application – Air-conditioning for Urban and Suburban Rolling Stock –Comfort parameters'. car shall include devices to secure Baggage Containers against movement.

2.3 Air –Conditioning

In the event of failure of air-conditioning unit/units, there shall be an arrangement for forced ventilation of the vehicles.

2.3.3 The air-conditioning system shall provide a high rate of renewed air, maintenance of constant temperature and take in to account the frequent door opening and passenger density. A temperature of 23^0 C and relative humidity (RH) of 55% is considered to be comfortable in summer. In winter a temperature of 18^0 C and RH of 55% shall be maintained.

2.4 Train Operator's Cab

2.4.1 The Passenger Train Operator's cab shall have full frontal view of the track ahead from his seat on the left side of the cab.

2.4.2 The console layout shall be ergonomically designed with all controls within the easy reach of the Operator sitting position;

2.4.3 The Continuous Automatic Train Control System control and indications shall enable Operator drive modes.

Refer to Part III Chapter 4 Signalling and Train Control System Specification

2.4.4 Train Operator Communications Panel shall include Radio for communication with the OCC and PA and Intercom for in-train communications.

Refer to Part III Chapter 6 Communications Systems Specification

2.4.5 Each cab shall be equipped with a microprocessor based diagnostic system. Diagnostic information shall be displayed on the Train Operator's VDU;

2.5 Bogies

2.5.1 The bogies pneumatic springs shall have fail safe rubber springs inside to cater for bursting of an air bellow, and to obtain maximum life of the bellows.

2.5.2 Mono block wheels shall conform to EN 13262:2003 –'Railway Applications – Wheel Sets and Bogies – Wheels –Product Requirements. Wheel sets shall conform to EN 13260:2003 – Railway Applications – Wheel Set and Bogies – Wheel Sets – Product Requirements'.

2.5.3 The structural design of the bogie frame shall conform to EN 13749:2005 –'Railway Applications – Method of Specifying Structural Requirements of a Bogie Frame';

2.5.4 The bogies of powered cars' (Driving Motor & Motor cars) shall conform to EN 13104:2001 – 'Railway Applications – Wheel sets and Bogies – Powered Axle Design Method' or UIC 615 -4 Motive Power Units – Bogie and Running Gear – Bogie Frame Structural Strength Test':

2.5.5 The bogies of non-powered cars (Trailer cars) shall conform to BS EN 13103:2001 – 'railway applications – wheel sets and bogies – non-powered axle design method' or UIC 515-4 'Passenger rolling stock – Trailer bogies -- Running gear – bogie frame structural strength test'.

2.5.6 Axle bearings shall have a minimum life rating of 3 million kilometres;

2.5.7 The bogies shall have frame mounted asynchronous three phase A.C. motors suitable for IGBT based VVVF traction system;

2.5.8 The bogies shall have independent brake cylinder for each wheel;

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2.5.9 The ride quality of the whole car with appropriately designed bogies shall conform to EN 2631-4:2001 – 'Mechanical Vibration and Shock. Evaluation of human exposure to whole body vibration. Guidelines for evaluation of the effect of vibration and rotational motion on passenger and crew comfort in fixed guide way transport system'. Sperling ride index of the car, at 120 kilometres per hour speed, shall not exceed 2.5 in both vertical and horizontal directions;

2.5.10 The diameter of the wheel shall be based on track stress calculations;

2.5.11 The tread profile of the wheel shall be designed for minimum wear of wheel and rail with a view to have long interval between wheel re-profiling.

2.6 Brake System

2.6.1 The brake system shall comprise of the following types of brakes:

- Electro-pneumatic (EP) service friction disc brakes;
- Electric regenerative service brakes;
- Fail safe emergency pneumatic brakes; and
- Spring applied, pneumatic release parking brakes

2.6.2 There shall be continuous and smooth blending of electro-pneumatic brakes and regenerative brakes.

2.6.3 The brake system shall provide for automatic wheel slip – slide protection.

2.6.4 The complete brake system shall conform to EN 13452-1:2003 – 'Railway application – Braking – Mass transit Brake System Performance Requirements'. In the event that the air supply fails, the traction power shall automatically reduce and the train speed brought under control of the Train Operator, sufficient to enable the train to reach the next station.

2.6.5 When operation in CATC modes, the Train Operator may apply or increase the brake effort at any time.

2.7 Electric Propulsion System

2.7.1 Powered cars shall be provided with Insulated Gate Bipolar Transistor (IGBT) based Variable Voltage Variable Frequency (VVVF) traction system. It shall have total traction and regenerative braking control with smooth control, free from jerks.

2.7.2 The entire propulsion system shall be provided with microprocessor based diagnostic system and the same shall be integrated with similar diagnostic system of entire car/train;

2.7.3 Traction motors shall be asynchronous three phase A.C motors;

2.7.4 The capacity of traction motors and other equipment shall be so designed that even on failure of one motor car, a train shall be able to complete its journey to destination without loosing time.

2.7.5 The train traction current shall be collected from the OHLE contact wire by a roof mounted pantograph. Roof mounted equipment shall include lightning arrestors, arcing horns and a reliable disconnection switch.

2.7.6 The High Voltage equipment and housing shall be securely grounded to the car body and bogies.

2.8 Auxiliaries

2.8.1 The auxiliary power supply shall be static inverter-converter based system with back-up batteries and battery charger.

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2.8.2 Back-up and standby batteries shall be nickel cadmium type with stainless steel casing.

2.8.3 Standby batteries shall be of adequate capacity to power all emergency equipment and services as specified in NFPA130 Standard for Fixed Guide way Transit Systems.

2.8.4 The Air Compressor shall be air cooled type and provided with regenerative type air drier system. Redundant Air Compressors shall be provided and arranged such that either one Compressor may provide sufficient air supply for the train to operate safely.

2.9 Environmental Considerations

2.9.1 Emitted noise

The average noise level with a train stationary on a straight level track with all auxiliary systems operating simultaneously under loading conditions which generate maximum noise, the noise level measured at a position 7.5m horizontally from the track centre line and 1500mm above head of rail shall not exceed 70/72dB at any point along the length of the vehicles or on any side.

The noise levels specified above shall be measured in accordance with ISO 3095 - Measurement of Noise Emitted by Rail bound Vehicles.

Moving on Surface Section

A train moving at speeds of up to 80 km/h on straight level track, operating in any mode of acceleration/deceleration with all auxiliary systems operating in maximum condition, shall not exceed a noise level of 75/78 dB when measured at a distance of 25m from the track centre line and 1500mm above the head of the rail, from either side of the train.

The noise levels specified above shall be measured in accordance with ISO 3095- Measurement of Noise Emitted by Rail bound Vehicles

2.9.2 Interior Acoustic Performance

1) Passenger Saloon

The average noise level along the length of the interior of each car, measured at a height of 1.5 metres above the floor at the car centre line, shall not exceed the following levels when all equipment is operating and the LRV is running on new level tangent track conditions, with an empty car and with all windows and doors closed:

At 80 km/h	65/68 dB
With car stationary	57/60dB

The noise levels specified above shall be measured in accordance with ISO 3381- Measurement of Noise Inside Rail bound Vehicles

The average noise levels shall exclude measurements taken in the inter-car connecting gangway.

2) Vehicle Operators Cab

The average noise level in the cab shall not exceed the following levels with all equipment operating and the vehicle running on new level tangent track conditions, with an empty car and with all windows and doors closed:

At 80 km/h	65/68 dB
With car stationary	57/60 dB

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The noise levels specified above shall be measured in accordance with ISO 3381-Measurement of Noise inside Rail bound Vehicles.

2.9.3 Equipment housings shall be compatible with BS EN 50125 Part 1: Railway Applications: Environmental conditions for equipment. Equipment on board Rolling Stock and Part 2: Railway Applications: Environmental conditions for fixed electrical installations.

2.9.4 Enclosure provided to protect equipment from the environment shall comply with EN 60529: Specification for the Degrees of Protection Provided by Enclosures (IP rating), as appropriate.

2.10 Interface Criteria

2.10.1 General

The Concessionaires train shall fit within the Alignment Swept Path, prescribed by the Exemplary as dimensioned in Chapter 2 Track work and Alignment Design Criteria. The Concessionaire shall describe how the criteria for the minimum platform gap are to be met.

2.10.2 The maximum axle load at AW4 loading shall not exceed ***16*** tons

2.10.3 Non–revenue vehicles

The Concessionaire shall provide adequate non-revenue vehicles to perform routine maintenance, recovery of failed trains, removal of obstructions and support for unplanned events.

Non-revenue trains required to operate on the revenue line while passenger services are in operation shall be equipped with CATC equipment for CM modes of driving.

2.11 Ride Quality

Passenger vehicles shall be designed to be free from objectionable vibration and shock. All equipment mounted in the passenger saloon shall be free from resonance to avoid audible noise and visual distraction.

The ride quality shall be evaluated according to ISO 2631. The rms acceleration shall not exceed the "1 hour reduced comfort level" boundaries derived from Figure 2a(vertical and Figure 3a (horizontal) of ISO 2631-1978 (E) or as amended in the current issue of ISO2631

END OF SECTION 2

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3 Performance Specification

3.1.1 The Train shall be capable of continuous operation at 120 kph

3.1.2 Train Operating Modes

All passenger trains shall be equipped with CATC equipment and Train Operator Controls to operate the train in the following modes:

a. Automatic Mode (AM);

b. Coded Manual (CM);

c. Restricted Manual (RM);

d. Yard Mode (YM); and

e. Wash Mode (WM).

3.1.3 Platform Stops

The Train Control equipment shall interface with the CATC equipment to ensure station stops are within +/- 500mm of the Correct Stopping Position.

On the Revenue Lines, the train equipment shall ensure that train doors on the platform side may be opened. Manual over-ride shall be arranged to mitigate the risk of a Train Operator opening the incorrect doors.

3.1.4 An emergency stop facility shall be provided in a prominent position on the Train Operator Console.

3.1.5 Absorption materials and resilient mountings shall be included to reflect a calm atmosphere throughout the journey.

3.1.6 Video cameras may be provided in each passenger saloon and baggage car, with a monitor on the driver console.

3.1.7 The Concessionaire shall provide power and capacity of the traction motors, transformers, converters, inverters etc. such that an empty train may propel a train loaded at AW3, from any location in the AMEL.

3.1.8 Platform Screen Doors

The CATC shall be connected to the Platform Screen Door system so that, when the doors of a train that is berthed in a platform are opened or closed, the Platform Screen Doors, within the Platform Edge Screen shall be opened or closed at the same time.

3.1.9 Diagnostic facilities

The Concessionaire shall propose microprocessor based Train Diagnostic Equipment.

The Diagnostic equipment shall monitor all operationally critical equipment and predict disturbance to its normal working and record failures.

Operating events shall be recorded to enable unplanned events to be analyzed.

END OF SECTION 3

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Chapter 4

SIGNALLING AND TRAIN CONTROL

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1 General

1.1 Specification

This Specification stipulates the performance requirements for the Signalling and Train Control System to be designed, constructed, commissioned and operated by the Concessionaire for the Airport Metro Express Line (AMEL)

1.2 Definitions

In this Particular Specification, the following defined terms shall have the meanings ascribed to them below

Abnormal Operation	The situation where the Train Control and Signalling System operates in an unscheduled situation.
Bi-direction	Operation of trains in Normal or Reverse directions over the same section of track
Broken Rail Protection	Detection of fractures to the running rail condition, inhibiting the CATC authority for a train proceeds.
Civil Speed Limit	The permanent maximum speed limit determined by the track geometry for all trains upon a particular section of line. This speed limit shall not be exceeded at any time.
Command	The facility to perform or modify a function of the System.
Correct Stopping Position	The point at which the train is required to stop in a station platform
Delay	Delay is caused when a train is unable to move or its speed is reduced due to failures in the System.
Design Headway	Minimum time interval between successive trains operated at the permitted line speed, such that the speed of a following train is not reduced by the train ahead.
Direction of travel	The Normal (N) direction of travel shall be the left-hand track, as viewed by a Train Operator the lead cab. The Reverse (R) direction of travel shall be the right-hand track, as viewed by a Train Operator the lead cab.
Dwell	The period of time taken from the instant that a train's wheels stop at a station until the point in time when the wheels start in motion again.
Equipment	A part of the Permanent Works.
Failure	A failure is an event which causes loss of function or performance within any part of the Signalling and Train Control System and requires a maintenance intervention to restore full functionality and performance
Limit of Movement Authority	Section of line ahead of a train which is clear for the train to proceed.

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Line Capacity	The maximum number of trains which may be operated in a Line during a one hour period. (Trains per hour)
Man Machine Interface (MMI)	The interface between the Controller and the control system
Maximum Safe Speed (MSS)	The maximum safe speed shall be the lowest of: the Civil Speed Limit, the safe speed required to ensure any Temporary Speed Restrictions in force, maximum permissible train speed, maximum speed set by the current operating mode and train parameters.
Mimic	A graphical representation of the railway and its global operating status.
Modes of Driving	Automatic Mode (AM); Mode of driving enabled by ATO and supervised ATP Controlled Manual (CM); Mode of driving supervised by the ATP system Restricted Manual (RM); Fall-back mode of driving during equipment failures, restricting the train speed to 40kph. Yard Manual (YM); Mode of driving in a stabling or workshop area restricting the train speed to 25kph.
Operating Headway	The Design Headway plus an operating margin that caters for variances between like equipment, driver reaction and station Dwell times. (Operating margin to be assumed 25 % of Design Headway time)
Revenue Service	Operation service with fare paying services.
Route	A part of the line originating at a signal for which the points have been set and secured to enable the safe passage of a train.
Safety-Critical	Failure of the system, sub-system or equipment that will directly lead to a situation with the potential to cause harm, injury, damage to property, plant or equipment, damage to the environment, or economic loss.
Service	When the railway is available for the use of fare paying passengers.
Service Affecting Failure	A failure which causes a Delay.

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Target Speed	The optimum speed at which the train should be driven, as determined by the Train Control System.
Trip Time	The time for a train to travel from one terminal to the opposite terminal on the same line, with pre-determined dwell times at each intermediate station. This time does not include any layover time at the termini.
Vital	That which is necessary for the safe operation of the Railway.
Workstation	The collection of processors, screens and input devices necessary to provide one Controller with the necessary System displays and Commands.

1.3 Requirements

1.3.1 The revenue line Signalling and Train Control System shall be a Continuous Automatic Train Control System (CATC), comprising Automatic Train Protection System, Automatic Train Supervision System and Automatic Train Operation System, and provide bi-direction working over each track.

1.3.2 The CATC system shall be controlled from the Operations Control Center (OCC). During periods that the OCC is unavailable the supervision of the CATC shall automatically transfer to the Local Control Operator work-stations provided in each station, without any loss of control capability.

1.3.3 The Signaling and Train Control System electronic equipment shall be designed and supplied for a minimum Design Life of 20 years and associated wayside equipment shall be designed and supplied for Design Life of 30 years.

1.4 Systems Assurance

1.4.1 General

The System engineering shall be planned and managed in accordance with the requirements specified in Schedule D Part III Chapter 1, General Technical Specification.

1.4.2 Reliability Requirements

The CATC for the revenue line shall be engineered for a minimum useful life of 15 years, based on the equipment being continuously in operation, and shall achieve an MTBSAF of no less than 1000 hours between any failures affecting the revenue train service.

The Depot Signalling shall be engineered for a minimum useful life of 15 years, based on the equipment being continuously in operation, and shall achieve an MTBF of not less than 7 days where no fault is recorded by the Failure Review Board (FRB).

1.4.3 Availability Requirements

Availability shall be recorded as the Mean Down-time Between Service-Affecting Failures (MDTBSAF), in minutes of time.

The CATC shall be engineered a minimum useful life of 15 years, based on equipment being continuously in use, and achieving a minimum of Operating Available for 99.99%.

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1.4.4 Maintainability Requirements

The System shall be engineered to maximise Availability during traffic hours and ensure that the preventive and corrective maintenance activities can be carried out without disruption to revenue services.

The Maintainability measure for the CATC shall be Mean Time to Restore (MTTR) and shall not be greater than specified in Schedule D Part III Chapter 1.

1.4.5 Safety Requirements

The safety of the CATC shall be demonstrated by the Concessionaire before the commencement of revenue service. The demonstration methodology shall be defined by the Contractor and approved by the DMRC.

1.4.6 Risk Assessment

The Concessionaire shall undertake a Risk Analysis for the System and mitigate the potential Hazards as low as reasonably practical, in accordance with IEC 62278 Standard. The Concessionaire shall establish and maintain a Hazard Log throughout the Concessionaire period, recording the hazards identified and mitigation measures provided; residual risk management procedures shall be proposed to the DMRC for his Consent.

The System safety sub-systems shall be engineered for a Safety Integrity Level 4 (SIL 4), as defined in IEC 61508 Standard. Hazardous events shall not occur with a greater frequency than 1 in 100 years.

As part of the Systems Assurance Program, the Concessionaire shall conduct a Risk Assessment in order to establish what measures are needed to mitigate risks from the possibility of a broken rail or staff working on the track. The Concessionaire shall make the CATC fulfill any duties that this process identifies as necessary.

END OF SECTION 1

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2 Design Criteria

2.1.1 The Normal direction Design Headway of the CATC System shall be 120 seconds and the Reverse direction Design Headway 150 seconds during short working, as a result of emergency working and reversal at the terminal stations, train reversal shall be enabled at 150 second intervals.

2.1.2 All trains within and approaching a bi-direction section shall be brought to a standstill before the direction control is implemented. (N->R or R->N)

2.1.3 The Concessionaire shall conduct Operating simulations for normal and abnormal working service patterns to establish that the integration of track turnouts and the Signalling and Train Control System can consistently sustain the specified Operating Headways. Operating simulations shall be provided for both Normal and Reverse direction working.

2.1.4 The CATC System shall provide the following:

(1) Continuously define a train limit of movement authority and adjust the train speed within the envelope;

(2) provide safe separation between trains;

(3) prevent derailment due to misdirection of trains at points;

(4) prevent excess speed of trains;

(5) give authority to proceed along a route set and locked for each train;

(6) verify all trains approaching or within a bi-direction section shall be proven to be at a standstill before the direction of operation is reversed (N->R or R->N).

(7) provide "broken rail protection";

(8) automate routine operations;

(9) alarm potentially unsafe operating situations;

(10) Trains shall berth at the Correct Stopping Position, +/- 500mm.

(11) Trains shall be verified to be at rest before enabling PSD's to open.

(12) Automatically limit the number of trains to one, per tunnel ventilation section, unless over-ridden by the OCC control under Rules and Procedures.

2.1.5 The design for the CATC shall be fully integrated with all other systems that constitute the Railway System so that the overall requirements of the DMRC are met.

2.1.6 Equipment and locations that may need to be identified in emergencies (including all stations, signals and ends of points) shall be uniquely and indelibly named or numbered in a way that is visible to Passenger Train Operator's (PTOs) and these numbers shall be co-ordinated with the associated control equipment and the displays in the OCC and DCC.

END OF SECTION 2

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3 Performance Specification

3.1 Signalling

3.1.1 The signalling shall support a maximum line speed of 120 kilometer/hour in Automatic Mode or Coded Manual mode in either Normal or Reverse direction over the same track and shall have facilities for speed restrictions to be imposed on sections of track determined by the alignment design criteria. The speed restriction details shall be transmitted to trains in a fail-safe manner so that the trains are driven and supervised in compliance with those speed restrictions.

3.1.2 The System shall ensure that sufficient distance is provided for braking a train to a stand-still using the service brake, from a train ahead or to a defined stopping position.

3.1.3 The train control system shall include a vital interlocking which shall manage the setting, locking and releasing of routes for trains. The interlocking shall prevent conflicting routes from being set. As the train proceeds through a set route, the points and sections of track behind it shall be released automatically for use by following trains. The OCC staff shall also have a facility to release routes manually provided there is no danger of the train subsequently proceeding due to having previously received permission to proceed.

3.1.4 The OCC staff shall be provided with a convenient facility to call for emergency replacement of all signals to danger. Following use of the emergency replacement function the equipment shall make all signals display their most restrictive aspect and the automatic systems shall not set routes. When the emergency replacement function is cancelled the signals shall return to normal operation, but Automatic route setting shall remain inactive until the OCC staff re-activates it.

3.1.5 Each set of points shall be provided with indicators that show the PTO whether or not the points are set correctly and whether or not they are locked. The indication shall be visible to the PTO of a train driven in RM mode, in time for the PTO to stop the train short of the points in the event of the points not being set and locked correctly.

3.2 Automatic Train Protection

3.2.1 The Automatic Train Protection (ATP) function shall automatically control trains according to information about the direction, safe speed and position limits for the train. If the train exceeds the permit speed and position envelope, at any location for that train, then the ATP function shall automatically apply the train brakes and bring the train to a halt. The ATP function shall be fail-safe. A warning (such as a distinct sound) may be given to the PTO when a train is exceeding the MSS and the ATP will apply the brakes unless the PTO moderates his driving promptly. After the ATP has applied the brakes, the brakes shall not be released until the train has stopped and the PTO has confirmed that he has taken control. The Concessionaire shall devise and implement procedures for enabling a train to proceed safely after ATP braking, bearing in mind the fact that the train may have stopped beyond the movement authorized by the OCC.

3.3 Automatic Train Operation

3.3.1 Trains shall normally be driven automatically, but with a PTO present in the front cab. The PTO shall decide when the doors may be closed and when it is safe for the train to depart a platform; the ATO function shall then undertake all driving functions up to and including the opening of the train doors on the correct side at the next station. The ATO function shall drive the train within the applicable direction, speed and distance limits so that the ATP function does not need to apply the brakes. Trains shall berth at the Correct Stopping Position and shall be verified to be at rest before enabling Platform Screen Doors to open.

3.3.2 The Concessionaire shall determine the accuracy needed for the alignment between the train doors and the Platform Screen Doors. If the train stops without achieving this accuracy of alignment then an alarm shall be presented both to the PTO of that train and to the OCC staff. The Concessionaire shall establish procedures for prompt recovery from such door misalignment.

3.3.3 The ATO function shall be implemented independently from the ATP function so that no malfunction of the ATO equipment can inhibit the ATP function.

3.3.4 The ATO operation shall be arranged to provide optimization of energy consumption.

3.4 Automatic Train Supervision

3.4.1 The centralized train control system shall automatically manage all events that would be predicted from the timetable. The Train Service Regulator (TSR) shall not need to intervene unless the traffic has substantially deviated from the timetable or an equipment failure has occurred. Minor deviations from the time table shall be adjusted automatically by modifying the station dwell/layover time and coasting.

3.4.2 The ATS System shall enable time tables to be written and installed for revised service patterns.

3.4.3 Programs shall also be provided for Abnormal Working during emergency working situations and restoration of Normal working.

3.4.4 During any loss of the OCC, supervision of the CATC shall automatically fall-back to Local Control at each Station. The ATS Local Processing Units (LPU) shall enable similar train control features to the Central Processing Units.

3.4.5 Human/Machine Interfaces (HMI) for controls and indications at the OCC shall be consistent throughout the Railway System.

3.5 Normal and Abnormal Working Requirements

3.5.1 When all systems are working normal the railway shall be controlled automatically and monitored by the OCC staff. If traffic perturbations occur the changes to the traffic arrangements will be managed using the OCC controls. If the OCC are unavailable for any reason, working shall automatically be instituted by local supervision from Local Control Panels at Station Control Rooms (SCR), without any loss of automatic operation.

3.6 Alarms and Reports

3.6.1 The train-borne equipment shall inform the PTO promptly if a defect arises which prevents the ATP system from protecting the train. The information should indicate as accurately as possible whether the CATC defect is on the train or on the track.

3.6.2 The train-borne equipment shall confirm to the PTO when its self-test is completed successfully.

3.6.3 The train-borne equipment shall inform the PTO if possible when a defect arises in the train-carried equipment.

3.6.4 The train-borne equipment shall advise the PTO when the brakes have been applied by the ATP system and the reason. The train-borne equipment may warn the PTO before the brakes are applied by the ATP system.

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3.6.5 The trackside equipment shall alert the OCC staff and record the system defect in a log when a defect arises in the trackside equipment.

3.6.6 The Signalling and Train Control equipment shall immediately report certain functions, typically, but not limited to the following:

(1) Identification of failure of point throwing or detection;

(2) Identification of signal defects;

(3) ATP System failures;

(4) Power supply defects including UPS defects and earth faults;

(5) Untimely or out-of-sequence operation of equipment;

(6) Unauthorized or potentially unsafe train movement;

3.6.7 Diagnostic and condition monitoring information shall be available at the Maintenance workstation, when available within local equipment.

3.6.8 The trackside equipment shall monitor the positions of the trains continuously and shall indicate them in, approximately, real time on the OCC mimic and workstations. The displays shall draw attention to any train that exceeds its permitted movement or proceeds backwards or appears to have become divided or whose position becomes unknown.

3.6.9 All alarms shall clearly indicate the nature and the location of the cause. PTOs and OCC staff shall have manual facilities to acknowledge (and thus cancel) each alarm individually.

3.6.10 The Signalling and Train Control System shall enable a non-volatile log to be compiled of all Operator actions, changes of state of indicators and points, transmissions, alarms, alarm cancellations, train progress, mode of operation and changes, ATP and train brake applications, etc., during the previous 48 hours, all date and time stamped in accordance with the Master Clock. This log shall be made available to the DMRC during incident investigations.

3.7 Test Facilities

3.7.1 A section of the revenue Line in proximity to the Depot shall be defined as Test Tracks, for testing Rolling Stock during non-revenue hours. Both tracks shall be equipped to enable all train CATC functions to be tested in both directions for all ATP speeds and ATO station facilities.

3.7.2 As a minimum, the Depot departure transfer tracks shall include facilities that test every departing train is equipped with working brakes and train-borne systems and is in the correct driving mode for the revenue lines.

3.7.3 The test track that enables all train ATP and ATO functions to be tested in both directions of running, including functions associated with stations.

3.7.4 Whenever irregular operation of the CATC is suspected, the Concessionaire shall immediately establish accurately whether a dangerous defect is present, and if so shall take immediate action to avoid the danger. The Concessionaire shall provide whatever test facilities and recording functions are necessary to meet this requirement.

3.7.5 The Test Track shall provide a controlled environment for testing the train borne parts of the CATC.

3.8 Operations Control Center

3.8.1 The AMEL operational status shall be continuously displayed on a mimic panel and work

station in the OCC. Route setting, track occupancy; point position and point indicator aspect shall be mimicked in near to real time. Trains shall be identified by unique number and step in correspondence with the train movement.

3.8.2 Supervision of train operations from the OCC shall be enabled automatically by the ATS or by manual operation by the Train Service Regulator (TSR). Normal working shall be by automatic route setting in accordance with time table resident in the ATS CPU. The ATS system shall have the capability to generate new time-tables for modifying train service operation by the CATC.

3.8.3 When required to reform a service, the TSR may enable a Train Hold facility to inhibit trains departing a platform in CM mode of driving.

3.8.4 The Concessionaire shall integrate the CATC central control computers with other associated control Systems at the OCC to provide the operators with the required facilities for supervising and controlling the entire Railway System, apart from the Depot.

3.9 Depot Signalling

3.9.1 The Depot Signalling system shall control movements of the trains within the Depot up to the limits for transfers with the revenue line signalling system. As a minimum, a vital two aspect line side signal system shall provide route setting and holding with indications of train locations displayed on a mimic panel and shall be controlled from a Depot Control Centre (DCC) to be provided.

3.9.2 Signalled routes shall be interlocked against conflicting train movements without compromising operational requirements.

3.9.3 A facility shall be provided on the transfer berth(s) for trains entering the revenue line from the Depot, to establish the correct mode of driving and train run data.

3.9.4 A facility shall be provided for trains leaving revenue service at the Depot entry transfer berth(s) to change to Depot operation mode and to download train identification and condition data.

3.9.5 A warning system shall alert staff working in workshop areas of approaching vehicles

3.10 Palam Sidings

3.10.1 During Normal Operations, Palam Siding signalling controls and indications shall be operated from the OCC.

3.10.2 During loss of the OCC control, the operation of the Siding routes shall be from the Local Control Panel of one adjacent Station.

3.10.3 The signalling routes shall be interlocked with conflicting routes of the Revenue Line.

3.11 Train Operating Modes

3.11.1 General Description

All passenger trains shall be equipped to operate in either direction, in any of the following modes:

(1) Automatic Mode (AM) of driving shall be used as the normal method of train control in the tunnel section of the revenue lines;

(2) Coded Manual (CM) driving shall be used as a fall-back method of train control in the tunnel section when a train or track-side equipment fault prevents AM driving;

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(3) Restricted Manual (RM) driving shall be used as a fall-back method of train control when a train or track-side equipment fault prevents ATP supervision being provided;

(4) Yard Mode (YM) driving, which shall be used as the normal method of train control in the Depot;

(5) Wash Mode (WM) driving, a sub-mode of YM shall be used for controlling the low speed movement of trains through the Depot wash plant.

Non-revenue trains required to operate on the revenue line while passenger services are in operation shall be equipped with CATC equipment for CM and RM modes of driving.

3.11.2 Automatic Driving

The Automatic Train Operation (ATO) function shall be active when ATP is active both on the train and on the track, when AM is selected by the PTO, or automatically selected for test purposes. The ATO function shall undertake all the actions that would be undertaken by a PTO in order to drive the train from station to station with the exception of:

(1) deciding when it is safe to close the doors and operating the door closing control;

(2) deciding when the train may proceed;

(3) Operation of the Emergency Brake switch;

(4) observing the cab indicators;

(5) Verbal communication with passengers and the control centre.

3.11.3 Coded Manual Driving

Coded Manual Driving shall be active when ATP is active both on the train and on the track and Coded Manual Driving has been selected by the PTO. The effect shall be that the PTO may use the train driving controls to operate the train within the set route direction, speed and distance limits imposed by the ATP system. The PTO shall be provided with information about the direction, speed and distance limits defining the signalled route within which he may drive.

3.11.4 Restricted Manual Driving

Restricted Manual Driving shall be active when ATP is not active on the train or the track

and the PTO has selected Restricted Manual Driving. The effect shall be that the PTO may use the train driving controls to operate the train on the revenue line, in the forward direction, up to a maximum speed determined to be safe for unsupervised driving.

3.10.5 Depot Modes

"Yard" Driving shall be active when the driver of a train within the Depot working limits has selected Yard Mode Driving. The effect of selecting Yard Mode shall be that the driver may use the train driving controls to operate the train within the speed limit for the Depot and enable routine inspection work. Wash Mode, a sub-mode of YM shall limit the train speed when washing in fixed plant and for automatic coupling of Trains.

The Depot shall also provide facilities for testing all trains routinely before they move out of the Depot into service, and for undertaking other tests as required.

3.10.6 Mode Transitions

Mode transition may be requested by the PTO at any time when the train is stationary, in order that the PTO may have every opportunity to pass defective infrastructure and return to normal

operation as soon as possible afterwards. Every mode transition shall be recorded in a non-volatile medium on the train.

Where mode transitions are required routinely they shall be initiated automatically; The following mode transitions shall be undertaken routinely and automatically:

(1) Entry into service: when a train enters the Transfer Berth between the Depot working limit and the revenue lines, the train shall be automatically tested in ATO Mode and if successful, shall then automatically be transferred to the appropriate revenue line Mode for driving;

(2) Departure from service to the Depot: before a train enters the Depot working limit, the train shall automatically transfer to "Yard" driving mode;

(3) While the train is moving; the Concessionaire shall provide a Risk Assessment for changes in the mode of driving to ensure any reduction in safety is inhibited.

END ON SECTION 3

4 Equipment

4.1 General

The CATC shall be arranged to minimize the amount of equipment that has to be accommodated in track-side apparatus housings; the equipment should be installed in Signalling Equipment Rooms (SER) linked by secure cable routes where possible. All equipment shall be mounted in a position clear of the track so that it can be accessed and maintained safely while trains continue to run, unless this is inconsistent with its function. The equipment shall be accommodated in a way that not only enables the equipment to function as required but also which enables maintainers and testers to carry out their duties efficiently.

The following standards shall apply to the entire Signalling and Train Control system, where applicable:

(1) BS EN 50125 Part 1: Railway Applications: Environmental conditions for equipment. Equipment on board Rolling Stock and Part 2: Railway Applications: Environmental conditions for fixed electrical installations;

(2) BS EN 60529: Specification for degrees of moisture protection provided by enclosures (IP codes);

4.2 Local Control MMI

A signalling local control workstation shall be provided in the SCR of each station which enable the setting of routes and control points, to provide fallback control and indications of the signalling arrangements associated with the area. When enabled from the OCC, the local control panel shall provide the following functions:

i) Controls

- Worn-station Enabled;
- Route setting;
- Signal replacement
- Point setting;
- Bi-direction control;
- Staff Protection Key Switch release; and
- Emergency Stop Plunger reset.

4.I Indications

- Point correspondence and locking;
- Signal aspect;
- Track occupancy;
- Direction of operation;
- Platform Edge Door open/closed;
- Staff Protection Key Switch normal/reverse;
- Emergency Stop Plunger status; and
- Power / grounding status alarms.

4.3 Staff Protection Key Switch

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A Key Switch facility shall be provided in platform unpaid areas, adjacent to special track work, which when operated will inhibit train movement in CM mode, from entering a defined area which staff may occupy

4.4 Platform Screen Doors

The CATC shall interface with the Platform Screen Door system so that, when the doors of a train that is berthed in a platform are opened or closed, the Platform Screen Doors, within the Platform Edge Screen shall be opened or closed at the same time.

4.5 Emergency Stop Plungers

If passengers at a station operate one or more platform emergency stop plungers then trains near that station shall automatically be signalled to make an emergency stop. For the purposes of this requirement a train shall be considered to be near the station, when any part of the train is alongside a platform of that station or when the train is approaching the station and within braking distance of it. If other trains approach the station before the emergency plunger operation has been cancelled those trains shall be brought to a standstill before they enter the station.

The manner in which that signal is acted on shall be dependent on the mode in which the train is being driven.

4.6 Train Equipment

All rolling stock, passenger trains and on-line maintenance vehicles required to operate during revenue service shall be fitted with facilities for self verification of correct operation of the onboard CATC equipment and train safety systems. Any failure of safety critical equipment, as specified in the safety case, shall result in the rolling stock not being admitted to the revenue lines, and if a failure occurs in service the affected vehicles shall be taken out of revenue service at once. As soon as possible, the defective train shall be removed from the revenue line, with suitable precautions to ensure safety.

When in AM mode, Train berthing facilities shall automatically open train doors on the platform side. In CM/AM modes an indication shall be given to the driver that the train is correctly berthed and which side passenger doors may be opened.

Where applicable, the train-carried equipment shall meet the standards IEC 571: Electronic equipment used on rail vehicles.

4.7 Power Supplies

The Concessionaire shall ensure that the power supply system for the CATC functions reliably under any feeding arrangements that permit trains to run, and the discrimination between all forms of protection is such that equipment failures cause minimum disruption to the Railway System.

The Concessionaire shall investigate what facilities, if any, are required for the public emergency services to switch off power supplies (for example, in the event of fire) and shall provide facilities that meet the requirement effectively, including disconnecting any uninterruptible power supplies, but without exposing the system to avoidable risk of outside interference.

4.8 Cabling

The Concessionaire shall provide Fire Retardant Low Smoke Zero Halogen (FRLSOH) cabling as a minimum in confined public areas, tunnels and equipment rooms.

4.9 Points

Trains shall not pass over points in the facing direction unless the points are known to be set correctly and locked.

All points shall be wired so that the failure of the switch rails to throw (or be detected as thrown) does not cause loss of functionality of signalled routes that do not traverse those points or rely on them for secondary protection.

The Concessionaire shall provide point mechanisms that are fit for the purpose of moving the switch rails to the required position promptly when required, locking them (in cases where trains pass over the points in the facing direction), and detecting in a fail-safe manner that the rails are positioned and locked properly.

The Reliability of points machines shall be engineered not to exceed one failure in 1 (one) million operations.

The Concessionaire shall determine the standards to be applied to the positioning of the switch rails.

The Concessionaire shall provide arrangements (which may use procedures or equipment or some combination of the two) to avoid danger to staff who are required to work on or near movable equipment including points.

The points shall be suitable for being moved and locked manually in the event of failure in the power, control or indication system.

The Point Machines shall meet the following standards, where applicable:

BS 4575: Fluid power transmission and control systems;

EN 60204-1 (1998): Safety of Machinery-Electrical Equipment of Machines;

4.10 Vehicle Position Detection

The Concessionaire shall provide equipment for detecting the positions of trains which is fit for its purpose according to the modes in which trains may run at that location. The train detection equipment on the revenue line shall be fail-safe.

The train positions shall be determined with the accuracy required to meet the requirements in this specification relating to:

(1) Stopping accurately alongside Platform Edge Doors;

(2) The locking of points;;

(3) The prevention of collisions between trains;

(4) The prevention of over-speeding where a speed limit applies;

(5) The co-ordination of train doors with adjacent platforms;

(6) The response to a passenger alarm, providing accurate information about the train service to passengers;

(7) Information to utilize staff efficiently; and

(8) Event recording.

The vehicle position detection equipment shall be highly reliable and shall achieve the accuracy required to meet the requirements for providing accurate information about the train service to passengers, information to utilize staff efficiently, and for event recording.

The vehicle detection equipment shall reliably detect not only passenger trains but any other rail vehicles that run from time to time.

The resolution of the vehicle detection system in places where trains are coupled together shall be sufficient to provide the TSR in the OCC or Depot Controller in the DCC, as appropriate, with sufficiently detailed track occupancy information to assist staff at the track-side in joining trains.

If axle counters are used, the "disturbed" state shall be indicated to the OCC staff as well as the "occupied" and "unoccupied" states. Also if an additional state is provided for use during re-commissioning, this shall be indicated to the OCC staff.

4.11 Signals and Point Indicators

Point Indicators shall be designed and mounted so that they can be seen clearly and understood by PTOs but without excessive visual intrusion.

Point Indicator and Signal aspect colors and meaning shall comply with BS 376. All signals shall be legible, unambiguous and clearly visible sufficiently early for the PTO to have five seconds to read the indication and think before reacting.

END OF SECTION 4

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CHAPTER 5

ELECTRIC POWER SYSTEM

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1 GENERAL

1.1 Specification

This Specification stipulates the performance requirements for the High Voltage (HV) Electric Power System to be designed, constructed, commissioned and operated by the Concessionaire for the Airport Metro Express Line (AMEL)

1.2 Supply Connections

The DMRC shall provide two Railway Supply Substation's (RSS) within the AMEL reserve, RSS 1 near Kendriya Bus Termina,l Church Street and RSS 2 within IGI Airport complex both substations are connected to diverse TRANSCO 66kV grid supplies. Each of the RSS's equipment shall transform the supplies, as follows:

(1) 33 kV 3phase 50 Hz for Auxiliary power supplies. Two fully redundant supply points shall be provided for the Concessionaires to connect an HV ring main.

(2) 25 kV 1phase 50 Hz for traction power. Two fully redundant supply points shall be provided for the Concessionaires to connect to the Overhead Line Equipment (OHLE).

The Concessionaire shall supply and commission the SCADA System equipment for the control and monitoring of each RSS switching and protection equipment and TRANSCO supplies.

All temporary power supplies for Dwarka Depot, during construction shall be provided by the Concessionaire.

1.3 Definitions

AC Traction Manual	Ministry of Railways Regulations for OHLE clearances and Earthing and Bonding
DISCOM	Distribution Company, of electric power. Licensed to sell electric power
Earthing	Synonymous with grounding. The connection of equipment enclosures and non current carrying metal parts to earth to provide safety to personnel, public and to the equipment.
EIG	Electrical Inspector of the Government of India. Statutory Agency
Embedded E&M	Electrical and Mechanical facilities, such as Earth mat, bonding, and the like, to be included within the structures provide by the DMRC designated contractor for Civil and Structures.
High Voltage	As applied for the AMEL, the high voltage is 66kV, 25 kV, 33kV
PTCC	Power and Telecommunications Consultative Committee. Statutory Agency
RSS	Railway Sub-station, comprising Traction Sub-station (TSS) and Auxiliary Sub-station (ASS)
TRANSCO	Transmission Company, of electric HV power

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1.4 Requirements

1.4.1 The electric power load to be connected shall comply with the DISCOM Regulations for electrical loads.

1.4.2 The proposed capacities, ratings and number of equipment to be connected as determined through the engineering development, shall be demonstrated by simulation study and proper engineering.

1.4.3 The main components of the equipment provided shall be sized to operate the AMEL services, under all conditions, for the forecast patronage of the year 2041.

1.4.4 The current collection system shall be overhead equipment, providing electric power at 25kV 50Hz, designed for operating rolling stock at a line speed of 120kph.

1.4.5 (i) RSS 1-Church Street

(a) DMRC will lay two 66 kV lines between TRANSCO grid to RSS and Erect& commission a combine 66/33/25 kV RSS near Kendriya Bus Terminal, Church Street , which will be utilized by DMRC for CTST-Badarpur Line and by Concessionaire for AMEL.

(b) Normally, power will be drawn by DMRC & Concessionaire through their independent circuit and the billing of the respective circuit of 66 kV will be dealt with by Concessionaire and DMRC for their own consumption of power. The Concessionaire will operate and maintain his part of substation from 66 kV incoming breaker onwards.

(c) DMRC will operate and maintain 66 kV cable links and their part of the substation from one of the 66 kV incoming circuit breakers.

(d) There will be an arrangement of metered power transfer between DMRC and Concessionaire, in case of emergency or dislocation of the services on either side.

(e) Concessionaire will lay, operate and maintain 33/25 kV cables from RSS to their feeding Post.

(ii) RSS 2 IGI Airport

(a) DMRC will install two 66 kV links between Transco Airport grid switch Station to the adjacent RSS 2 and erect the RSS structure, install and commission the reticulation equipment for 66/33 kV 3 phase Auxiliary supply and 25 kV single phase Traction System supply. The Concessionaire shall design, supply and coordinate the SCADA equipment for the control and monitoring the HV equipment. DMRC will Hand-over RSS structure and installed equipment along with the 66 kV links to the Concessionaire to operate & maintain the same.

(b) Concessionaire will install, operate and maintain the 33/25 kV links from RSS to their feeding post within the AMEL alignment.

1.4.6 The Electric Power System equipment shall be designed and supplied for a Design Life of 30 years.

1.5 RAMS Requirements

1.5.1 General

The System engineering shall be planned and managed in accordance with the requirements Specified in Schedule D, Chapter 1, General Technical Specification.

1.5.2 Reliability Requirements

The HV Electric Power System for the revenue line shall be engineered for a minimum useful life of 30 years, based on the equipment being continuously in operation, and shall achieve an MTBSAF of 40000 hours between any failures affecting the revenue train service.

1.5.3 Availability

(1) The Electric Power System shall be engineered for a minimum operational life of 30 years based on the equipment being in continuous use and achieving a minimum Service Affecting Availability of 99.99%

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(2) Loss of one supply to an RSS or one RSS providing the HV Power for Auxiliary supplies and the OHLE shall be transparent to the operation of the passenger trains.

(3) Failure at the RSS or Station ASS of any single item of equipment shall be transparent to the operating transit system.

(4) As far as is reasonably practicable, failures of the overhead line, or support equipment shall not cause loss of traction supply to more than one track, nor to sections of route that do not pass over the section of track where the fault occurred. Provision shall be made, through section motorized isolators and other means, to allow reconfiguration of the traction power supply to feed the overhead line in areas not directly affected by the fault. Motorised Isolators shall be controlled by the SCADA System and Engineering Controller at the Operations Control Center. (OCC)

(5) Means shall be adopted, in the engineering and installation of the OHLE, to prevent equipment and component failures or overhead line structural collapse.

(6) OHLE over each track on the revenue lines shall be supported independently, the engineering of supports of depot and secondary lines shall be of sufficient robustness so that an impact by a train pantograph shall not cause a failure affecting other running lines.

1.5.4 Maintainability

(1) The Concessionaire shall undertake Maintainability analysis to asses the maintenance requirements to assure the Availability targets of the systems.

(2) The equipment to be supplied by the Concessionaire must be engineered for minimum maintenance wherever possible. Maintenance activities required must be capable of being performed without impact on the planned train service.

(3) To optimize speedy corrective maintenance, techniques employing automatic diagnostics test points, and rapid repair facilities shall be provided.

1.5.5 Safety

(1) The Operation and Maintenance Plan shall include the safety requirements for the equipment of the OHLE and Auxiliary HV Distribution Systems.

(2) Safety Requirements

(a) The engineering shall incorporate measures to avoid presenting safety hazards to people.

(b) The Systems engineering shall incorporate measures to provide for its safe management and Operation and Maintenance.

(c) The Systems shall not give rise, or be subject to, dangerous interactions within the railway or with other systems.

(d) The engineering of the Systems shall consider the Safety and Reliability of susceptible equipment adjacent to the AMEL.

(e) The installation shall meet the fire safety requirements of NFPA130 Guidelines.

(f) The engineering of the Earthing system shall conform to EN 50122-1 and BS7430 Code of Practice for Earthing

(3) Risk Assessment

(a) The Concessionaire shall show that the HV System's can be operated and maintained safely. The Concessionaire shall prepare a Risk

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Assessment Report identifying the risk to people and property. The Assessment may be based on a comparison of System features and operating practices with other comparable railway systems for which risk levels are known.

(b) The Concessionaire shall demonstrate that risk to passengers, members of public, including trespassers is low as reasonably practicable. Residual risk shall be recorded in the HAZARD Log and Operator Rulesand Procedures developed to mitigate them shall be proposed by the Concessionaire, for Approval of the DMRC.

1.6 System Overview

1.6.1 HV Supplies

(1) TRANSCO will provide two 66kV switch bays at each of their Grid Sub-stations at Park Street and IGI Airport; each switch bay shall be supplied from a diverse power source. The DMRC Designated contractor shall provide RSS 1RSS 2 near Kendriya Bus Station, Church Street and within IGI Airport complex and connections with TRANSCO Grid substations, together with spare connection cables.

The Concessionaire and DMRC shall operate and maintain one connection each of 66 KV between TRANSCO Park Street Switching Station and the combined RSS at Kendriya Bus Terminal, Church Street. The Concessionaire shall operate and maintain the connection between TRANSCO IGI Airport Switching Station and the adjacent RSS 2 . The Concessionaire shall operate and maintain the RSS structures and electric power equipment provided by the DMRC Designated contractor, after hand-over.

(2) Each RSS shall comprise 66 kV switch bays for receiving the TRANSCO power supplies, Traction Tap Changing transformers and Auxiliary Power Supply transformers and switchgear. Each circuit shall be duplicated and configured for full redundancy.

(3) Each of the RSS's will provide connection points with two redundant 33kV 3 phase 50Hz supplies and two redundant 25 kV 1 phase 50 Hz supplies. The Concessionaire shall connect to the 33 kV 3 phase supplies for the AMEL Auxiliary power radial feeder and the 25 kV 1 phase supplies for traction power.

(4) The Concessionaire shall provide a SCADA System for the management of the HV networks. During any loss of supplies, the SCADA system shall automatically reconfigure the arrangement of the networks; reconfiguration of the traction system shall be transparent to normal train service operation. Manual supervision of the HV network shall be by the Engineering Controller located at the OCC.

1.6.2 LV Supplies

HV Auxiliary Power Supply Systems shall be reticulated at each station, Dwarka Depot and line-side equipment room to 415V 3 phases and 240V single phase for Essential and Non-essential Auxiliaries supplies. Chapter 9 specifies the LV power supply requirements.

1.6.3 Earthing and Bonding

Earthing of equipment shall comply with EN 50122-1 Railway Applications: Protective Provisions for Electrical Safety and Earthing and Against the Effects of Stray Currents, AC Traction Manuel (Ministry of Railways) and BS7430 Code of Practice for Earthing

END OF SECTION 1

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2 Design Criteria

2.1 General

2.1.1 Voltage Unbalance

The Concessionaire shall ensure that the overall voltage unbalance of electrical supplies taken by the Electrical Power system is in accordance with EN 50160.

2.1.2 Power Factor

The Concessionaire shall ensure that the overall power factor of electrical supplies taken by the Electrical Power system does not exceed 0.95.

2.1.3 Harmonic Disturbance

The Concessionaire shall ensure that the total harmonic disturbance to TRANSCO – DISCOM HV distribution network does not exceed the UK Engineering Council Recommendation G5/4,

2.1.4 Cables

All HV power cables shall be XLPE insulated or equivalent, in accordance with IEC 60331 and NFPA 130. Where protection is required the Concessionaire shall provide suitable ductwork. In tunnels and constrained areas FRLSOH cables shall be provided. Control and Power cables shall be separated through out the route. All critical, duplicate and/or ring main cables shall be routed separately such that damage to one cable/route will not compromise performance and safety. All cabling and protection equipment shall also comply with the IEC/EN standards as a minimum.

2.1.5 HV Power Supplies

The Electric Power supplied by TRANSCO shall generally be, as follows:

- Voltage: Uc +10% /-12.5%, where Uc is the nominal Voltage;
- Frequency; 50 +/- 3% Hertz

2.1.6 The Concessionaire shall arrange direct line voice and data communications facilities between the TRANSCO and the OCC to enable good management of the power supply to the AMEL.

2.2 Auxiliary Supply Substations (ASS)

2.2.1 Power Transformers shall be in accordance with EN 60076.Two transformers shall be provided in each ASS, configured for redundant operation.

2.2.2 Switchgear

HV switchgear shall be Gas Insulated Switchgear in accordance with IEC60056, IEC 60186, IEC 60298, IEC 60376, IEC 66044-3.

LV Switchgear shall be in accordance with EN 60439 – 1 and 60947-1/-/5

2.2.3 Electrical Protection Systems

Protection facilities with fast discrimination and reliable operation, based on micro-processor technology, shall provide the protection scheme logic. The zones of protection shall overlap providing back-up protections. The scheme for protection shall be fully coordinated with the DMRC.

The Concessionaire shall ensure that discrimination between all forms of Station substation protection is such that equipment failures cause minimum disruption to the Railway System

operation.

2.2.4 An interlocking and protection scheme that prevents inadvertent operation of switchgear resulting in electrical accident by inadvertent or spurious re-energization of the supply shall be submitted to the DMRC for Approval.

2.3 Traction Power System

2.3.1 Traction supplies shall be distributed at 25kV in accordance with EN 50163 Railway Applications – Supply Voltages of Traction Systems.

2.3.2 The Concessionaire shall provide traction power simulation studies to establish the Traction Power System requirements. The short circuit levels and load flow studies on the system during normal and abnormal working and failure conditions shall be determined and coordinated with the DMRC for his design of the Traction Sub-station equipment.

2.3.3 OHLE

(1) The OHLE design shall be in accordance with IEC 60913. The height of the contact wire above rail level shall normally be 5000mm on elevated and Cut and Cover Tunnels, 4324 mm in Bored Tunnels and an absolute minimum of 4318 mm. Safe clearance from adjacent structures and people shall be in compliance with EN 50122-2.

(2) That each element of the OHLE has a safety factor for electrical and mechanical stresses as defined in EN 50119 "Railway Applications – Fixed Installations – Electric Traction – Overhead Contact Lines";

(3) The traction return (running rails) shall be continuous throughout the AMEL;

(4) The OHLE and interface equipment shall be protected from switching surges and lightning strikes;

(5) The OHLE is designed so that in the event of a single failure of a mechanical element the system shall not cause a hazard and wherever practicable allow the continued operation of the transit system albeit at reduced performance;

(6) OHLE equipment with a proven history of service on similar Railway Systems shall be employed;

(7) The OHLE grooved conductor shall comply with DIN 43141 and have a continuous rating commensurate with power supply rating in still air at the highest maximum ambient temperature and solar radiation levels to be expected on the Railway System. This rating shall be achieved without exceeding the OHLE conductor maximum temperature; and

(8) In bored tunnel sections where the clearance is restricted, the contact wire shall be supported by a rigid rail suspended by OHLE insulating equipment. In all other areas the contact wire shall be suspended by a messenger wire under tension.

2.4 SCADA System

The main function of the Supervisory Control and Data Acquisition (SCADA) System shall be to provide remote monitoring and control for the traction power supply system from Operations Control Center (OCC).

2.4.1 The functions provided by the SCADA shall include:

(1) Data acquisition and processing from the Remote Terminal Unit (RTU);

(2) Alarm processing;

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(3) Provision of Man Machine Interface (MMI) for operator monitoring and control;

(4) Individual control, sequence of control and time schedule control.

2.4.2 The SCADA shall provide monitoring and both manual and automatic control of the power equipment, including:

(1) 66 kV switchgear (TRANSCO bulk power supply feeders);

(2) RSS equipment status and switching, including Traction Transformer on-load tap changer;

(3) Reconfiguration of the HV Auxiliary ring main and ASS equipment;

(4) Reconfiguration of the OHLE sections; and

(5) Metering.

2.5 System Earthing

2.5.1 Earthing and Bonding equipment to be embedded in the structures shall be provided by the DMRC Designated contractor for Civil and Structures.

2.5.2 System protective Earthing for providing electrical safety at stations, substations, line-side buildings, Dwarka Depot, Palam Sidings, viaduct and the tunnel track sections. The Concessionaire shall engineer the Earthing system on the basis of safety for people against hazardous touch and step potential and fire hazards. The Earthing system shall conform to EN 50122-1.

The Earthing System for Stations, depot and Line-side structures shall comply with the BS7430 Code of Practice for Earthing

2.5.3 At stations and line-side structures, copper earth mats and connecting conductors shall be used. Down conductors fixed to viaduct columns, connecting the Structure Earth mat/spike to the viaduct bus bar may be provided as aluminium.

The conductance of Earth Systems and deep earth shall meet the criteria of Table 2.5.3.

Table 2.5.3 Earth System conductance

Location	Earthing System conductance to deep earth
Traction Substation	2.0 Siemens
Stations, depot and buildings	2.0 Siemens
Structure Earthing (Viaduct and tunnel)	0.2 Siemens

2.5.5 Structure Earthing System for tunnel and viaduct sections of the track

The equi-potential bonding of the metallic re-inforcing in stations and line-side buildings shall be connected to the associated Building Earth System specified in Chapter 9. Tunnels and viaducts shall be sectionalised at, approximately two beam lengths, and the Bonding of metallic re-inforcing in viaduct structures, tunnels, slab-track bed; OHLE masts; handrails, and the like, shall be connected to a common Structure Earth.

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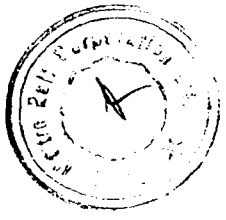
2.6 Insulation Coordination

Equipment shall have insulation levels according to EN 50124, Railway Applications – Insulation co-ordination

END OF SECTION 2



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3. PERFORMANCE SPECIFICATION

3.1 Auxiliary Power Supply System

3.1.1 The Auxiliary power Supply System shall be the prime source of electric power for operation equipment at stations', CAT's, Dwarka Depot, Palam Sidings, on-line equipment rooms, OCC and system-wide equipment.

3.1.2 The Railway E&M equipment shall be classified into Essential equipment and additionally supported by UPS and diesel-generator set, and Non-essential equipment. Essential equipment shall comprise the Metro Railway System safety and operationally critically facilities.

3.1.3 The Concessionaire shall provide an 33kV 3 Phase ring-main circuit within the AMEL infrastructure, providing redundant connections to Auxiliary Sub-station (ASS) at each station, Dwarka Depot and on-line equipment rooms. Cable route diversification shall be provided. The ring-main circuit shall be supplied from RSS 1 and RSS 2 operating in full redundancy.

3.1.4 Two ASS transformers' shall reticulate the 33kV 3phase to 415V 3 phase and 220 V 1 phase supplies. Each transformers and associated switchgear shall normally supply part of the ASS load and in the event of a failure or maintenance activities, one transformer shall automatically assume the full load of the ASS.

3.1.5 The ASS control panel fast acting protection equipment shall monitor the transformers and switchgear performance and immediately enable the isolation of defective equipment.

3.1.6 Each ASS shall be supervised by the Engineering Controller at the OCC, via the SCADA System. The SCADA System shall automatically re-configure the Auxiliary Power System during failure and maintenance activities alarm the Engineering Controller, record power consumption and maintain a log of events.

3,2 Traction Power System

Electric power shall be supplied to trains in the AMEL at 25 kV via OHLE and the running rails, from RSS 1 and RSS 2 Traction Supply System (TSS) Each TSS shall be configured for full redundancy.

3.2.1 Overhead Line Equipment.

1) The OHLE shall comprise a contact wire, suspended from a messenger wire under tension or rigid rail, at a constant height above rail level, supported at intervals by fixed columns/infrastructure fixings and maintained about the track centre by purpose designed cantilever equipment.

2) The contact system for each track shall consist of separate electrical sections and sub-sections. Sections shall be arranged, as follows:

a) At traction supply in-feeds. Neutral Zones (non-bridgeable gaps) shall be provided, in accordance with Standard EN50149 and UIC 870 to prevent the connection of traction power of different supply points and/or phases.

b) At special track-works. Section Insulators shall be provided to prevent the joining of the contact system for adjacent tracks.

c) At Dwarka Depot Link Lines and Palam Siding. Section Insulators shall be provided to isolate the Non-revenue Line OHLE from the Revenue Line OHLE.

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(d) Refuge tracks;

(e) After buffer stops; and

(f) Section Isolators shall be fitted with a motorized by-pass isolator and lightning protection equipment. The SCADA System shall control and monitor the motorized circuit breakers.

(3) Safe clearance between energized parts of the OHLE and people and infrastructure shall comply with the requirements of EN 50122-1 and IEC 913; and

(4) At above-ground sections of the alignment the OHLE shall de designed for minimum visual intrusion to the environment.

3.2.2 Traction Return Circuit

The running rails shall be connected to the common Traction Power System Neutral at each traction sub-station to provide the traction current return path. Both tracks shall be bonded together at defined locations. Cross-bonding between tracks shall not compromise the broken rail detection provided by signaling track circuitry.

To limit the extent of conducted EMI, electrical connections with the guide-way infrastructure metal reinforcements shall be connected to an elevated Earth drain-wire.

3.2.3 Dwarka Depot Traction Power System

Dwarka Depot area traction power system shall be sectionalized at the Link Lines, to optimize the Reliability of the Revenue Line Traction Power System.

Within the Depot area where it is proposed to section track areas for O&M purposes, the OHLE shall be similarly sectionalized.

Within workshops where it is necessary for people to access train roof mounted equipment, the Concessionaire shall employ Approved OHLE and safe working procedures.

3.3 SCADA System

3.3.1 The OCC equipment shall comprise the Engineering Controller workstation, mimic panels displaying the entire Traction Power System and Auxiliary Power System for the AMEL. Two hot-standby redundant servers shall acquire real time equipment status from the Remote Terminal Unit's (RTU), process operator commands and perform the core SCADA functions.

3.3.2 The System shall monitor the entire Traction Power System and Auxiliary Power System for the AMEL and automatically reconfigure the equipment in the event of a failure or maintenance activities, such as not to affect safety or normal operation of the AMEL services.

3.3.3 Any change of state of an input shall be reported at the OCC within 4seconds of the occurrence.

3.3.4 Any System reconfiguration time shall not exceed 10seconds.

3.3.5 The SCADA system shall record any events caused by faults, malfunctions, warnings or alarm information generated automatically by the selected equipment.

(1) A central recording system shall be provided to record the following events, including but not limited to:

(a) Change of state of RTU input parameters

(b) Events designated as alarms

(c) Faults

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(d) Control actions

(e) System generated messages, e.g. equipment malfunction, etc.

(2) Events shall be given an order of priority to allow them to be classified, sorted and filtered. Subject to the requirements of the Operations Plan, events shall be classified as.

(a) Emergency – this type of fault shall require instant attention in order to minimize interruption of the normal operation of the AMEL services or the risk of injury to people.

(b) Urgent – this type of fault shall require reasonably prompt, but not instant attention in order to minimize interruption of the normal operation of the AMEL services.

(c) Non urgent – this type of fault shall be dealt with in a more convenient manner while more urgent events are dealt with first. This type of event shall not directly result in any degradation of the normal operation of the AMEL services.

3.3.6 Sub-station Equipment

An RTU shall be provided at each RSS and Station and Depot ASS sub-station to communicate with the central SCADA servers. The RTU shall interface with the Remote Input/Output (RI/O) units of which the field equipment to be monitored or controlled are connected.

A Local Control Panel shall be provided in each sub-station for the monitoring and control of all the equipment associated with a particular RTU.

For the event of loss of the OCC, a fall-back arrangement shall be provided to enable the supervision of the entire Electric Power System.

END OF SECTION 3

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CHAPTER 6

COMMUNICATION SYSTEMS

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1 General

1.1 Specification

1.1.1 This Specification stipulates the performance requirements for the Communications Systems to be designed, constructed, commissioned and operated by the Concessionaire for the Airport Metro Express Line (AMEL)

1.2 Requirements

1.2.1 Operationally critical and safe working areas of the AMEL require back-up with alternative communications system being provided.

1.2.2 The Concessionaire shall coordinate with the Designated Contractors of the Airport Authority of India, to establish all necessary Control and Communications facilities required for the normal operation of the CAT's and interface with relevant IGI Airport Systems.

1.2.3 The Communications System control equipment shall be designed and supplied for a Design Life of 15 years. Associated wayside equipment shall be designed and supplied for Design Life of 30 years

1.3 Reliability and Maintainability

1.3.1 The operationally critical DTS System Availability shall not be less than 99.995% of all time and other Control and Communications Systems Availability shall be not less than 99.99% of all time

1.3.2 The system shall be engineered for a minimum operational life of 15 years, based on the equipment being in continuous use.

END OF SECTION 1

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2 Data Transmission System

2.1 General

2.1.1 The Data Transmission System (DTS) shall be the communications backbone between the OCC, stations, sub-station and the depot.

2.1.2 The DTS shall be a highly reliable system since it shall be the primary means of remote communications between OCC, stations and the depot, on which a number of other operationally critical systems rely.

2.1.3 The DTS shall be STM-16 to ITU-T standards and capable to transport all of the user communication interfaces and therefore the bandwidth provided by the DTS shall be matched to the loading required by the data speed of the subsystem's interfaces. The DTS shall provide sufficient bandwidth to cater for the data loading required at the present implementation stage and shall provide an additional spare bandwidth of at least 30% of the useable total bandwidth.

2.1.4 The DTS shall provide voice and data communications circuits or bandwidth for the following systems but not limited to:

(1) Channels for the Public Address System

(2) Circuits for the Telephone System

(3) Data circuits for the Radio System.

(4) Data Circuits for the Closed Circuit Television System, Flight Information Display System, Passenger Information Display System, Clock System, SCADA, OA/IT, Signaling, AFC, Security System and the Station Management System. Connections for each above named application need to be fire walled between each other to provide a maximum security level. The DTS also needs to provide a bandwidth management to ensure sufficient transmission capacity for each application to function under all traffic circumstances on the DTS system.

(5) Other data circuits or Ethernet 10/100 ports as required

2.1.6 In each station, sub-station, OCC and the depot, a Local Area Network (LAN) to Fast Ethernet standard shall be built for local data applications.

2.1.7 At the OCC, a Network Management System (NMS) shall be provided to carry out real-time monitoring and measurement of network status and performance, and the ability to take prompt action to control the flow of traffic when necessary.

2.1.8 The NMS functions shall include:

(1) Alarm surveillance - monitoring the incoming high speed and low speed signals to activate and deactivate failure alarms

(2) Performance monitoring and alarm recording - supervising all the network elements with respect to their operational status and performance on a real-time basis

(3) Failure management - Carrying out performance measurement and fault diagnosis to provide the basis for any decision on whether any network control action should be taken

(4) Provisioning - allocating and administering equipment resources

2.1.9 The Concessionaire shall provide at least 20% spare capacity available at the time of system acceptance for future expansion of fiber network, voice circuits and data communications

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circuits or bandwidth.

2.2 System Description

2.2.1 Fiber Backbone Network

(1) To protect against a fiber cut or node failure, the Concessionaire shall install two optical fiber cables running on separate tracks, thus providing cable path diversity

(2) The whole optical backbone network shall form a closed ring with the cables terminating at fiber patch panels at each station and OCC.

2.2.2 Data Transmission Equipment

(1) The DTS network shall be built on an optical backbone ring. The OCC and each station shall have a node in the ring. With this ring configuration, even when there is a connection break between any two nodes, the data traffic shall still be maintained with no interruption between all the nodes.

(2) The subsystems shall be located at different locations along the line and shall be connected via transmission nodes to the optical transmission rings. At every location where the transmission system has to be dropped, one or several nodes shall provide the interfaces to the subsystems.

(3) The DTS shall be capable of expansion to utilize this spare bandwidth by addition of peripheral interfaces such as new nodes or additional channel cards at an existing node but without re-engineering of the overall system architecture

2.2.3 Fast Ethernet LAN Network

(1) A Fast Ethernet/Ethernet Switch shall be interfaced to the DTS to provide the necessary packet-switching based Ethernet interface.

(2) Further data hubs and routers shall be connected to the Fast Ethernet Switch to form the station LAN.

2.2.4 Network Management System

(1) A NMS workstation and logging printers shall be provided at OCC.

(2) The workstation shall have a Graphical User Interface using pull-down menus and icons for user-friendly manipulation of the NMS.

(3) On-site local maintenance functions shall be possible by using a laptop PC

2.2.5 The DTS shall conform to the applicable ITU-T and IEEE standards and shall fulfill as well the EMC standards EN55022 class A and EN50082-1

2.3 Performance Specification

2.3.1 The maximum traffic interruption time for any required service bit rates due to link, node or any other failure shall be less than 50ms. It shall include time for protection switch completion time with the sequence of events below:-

(1) From the onset of a failure detection to the completion of protection switching.

(2) From the clear of a failure to the completion of protection switching recovery (in case of reversion switching).

(3) From the activation of recovery command to the completion of protection switching recovery (in case of non-reversion switching).

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(4) Re-framing time required by PCM equipment including SDH equipment, Flexible Multiplexer, optical data modem and data modem.

2.3.2 The absolute group delay at the frequency of minimum group delay should not exceed 600 microseconds taking into account of the worst delay scenarios.

2.4 Technical Specification

2.4.1 Fiber Backbone Network

(1) The Concessionaire shall install redundant single mode optical fiber cables between the Communications Equipment Rooms (CER) each station, Dwarka Depot, on-line equipment rooms and the OCC, using separate physical routes.

(2) The optical fiber cables and the connectors shall follow IEC793 and IEC874.

(3) The characteristics of single-mode optical fiber cable shall follow ITU-T G.652.

2.4.2 DTS Network

(1) The Transmission Network equipment shall be capable of deriving the synchronization timing signals from, but not be limited to, the following timing sources:

(a) An external GPS based timing reference

(b) An incoming high speed STM interface

(c) An incoming E1 signal carrying traffic with external synchronization interface

(d) An internal clock.

(2) The SDH Transmission network equipment shall have the ability to switch to another timing reference if the selected timing reference is lost, under the criteria as stipulated in ITU-T G.782.

(3) The SDH equipment shall provide user-selection of synchronizing the outgoing STM signal in one of but not be limited to the following synchronization modes:-

(a) Internal Clock Mode

(b) Incoming STM to outgoing STM signals

(4) When all incoming timing reference is lost, the equipment shall be capable of entering into holdover mode.

(5) The Network Element equipment shall support programmable prioritized synchronization source selection scheme covering all available synchronization sources.

(6) When failures of synchronization at a source occur, the equipment shall be able to select automatically a lower priority source to prevent loss of synchronization.

(7) The priority list and the synchronization source currently used by the equipment shall be retrievable via the Operation/ Services Interfaces.

(8) The priority of the synchronization sources from high to low shall be the GPS, the STM interface, El signal and the internal clock.

(9) The Network Element equipment shall be able to monitor all failed and normal synchronization source(s) and select the one available with the highest priority.

(10) The synchronization network shall be protected against single Transmission Network node/link failure, that is, a single node/link failure shall not cause a complete loss of

synchronization reference to any Transmission Network nodes.

(11) Engineering of the synchronization network plan shall ensure the normal functional operation and no voice performance degradation of the inter-telephone switch communication.

(12) The automatic re-configuration of synchronization source shall not cause any interruption or generation of errors in any low speed and high speed signals being transported by the Network Element equipment.

(13) The synchronization plan shall prevent repeated switchovers of synchronization sources automatically when *intermittent/frequent* failures occur in the clock sources(s).

(14) The Network Element equipment shall provide manual switchover to a specific synchronization source irrespective of its priority in synchronization sources selection. Manual switchover to a failed synchronization source shall be prevented by the equipment.

(15) Facilities shall be provided at the Network Element equipment to monitor the performance of the derived synchronization timing signals and report the corresponding alarm conditions to the NMS.

(16) Each DTS node shall provide Operation Interface for centralized network management at the NMS.

(17) Each DTS shall provide service interface for local network management via portable service terminal.

2.4.3 Fast Ethernet/Ethernet Network

(1) Each stations and OCC shall have a Fast Ethernet/Ethernet Switch to be interfaced with the ADM to provide the necessary packet-switching based Ethernet interface.

(2) Switching hubs and routers shall be used to connect the Fast Ethernet Switch to form the station LAN.

(3) The characteristics of LAN and WAN cables shall follow ISO/IEC 8802-3.

(4) The characteristics of 50/125µm multimode graded index optical fiber cable shall follow ITU-T G.651.

2.4.4 Network Management System

(1) The Network Management System shall provide advanced Operations, Administration, Maintenance and Provisioning (OAM&P) functions such as synchronous source configuration, circuits configuration and mapping, line and circuit protection switching, network data flow and traffic control, alarm and event reporting and printing, etc.

(2) Graphical User Interface (GUI) shall be provided for user-friendly operations.

(3) The NMS shall be synchronized with the timing of the master clock via a LAN interface using NTP protocol.

END OF SECTION 2

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3 Clock System

3.1 General

3.1.1 The Clock System shall provide synchronized time for the whole AMEL. The source of time source shall be the Global Positioning System (GPS).

3.1.2 The synchronized time information shall be displayed on slave clock units and provided to other interfacing systems via the Data Transmission System.

3.2 System Description

3.2.1 A GPS receiver at OCC shall receive the time source via a rooftop antenna from the satellites of the GPS.

3.2.2 At each CER, a Station Master Clock Unit shall receive the time information from the DTS and shall convert it into synchronization pulses for the station slave clock units.

3.2.3 Slave clock units shall be of analogue or digital types. The clock units on the platforms and concourses shall be of single or double sides to suit the environment. The engineering shall ensure that these clock units shall provide good visibility for the passengers.

3.2.4 Each of the systems that require synchronized time information shall be connected to the OCC or station LAN's and obtain the information using the NTP, as the common time source distributed throughout the AMEL.

3.3 Performance Specification

3.3.1 The free run accuracy of the Master Clock Units shall never be more than 30 milliseconds different from the GPS reference.

3.3.2 Network time synchronization over the data network shall be using NTP, with an accuracy of ±0.1s per 24 hours to the reference.

3.3.3 The system shall have a minimum accuracy of 1s a day when they do not receive signals from the master clock.

3.4 Technical Specification

3.4.1 Antenna System

(1) Surge protector shall be provided to shunt potentially damaging voltages on antenna coaxial to ground.

(2) The system shall be weatherproof. It shall be tolerant to direct sunlight, wind, rain and other sources of water.

(3) The antenna shall be mounted at appropriate location to be identified during detail engineering.

3.4.2 Central Master Clock System

(1) Outages of power supply of normal duration to the system shall have no significant impact on the accuracy of the system time.

(2) Audio and visual alarm outputs shall be provided to indicate loss of time synchronization or power.

(3) Local display of the time shall be provided. Display shall include hours, minutes, and days of the year, system status, with selectable 12 or 24-hour display.

3.4.3 Station/Depot Sub-Master Clock

(1) The station/depot sub-master clock shall be synchronized by the central master clock.

(2) The station/depot sub-master clock shall has its own oscillator and be able to maintain accurate time for normal duration of loss of time synchronization signal. The system shall be able to detect the absence or abnormality of the synchronized time signal from the central master clock system.

(3) Local display of the time shall be provided. Display shall included hours, minutes, and days of the year, system status, with selectable 12 or 24-hour display.

3.4.4 Display Clocks

(1) The displayed time of all display clocks in the non-public area shall be to the second. The displayed time of all display clocks in the public area shall be to the minute.

(2) The system shall be able to support the required number of display clocks plus at least 20% spare capacity for each location.

(3) The display shall be clear under relevant, frequently occurring lighting conditions, including direct sunlight (from behind and in front), and when there are any reflections in the clock faces.

(4) The optical characteristics of the transparent display cover shall be selected such that the light transmission and display contrast are suitable for the environment in which the clocks are installed.

(5) The color, size, and mounting methods of display clocks at the public area shall match with the aesthetic design of the station. Subjected to the architectural constraints for each specific location, the clocks shall either be ceiling mounted or pole mounted.

(6) The display clock shall be provided at the following locations as a minimum requirement. Type of clock, i.e. digital or analogue and mounting method shall be determined the Concessionaire, subject to the approval of the DMRC before installation

Station

(a) Station Control Room

(b) Customer Service Centre

(c) Platform Supervisor Booth

(d) Staff Mess Room

(e) Station Computer Room

(f) Audit Revenue Room

(g) Baggage Handling Area

(h) Platforms

(i) Concourse

(j) Arrival Level in CAT: 1 double side clock

(k) Departure Concourse in CAT: 2 double side clock

Depot

(a) Fault Report Centre

(b) Maintenance Office

(c) Fire Control Centre/Guard House

(d) Train Staff Office

OCC

(a) Central Control Room

(b) Central Equipment Room

END OF SECTION 3

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4 Telephone System

4.1 General

4.1.1 The Telephone System shall provide the railway staff with telephone voice communications between locations equipped with telephone sets in the AMEL.

4.1.2 In addition to staff telephone conversations, help points shall also be provided for passengers to ask for assistance when they are within the concourses, platforms and elevators of stations.

4.1.3 Staff telephone services to be provided shall be divided into two types:

(1) Private Automatic Branch Exchange (PABX) service for staff - this shall require the staff to dial the extension number to call the opposite party

(2) Direct Line Telephone (DLT) service for staff - mainly for controllers to call destination party using one-touch buttons on the telephone sets for faster access.

(3) Emergency Telephone Communication system from the tunnel cross passages to the OCC/SCR.

4.1.4 DLT service shall also have higher Grade of Service (GOS) than PABX service when calling between telephones switches.

4.1.5 Locations to be equipped with telephone sets shall include control rooms, offices, and major plant rooms in the OCC, Palm Depot and station

4.2 System Description

4.2.1 A highly reliable digital telephone main and satellite exchange system shall be installed to provide communications to digital and analogue telephone sets at the OCC-CCR-Administration building-Depot workshops, the terminals, the stations and the traction power substations.

4.2.2 Satellite exchanges provide the analogue and digital ports for the subscriber at the stations. The telephones at the sub-stations shall be connected to the nearest Station or OCC Switch via the DTS system.

4.2.3 The link between the Main Switch and the Satellite Switches shall be using digital trunk lines at E1 level or Ethernet IP.

4.2.4 The Main Switch shall have connection to the Public Switched Telephone Network (PSTN). This shall allow pre-selected extensions to access the PSTN or vice versa.

4.2.5 The Main Switch shall have interface with the Central Radio Switch to handle the radio call patching function for the Control Superintendent (CS).

4.2.6 A digital Central Voice Recording System (CVRS) shall be provided in OCC to record all telephone conversations of all controllers in OCC, depot, stations, Call Center and Attendant Console.

4.2.7 A Centralized Voice Mail System (CVMS) shall be provided and integrated with the Switch to enable PABX users to leave, retrieve and broadcast voice messages to and from this single message centre.

4.2.8 A Network Management Computer with a workstation, system database, logging printers and mass storage devices shall be provided in the network management room of OCC.

4.2.9 Each telephone switch shall be powered by the AC mains, backed-up by a DC battery as

mandatory and UPS system as an additional means which shall be able to support 2 hours of operation upon AC interruption.

4.2.10 Surge protection shall be provided in each switch

4.2.11 The direct line or PRI interface between, AMEL OCC and SCRs' and IGI Airport control center shall be connected via a 2-4 wire tie line and/or E1 interface between the telephone switches at AMEL and IGI Airport and also with the existing DMRC Phase VII OCC system..

4.3 Performance Specification

4.3.1 The Concessionaire shall select equipment and cables with the appropriate specification to engineer and build a Telephone System which meets the system performance standard in this sub-section.

4.3.2 The Telephone System shall conform to applicable ITU-T standards.

4.3.3 The system shall provide non-blocking connection for extension calls within the same switch. For calls trunk or tie lines, the system shall provide a GOS of 1% and 0.1% respectively for PABX and DLT services for the traffic intensity during an average busy hour under normal condition without traffic overflow.

4.4 Technical Specification

4.4.1 The following type of telephones shall be provided at the following locations:

Table 4.4.1 Type of Telephones

Locations	PABX Digital Phone	PABX Analogue Phone	DLT Phone	Help Points
All OCC and Depot Controllers	X		X	
Manager Offices	X			
Staff Rooms		X		
Major Plant Rooms		X		
Power Equipment Rooms			X	
BHS Area		X		
Check-In Counters		X		
Customer Service Centers	X			
Platform Supervisor Booths		X	X	
Public Area				X
Elevator				X
Headwall/Tail wall Units			X	
Bubble Units			X	
All SER and TER rooms		X	X	
Siding Attendant		X		
OCC, CS and IGI Airport Control Centre			X	

Three Help points shall be provided on each platform, and two more to be provided in the concourse of IGI Airport Station.

4.4.2 DLT telephone sets shall have preset buttons such that by pressing one of these buttons shall immediately connect to the destination. On the opposite, when a telephone connected to a DLT service is picked up, the corresponding button on the controller's telephone set shall immediately flash together with the ringing tone.

4.4.3 The Help Point service shall be regarded as another form of DLT service whose function is to allow the passengers to seek assistance when necessary. A Help Point unit shall have a call button, a microphone and a speaker. Once the call button is pressed, the corresponding indication on the DLT set of the Station Controller (SC) shall flash. In the event that the SC fails to respond within 30s, the call shall be forwarded to the Control Superintendent (CS) in OCC. If the CS also fails to respond within 30s, the call shall be forward to Metro Security.

4.4.4 Help Point units shall be fitted with an induction loop to provide better reception for hearing-impaired passengers wearing hearing aids.

4.4.5 It shall be possible for the CS at OCC to communicate with a radio user by patching the telephone call to the Radio System.

4.4.6 The OCC and SCR of the IGI Airport Station shall have a Direct Line connection with the IGI Airport Control Centre. The OCC shall have hotline telephone connections to the emergency services and also the power company.

4.4.7 The CVRS shall provide recording of telephone conversations of all controllers as well as the audio signals of the Public Address System and Radio System. It shall be a digital system providing sufficient capacity for recording up to 3 days before overwritten. The CVRS shall also have the facility to transfer the recorded audio to removable archive for long term storage.

4.4.8 The Network Management Computer shall provide control, supervision and maintenance functions for the entire Telephone System.

END OF SECTION 4

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5 Closed Circuit Television

5.1 General

5.1.1 The Closed Circuit Television (CCTV) System shall provide video surveillance and recording function for the railway operators to monitor each station, the tunnel portal and the depot conditions.

5.1.2 Operators with CCTV monitoring functions shall include:

(1) Station Controller (SC) in the Station Control Room (SCR)
(2) Station security services, in the CISF office at the Concourse
(3) Platform Supervisor (PS) in the Platform Supervisor Booth (PSB)
(4) Control Superintendent (CS) in the OCC
(5) Traffic Controller (TC) in OCC
(6) Train Operators (TO) - viewing the headwall and bubble unit monitors when the trains are stationary on the platforms
(7) Depot Controller (DC) in Dwarka Depot
(8) Security Coordinator in OCC and each Station Security Office with coverage of the security inspection area and station entrance approaches;
(9) IGI Airport Customs Office, coverage of each CAT Station entrance security inspection area.

5.2 System Description

5.2.1 The CCTV System shall employ digital technology. Camera pictures transmitted back to the video switch shall be digitized before further switching or distribution take place. The digitization of video signals shall allow easy transmission of selected camera pictures from the stations to OCC via the Data Transmission System (DTS).

5.2.2 Two types of cameras shall be provided:

(1) Fixed cameras with fixed focal length lens and fixed orientation
(2) Pan/Tilt/Zoom (PTZ) cameras with variable focal length lens with adjustable orientation in both the vertical and horizontal directions.

5.2.3 Cameras shall be located at areas where monitoring for security, safety and crowd control purposes is necessary. These shall include station platform areas, ticket gate areas, escalator landings, inside elevators, Help Point areas, entrances and exits, evacuation routes and cash transfer routes. At each CAT and IGI Airport Station, CCTV coverage of the baggage handling areas shall also be included. The tunnel portal accessing the IGI Airport Station shall be equipped with cameras and sensors to detect intruders.

5.2.4 At the OCC, the depot and stations, CCTV control panels and monitors shall be provided to the SC, CS, TC, DC, Station Security and PS to select and view camera pictures.

5.2.5 In the PSB, a CCTV control panel and monitor shall be provided for the PS to select and view camera pictures.

5.2.6 At the station, a Station Video Codec and Switch shall be provided to route the camera pictures to the required monitors for display, according to the commands from the CCTV Control. The station video switch shall also accept PTZ commands from the CCTV Control Panel to control the viewing position and zoom range of PTZ cameras.

5.2.7 At the OCC, a Central Video Codec and Switch shall be provided to accept camera selection commands from the CCTV Control Panels of different controllers and shall send the command to the corresponding station switch via the DTS. The digitized video signal shall also be streamed back to OCC via the DTS, and displayed on the corresponding CCTV monitor of the controllers and the LCD wall panel The LCD wall panels (or other suitable rack

arrangement) shall be provided to achieve full benefit of the dynamically loading of digitized video images on the DTS to allow monitoring of any of the cameras in the network.

5.2.8 Camera pictures showing the conditions of passengers boarding and alighting the trains shall be routed to a CCTV monitor located at the headwall and bubble unit of the platform for the TO to monitor these conditions when the train is stationary on the platform.

5.2.9 At each station, a Digital Video Recorder (DVR) shall be provided to locally record selected camera pictures. At the OCC a Digital Video Recorder (DVR) shall be provided to remotely record selected camera pictures from all stations.

5.2.11 The Depot CCTV System can be an integrated or standalone system for the Depot Controller to monitor and record the conditions in the depot. The coverage areas shall include all the depot entrances and level crossings.

5.2.12 All operational menus on screen shall be shown in both English and Hindi language.

5.2.13 All tunnel entry/exit/mid-shafts shall be covered by the CCTV system at the nearest station and at the OCC

5.3 Performance Specification

5.3.1 The Concessionaire shall select equipment and cables with the appropriate specification to engineer and build a CCTV system which meets the system performance standard in this sub-section.

5.3.2 The general guideline for displaying the full frame image height of a 1.8m tall person standing upright, within the CCTV camera coverage area, on a 19-inch monitor shall not be less than 52mm high for both fixed lens and zoom lens cameras at the shortest focal length. The CCTV system shall be based CCIR-PAL system with a minimum 480 TV lines.

5.3.3 A maximum of four video streams from four different station cameras shall be able to be sent back to the OCC for one controller to form a quad display.

5.3.4 Passenger operation of Emergency Stop Plunger, Help Point facilities and intruder devices at the tunnel portal or remote substations shall automatically initiate CCTV cover and video recording of the associated area.

5.3.5 The DVR shall be equipped with sufficient storage capacity to record the selected camera pictures for at least seven days before the video is overwritten. The DVR shall be equipped with DVD writer to transfer the recorded video to DVD discs when necessary.

5.5.5 No "break-up", "frame-roll", "line pulling" or "line jittering" shall occur to the video images in any CCTV monitor, in either quad or full frame display format, immediately after video switching or any other circumstances due to the signal traveling time differences among video signals and power phase differences of video cameras within/among station(s).

5.5.6 The camera and lens assembly shall have auto-iris and auto-focus function.

5.5.7 All cameras shall have suitable and adequate protective housings.

5.5.9 Types and approximate quantities of CCTV cameras to be provided shall be as follows;-

Location	Quantity	Type
Each Station Platform	2	Fixed
Each Station Concourse	2	Fixed

Ticket Gates (each array if not covered by other cameras)	2	Fixed
Each elevator	1	Fixed
Each escalator landing	1	Fixed
Each Help Point (if not covered by other cameras)	1	Fixed
Entrances, exits, evacuation routes and cash-transfer routes	As required	Fixed
Each Platform of IGI Airport Station	2	Fixed
Concourse of IGI Airport Station	6	Fixed
CAT Concourse Level	6 5	Fixed P/T/Z
CAT Baggage Hall	5 5	Fixed P/T/Z
Each CAT Station concourse and platform baggage handling areas	As required	Fixed P/T/Z

Notes: The quantities of cameras to be provided shall be finally confirmed by the Concessionaire taking into consideration the requirements of DMRC security policy and the specifications of cameras to be installed.

Each of the 2 platform cameras shall cover the half of the length of the single train unit and be combined via a split-screen unit to suit the display.

END OF SECTION 5

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6 Public Address System

6.1 General

6.1.1 The Public Address (PA) System shall allow the operators at stations and OCC to make announcement to the passengers while they are in the station areas.

6.1.2 The announcements shall also be sent for broadcast on the trains via the Radio System.

6.2 System Description

6.2.1 Station PA system

(1) The Concessionaire shall provide an Audio and Selection Panel (ASP) at all Station Control Room (SCR) and Platform Supervisor Booth (PSB). The ASP shall be either a dedicated device, which fulfill the requirements specified as follows or shall be a client software installed in the SMS PC, which interacts with the PA Control Module.

(2) Announcements to the PA system located at stations, terminals and depot shall be possible from OCC, SCR and selected number of telephone subscriber by pre-recorded messages or verbally by a Controller.

(3) The Concessionaire shall provide a Digital Voice Announcement System (DVAS) for pre-recorded message announcement.

(4) The Concessionaire shall provide audio input ports for broadcast from OCC, and a music port from CD player for playing background music at the stations.

(5) The Concessionaire shall provide a PA Control Module for the control of the above mentioned audio sources to various zone groups selected by the operators at the local station and from OCC. The PA Control Module shall comprise of PC controlled Digital Voice Announcement System and a processor controlled PA Matrix.

(6) Each station shall be divided into a number of PA zones. The Station Controller shall be able to select each zone individually or in a combination.

(7) The selectable PA zones shall include:

(a) Station public paid area

(b) Station public unpaid area

(c) Individual concourse

(d) Individual entrance

(e) Baggage Handling System (BHS) area

(f) CAT Related Departure/Arrival/Waiting Area

(g) Individual platform

(h) Headwall of each platform

(i) Tail wall of each platform

(j) Individual (elevator)

(8) Areas in the stations which are required to be covered by the PA system shall include all public areas accessible by the passengers including the elevators and toilets. The PA system shall also cover part of the non public areas attended by staff to provide fire alarm messages. All areas on the platforms where a train stops shall be fully covered by the PA system. For future expansion to utilize the complete platform length, wires

shall be laid to all future platform speaker locations. Station and OCC equipment needs to be modular expandable to cater for such expansion.

(9) Since there are different broadcast sources which may be sent to the same PA zones, these sources shall have a pre-defined priority to which the system shall broadcast accordingly.

(10) The Concessionaire shall provide amplifiers, and automatic noise control and sensing devices to achieve optimum sound pressure level.

(11) The loudspeaker lines shall be supervised continuously by inaudible test tones> in case of a failure of an amplifier at a station, a standby amplifier shall be switched automatically to replace the defect one.

6.2.2 OCC PA System

(1) The Concessionaire shall provide an ASP for the Control Superintendent (CS) to broadcast message to the selected stations or to all trains.

(2) The CS shall only be able to select the station as a whole for PA broadcast, but a combination of stations shall also be able to be selected.

6.2.3 Depot PA system

(1) The Concessionaire shall provide a standalone or integrated PA system for the Depot Controller. No pre-recorded message announcement function is required in the depot.

(2) The selectable PA zones shall include:

(a) Maintenance Workshops

(b) Individual Level Crossing

(c) Stabling Tracks

(d) Maintenance Tracks

(e) Assembly Points

6.2.4 Pre-recorded Message Announcement and Recording

(1) The Concessionaire shall provide a DVAS for pre-recorded message announcement and recording.

(2) The Station Controller (SC) shall be able to activate broadcast of more than one pre-recorded message. A minimum of two simultaneous pre-recorded message announcements shall be allowed. The broadcast of pre-recorded message(s) shall not restrict the SC to make live announcement.

(3) When broadcast of the pre-recorded messages, the SC shall be able to choose to deliver a piece of message or a sequence of messages. The messages shall be able to be sent out once or periodically at a constant interval to the selected zone(s).

(4) The system shall be able to generate chime tones automatically before pre-recorded message announcement. The SC shall be able to enable or disable this feature via the Audio and Selection Panel (ASP)..

(5) The system shall allow simultaneous broadcast of different pre-recorded messages to seven combinations of zones in the express train stations. This limit shall already include all event-triggered announcements plus pre-recorded message announcements activated by all operators in the station.

(6) The system shall enable pre-listening and playback of any pre-recorded messages at the loudspeaker of the IAP, prior to broadcasting.

(7) SC and OCC MMIs shall have the facility to record, preview and broadcast new messages on a real-time basis.

6.2.5 Zone Occupancy and Announcement Priority

(1) The PA Switch shall report the zone occupancy of the PA system to the ASP when a command is received or at regular time interval. The selection and de-selection of zone(s) not activated by the ASP shall also be reported when it happens.

(2) In case different messages have the same target zone(s), the system shall handle the priority in first come first serve basis for live message. For DVAS messages, the Concessionaire shall define the priority of the different message types.

(3) When a zone has been selected for announcement of a message, only messages of higher priority shall be able to interrupt the current announcement to that zone and break in.

(4) If an activated zone is selected for a new message which has lower priority than the current one and is a DVAS message, the new message shall be placed on queue and broadcast after the completion of the current message.

(5) The SC shall be able to identify and delete messages in a queue using the SMS workstation.

6.2.6 Interface to Radio and Telephone System

The Concessionaire shall provide all required interfaces to the Radio System and PABX system to allow for selected user to make announcements on pre-defined zones from selected telephones and handheld radios.

6.2.7 The Concessionaire shall provide at least 20% spare capacity available at the time of system acceptance for future expansion of the DVAS, power amplifier, matrix input and output, selection button and associated control cables of ASP.

6.3 Performance Specification

6.3.1 The sound pressure level (SPL) of PA announcements shall be maintained between 10 to 15dB above the ambient noise level. The reference height of the measurement shall be between 1.2 to 2m above floor level.

6.3.2 The peak SPL of the system shall not exceed 95dB (A) and the lowest value shall not fall below 70dB (A).

6.3.3 The variations of SPL within a PA zone shall not exceed ±3dB. This shall be measured with the automatic noise sensing equipment disabled.

6.3.4 The intelligibility of all PA announcements shall achieve a minimum Rapid Speech Transmission Index (RASTI) of 0.5 for 95% of areas. The remaining 5% of areas with RASTI below 0.45 shall only be scattered uniformly among the station areas and shall not form clusters of appreciable size.

6.3.5 The frequency response of the system shall be from 100 to 15,000Hz ±3dB, excluding PA from OCC.

6.3.6 Total harmonic distortion of the whole system shall not exceed 3% at full rated output.

6.3.7 Total hum level shall be at least 80dB below full rated output.

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6.3.8 S/N ratio of the system shall be better than 40dB.

6.3.9 The processing and switching time contributed by the PA equipment shall be less than 250ms for any type of command.

6.4 Technical Specification

6.4.1 General Requirements

(1) The hardware and software of the system shall use modular design to allow for easy expansion of the system. Addition of input and output ports for the switching equipment shall be achieved by simple addition of plug-in cards.

(2) All equipment shall be of modern design, fully electronic, modularly constructed and with a proven field performance. The switching equipment shall use solid state switches. No relays or reed switches shall be allowed in this equipment.

(3) The characteristics to be specified and the methods of measurement for the equipment shall be in accordance with IEC268 Part 1 to 17 – Sound System Equipment.

(4) All PA equipment in equipment rooms shall be rack-mounted on equipment cabinets conforming to EIA310-C.

(5) Fire resistant Low Smoke Zero Halogen cables and PA equipment shall be used to maintain the circuit integrity in case of fire.

(6) All configuration data of the equipment shall be stored in non-volatile memory.

6.4.2 Specific Functions Requirements

(1) Station PAS

(a) An ASP shall have a gooseneck microphone, a number of function selection buttons, as well as a monitor loudspeaker. In case the ASP is client software in the SMS PC, zone selection buttons on the ASP shall be for backup PA control function. The PA Control Module shall accept the control commands from the ASP and shall provide the switching of the audio sources to the required output zones.

(b) Each PA zone, with the exception of the elevator zone, shall consist of a number of speakers fed using two separate amplifiers and circuits to provide redundancy. Noise sensors shall also be installed to detect the ambient noise of the stations so that the output level of the PA announcement shall be adjusted in a real time manner.

(c) Each elevator shall be equipped with one speaker fed by one amplifier, without the noise sensor.

(d) Different types of speakers such as projection speakers, ceiling speakers and column speakers shall be used to suit the architectural and acoustics environment of the stations.

(2) OCC PAS

The ASP shall provide a gooseneck microphone for picking up the voice from the operator, and the station selection buttons for selecting the stations for centralized PA broadcast. There shall also be a button for patching the PA call to the Radio System so that the announcements shall be able to be made to the trains. The PA matrix shall route the audio and control signals from the ASP to the selected stations or the Radio

System accordingly.

(3) Loudspeakers

(a) Loudspeakers shall not be driven at more than 80% of their maximum allowable input rating.

(b) Weatherproof type speakers shall be used in station areas which will be exposed to rain.

(c) Speakers in toilets shall be moisture proof. The diaphragm of these speakers shall have a moisture resistant coating such that the structure and performance of the diaphragm shall not deteriorate under prolonged use in a humid environment.

(4) Noise Monitoring System

(a) The noise monitoring system equipment shall be of a continuous monitoring type based on time-average of the noise. It shall have an A-frequency weighting characteristics, such that its output shall be proportional to the ambient noise level in dB (A).

END OF SECTION 6

7 Radio System

7.1 General

7.1.1 The Radio System shall provide wireless voice and data communications channels to support the operational and maintenance requirements of the Railway.

7.1.2 Wireless voice communications channels shall be provided between the following parties:

(1) Traffic Controller (TC) in OCC and the Train Operators (TO) for train regulation purpose in the running lines

(2) Control Superintendent (CS) in OCC and passengers on the trains (one-way announcement)

(3) Engineering Controller (EC) and railway staff carrying hand-portable radio sets at the trackside

(4) Depot Controller (DC) and the TOs when the trains are within the depot areas

(5) DC and staff equipped with hand portable radio sets in the depot areas for depot security purpose

(6) Between Operating and Maintenance (O&M) staff issued with hand-portable radio sets at stations, trackside and depot areas

(7) Radio Communication between the AMEL OCC and the DMRC OCC.

(8) Radio Communication between the AMEL OCC and Security.

(9) Security Coordinator in the OCC and each Station Security Office, Depot , Stations and Guideway.

(10) Palam Siding Attendant and TOs at the OCC

7.1.3 Wireless data communications channels shall be provided for the CS to send out visual messages to the display boards on the trains (together with the Central Passenger Information System (PIS) and Train borne Communications System). (Option)

7.1.4 The radio system shall also provide the transmission of the status of the operation of the emergency brake on the trains to OCC.

7.1.5 The Concessionaire shall provide the required RF infrastructure in the underground section of the railway to fulfill government regulations for transmitting the radio signals for the police force and emergency services, so that the police force and emergency services can continue to use their radio sets in the underground section where the outside signals cannot penetrate. Also, the Concessionaire shall coordinate with commercial mobile phones operators to provide coverage service in the underground station with coordination, so that passengers can continue to use their mobile phones in the underground section.

7.2 System Description

7.2.1 The Radio System shall be a digital trunk radio system (e.g. TETRA system, other proven digital radio systems) offering high reliability, fast call setup, flexible call configuration and dynamic channel assignment to efficiently utilize the radio channels. It shall support both voice and data communications. The Radio System shall have a patching connection with radio system of the IGI Airport and also that of DMRC's existing Radio System, if so requested by the DMRC, so that any radio calls made in one system could be broadcasted to all radio users in the other system, and vice versa.

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7.2.2 Radio channels shall be assigned for different functions including:

(1) Train PA broadcast

(2) Message display on trains

(3) Depot operation

(4) Operating and Maintenance

7.2.3 At the OCC, a Radio Dispatcher Workstation (RDW) shall be provided for the TC to make radio communications with the TO on the trains. The TC shall be able to call a particular train, a group of trains, or all trains. The TO shall also be able to initiate a radio call to the TC.

7.2.4 A Radio Control Panel (RCP) shall be provided for the TC as a fallback means to make radio calls to communicate with the TO in case the RDW fails.

7.2.5 Through the Central PA System and Central Passenger Information System, the CS in OCC shall be able to make PA announcement and send visual messages respectively to the trains via the Radio System.

7.2.6 Railway staff carrying hand-portable radio sets shall be able to communicate with one another or with the EC and DC on a talk group basis.

7.2.7 RCPs shall also be provided to the CC in OCC and the DC in the depot for the two controllers to make radio communications using the respective talk group. Transmission made in one talk group shall be repeated to all radio users who have selected the same talk group.

7.2.8 The CS shall be provided with a suitable Radio Control Panel..

7.2.9 All radio communications (including private calls) between controllers in OCC and the DC in the depot with other radio users shall be recorded by the Central Voice Recording System (CVRS) of the Telephone System located in the equipment room in OCC.

7.2.10 The Radio Central Switch in OCC shall automatically manage the necessary call establishment and switching of radio calls. It shall work with the local radio switches in stations to ensure the radio calls can be maintained when the mobile and portable radio sets cross from one radio zone to another to enable seamless radio handover between zones.

7.2.11 At the stations, the Radio Local Switches shall automatically manage the call processing and the necessary channel assignments. Radio base stations shall convert the audio signals to RF signals and vice versa.

7.2.12 In case the linkage between the OCC and stations fail, or the Central Radio Equipment fails, the Radio System shall be able to operate in a local repeat mode within the coverage zone of the base station.

7.2.13 On the trains, a mobile transceiver, an antenna and a Train Cab Communications Panel for the TO shall be provided. The mobile transceiver shall be further connected to the train borne PA system and train borne Passenger Information Display System to facilitate OCC to send out train borne PA announcements.

7.2.14 A maintenance terminal shall be provided in the equipment room in OCC for equipment configuration and alarm monitoring.

7.3 Performance Specification

7.3.1 The Concessionaire shall select equipment and cables with the appropriate specification to engineer and build a radio system which meets the system performance standard in this sub-section.

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7.3.2 The downlink signal strength shall be measured using a standard 0dBd dipole antenna with vertical polarization located at 1.2m above the floor level. For trackside coverage, the measurement shall be made inside the train saloon at the centerline with the train running at the maximum speed. The required signal strength for 95% of the time measured at 95% of coverage area for any interval of 100m for trackside coverage and any 40m path for station and depot coverage shall be better than -87dBm.

7.3.3 The uplink signal strength shall be measured providing a mobile transmitter source with vertical polarization located at 1.2m above the floor level, transmit power + 30 dBm. For trackside coverage, the transmitter source shall be located inside the train saloon at the centerline with the train running at the maximum speed. The measurement shall be made at the point of interconnection to the base station receiver. The required signal strength for 95% of the time measured at 95% of coverage area for any interval of 100m for trackside coverage and any 40m path for station and depot coverage shall be better than -90dBm.

7.3.4 The audio SINAD level shall be better than 18dB.

7.3.5 The downlink carrier to intermodulation ratio shall be better than 30dB and the uplink signal to noise ratio shall be better than 20dB.

7.3.6 The call setup time shall be better than 0.5s.

7.3.7 The response time on the screen of the workstation shall be better than 0.2s.

7.3.8 The Grade of Service shall be better than 3% of average system access delay of 3s.

7.3.9 The data transmission rate of the radio channel shall be at least 28.8 kbps.

7.3.10 The Concessionaire shall coordinate with the Police Force and Emergency Services Department and commercial mobile phone operators to implement radio coverage required by law or government regulations, or as requested by the commercial mobile phone operators.

7.3.11 Radio calls between the TC and TO shall have two priorities, viz. normal and emergency. During normal train regulation, normal priority radio calls shall be established. When there is an emergency incident, the TO and TC shall be able to make emergency radio call which shall have a higher priority in channel allocation. Emergency calls received shall cause the RDW to produce a flashing indication and a special audible alarm signal.

7.3.12 Different types of radio calls shall have different priorities. The priority of different types of calls shall be user configurable using the maintenance terminal in OCC.

7.4 Technical Specification

7.4.1 All major equipment and component of the Radio System shall have redundant engineering to minimize the effects of the failure of such equipment to the operations and performance of the Radio System.

7.4.2 The RDW shall have a user-friendly graphical Man Machine Interface (MMI) for the TC to perform the required radio operations.

7.4.3 Radio calls to trains shall be identified by the Train Service ID which shall be obtained from the train borne Vehicle Communications Controller (VCC).

7.4.4 The application of the emergency brake on a train by the TO shall also activate a status transmission to the Central Radio System. The information shall be displayed on the MMI of the Controllers RDW together with the corresponding Train Service ID for the attention of the TO.

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7.4.8 LCX cables to be provided shall be of the wide band type sufficient to accommodate all the necessary services in the railway. The cables shall not exhibit frequency selective properties with which signals of some frequency bands cannot pass through, be radiated or received.

END OF SECTION 7

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8 Station Management System

8.1 General

8.1.1 The Station Management System (SMS) shall integrate the control, status monitoring and failure alarm of station based E&M facilities into a computer based system. The SMS shall interface between system-wide facilities for the provision of data required to assist in the management of a station.

8.1.2 The SMS data transmitted to the OCC shall enable the central management of the transit system during normal and abnormal working.

8.1.3 The basic functions required for the SMS shall be as follows:

(1) Acquisition and processing from the Remote Terminal Unit (RTU)

(2) Alarm/event handling and processing

(3) Provide Man Machine Interface (MMI) for operator monitoring and control

(4) Allow individual and sequence of control

(5) Time schedule control

(6) Automatic control functions

8.1.4 At each station, the Concessionaire shall provide SMS operator workstations and consoles at the Station Control Room (SCR) for the Station Controller (SC) and a maintenance workstation at the Station Computer Room for the maintenance team.

8.1.5 The SMS operator workstation shall be capable to control and monitor the fixed station E&M equipment not limited to:

(1) Platform Screen Doors (PSD)

(2) Automatic Fare Collection (AFC) System

(3) Fire Alarm System

(4) Fire Fighting System

(5) Elevators

(6) Escalators

(7) Station Environmental Control System (ECS)

(8) Tunnel Environmental Control System (ECS)

(9) Pumping & Drainage System

(10) Lighting system

(11) Controlled Access Security System

(12) Communications systems

(13) Trackside Auxiliaries

(14) Baggage Handling System (BHS)

(15) Low Voltage Power Supply System

(16) Uninterruptible Power Supply

(17) Diesel Generator System

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(18) Building Services within on-line equipment rooms

8.1.6 At Station Computer Room, the Concessionaire shall provide a Maintenance Workstation for software maintenance, backup control of the SMS servers, and backup control and status monitoring of the connected E&M equipment.

8.1.7 At OCC, the Concessionaire shall provide SMS operator workstations and consoles for Engineering Controller and monitoring by the Control Superintendent. The workstations shall be capable to control and monitor the following operationally critical systems:

(1) Tunnel ECS

(2) Status alarms for PSDs, emergency and essential power supply, AFC system, Fire Alarm Panels, escalators, lighting, equipment room ECS, sump pumps, security system illegal entries and the baggage handling system.

8.1.8 In the event of loss of the OCC, the control of the tunnel ECS system shall be via the adjacent station SMS facilities.

8.1.9 The Concessionaire shall provide at least 20% spare capacity available at the time of system acceptance for future expansion of memory storages, processor power, hard disk storages, communication links/ports and I/O points.

8.1.10 The network loading shall not exceed 80% at any time during normal operations.

8.2 System Description

8.2.1 Station Equipment

(1) There shall be a pair of hot-standby redundant SMS servers which acquires real time equipment status from the RTU, processes operator commands and performs the SMS functions.

(2) The operator workstations shall provide user-friendly graphical-based Man Machine Interface to the operators for the monitoring and control of equipment.

(3) Two sets of dual screened operator workstation shall be provided for the Station Controller and one set of single screened maintenance workstation shall be provided for maintenance purposes at each station.

(4) A dual Ethernet LAN shall be provided for the communication between the SMS Servers, the operator workstations, the PLCs and the FEP.

8.2.2 OCC Equipment

(1) One set of dual screened operator workstation shall be provided for the Engineering Controller to monitor and control the tunnel ECS and trackside auxiliaries' equipment.

(2) One set of single screened operator workstation shall be provided for Control Superintendent for monitoring only.

(3) A dual Ethernet LAN shall be provided for the communication between the SMS operator workstations and the router.

(4) A router shall be provided for interface between the OCC dual Ethernet LAN and the backbone transmission network to enable communications among the SMS servers and the OCC operator workstations for the exchange of necessary information.

8.2.3 Field RTU

Field RTU shall be used to provide direct hardwire input and output channels.

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8.3 Performance Specification

8.3.1 Each RTU shall be sufficiently equipped with input/output points including a 30% spare capacity.. The SMS Servers provided shall be able to handle all required input/output points including a 30% spare capacity.

8.3.2 Any change of state of a digital input point received from the interfacing systems, either through hardwired or serial/LAN interfaces, shall be reported at the operator MMI screen within 5s since its occurrence.

8.3.3 Any control command shall be dispatched from the RTU interface within 5s after the operator's last key stroke operation.

8.4 Technical Specification

8.4.1 General Requirements

(1) A computer based, Window oriented SMS system shall provide control and monitor facilities for the Power Supply of the AMEL, as well as particular functions of selected station facility. The selected equipment supplied by the Concessionaire shall be identified from the outline operations plan, as described under the Operations & Maintenance Functional Specification.

(2) The Concessionaire shall design, manufacture, install and commission the SMS system to provide a safe, efficient and effective means of remote monitoring and controlling the operation of the AMEL network.

(3) The outline operations plan shall also identify the various levels of monitoring and/or control, including the system locations where these levels apply.

(4) The levels of information obtained from the monitoring equipment and the degree of control available at each level or system location shall also be identified from the operations plan. The mechanism of control and monitoring shall ensure that the selected equipment shall continue to function correctly and in a safe manner in the event of malfunction of parts or all of the SMS system.

(5) The SMS system shall provide sufficient maintenance related information to the designated maintenance centre.

8.4.2 Specific Functions Requirements

(1) The SMS shall automatically execute the associated congestion mode operation of the Tunnel Ventilation System when a control demand signal is received form the Signaling System.

(2) Upon receipt of the hardwired fire zone alarm signals from the Fire Detection System, the SMS shall automatically reconfigure the associated station ECS for emergency mode operation.

(3) The SMS shall receive train approaching information for each platform and the train ID of a berthed train for each platform from the Signaling System and shall trigger the appropriate Public Address announcement and Passenger Information Display automatically.

(4) The SMS shall send the train ID of the berthed train to the Baggage Handling System to enable the BHS to trace the location of the luggage.

8.4.3 Event Records

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(1) The SMS system shall record any events caused by faults, malfunctions, warnings or alarm information generated automatically by the selected equipment. A central recording system shall be provided to record the following events, including but not limited to:

(a) Change of state of remote terminal unit input parameters

(b) Events designated as alarms

(c) Change in the SMS workstation configuration

(d) Faults

(e) Control actions

(f) System generated messages, e.g. equipment malfunction, etc.

(2) Events shall be given an order of priority to allow events to be classified, sorted and filtered. Subject to the requirements of the approved operations plan, events shall be classified as.

(a) Emergency - this type of fault shall require instant attention in order to minimize safety hazards and interruption of the normal operation of the Initial System or the risk of injury to personnel or passengers

(b) Urgent - this type of fault shall require reasonably prompt, but not instant attention in order to minimize interruption of the normal operation of the Initial System

(c) Non urgent - this type of fault shall be dealt with in a more convenient manner while more urgent events are dealt with first. This type of event shall not directly result in any degradation of the normal operation of the Initial System

(3) The event records shall be available as a text table, with each event classified by its priority level and shall be tagged with details of the date and time at which the event occurred. Additionally, the operator identification code shall be recorded for each initiated event. Each event shall be displayed and highlighted until the event has been acknowledged and cancelled in the automatic event log, and provided the fault has been satisfactorily rectified in the equipment, which generated the event.

(4) All data messages transmitted through the SMS network shall be tagged with the time and shall be sorted and logged in time tagged order on the central database.

(5) Each SMS workstation shall be capable, at any time, of sorting and filtering events in accordance with their priority to the level required by the operator. A facility shall also be provided to enable a summary printed event record report to be prepared, listing not only the current active events, but also any events, including faults and alarms, reported and / or cleared during the period since the previous summary report. All data records associated with the day's railway service once stored within the central database shall be collated, sorted and accessible within one minute of a request being issued by any workstation in the SMS system.

(6) In the event that a particular incident gives rise to numerous SMS events, then the SMS workstations shall be capable of displaying either all such events or only the most important event. In case that the most all-encompassing event is chosen to be displayed, all the associated events shall still be recorded with the most all-encompassing event. When the all-encompassing event is either cancelled or acknowledged, this shall be achieved together with all the associated events.

8.4.4 Archive and Evaluation System

(1) A bulk data and software archive system with removable storage media facilities shall be provided at the OCC for the historical storage of database records. The system shall utilize optical disc technology, which shall allow the data to be indexed and shall allow random and sequential searches.

(2) An automatic alarm shall be triggered in the event that the accumulated data and software is stored for more than a pre-defined period without being backed up. The bulk data storage system shall have sufficient capacity to provide a master historical data storage of all software and recorded data for the entire SMS system. All software files contained within the SMS workstations shall be able to be up-loaded to the OCC for evaluation purposes.

(3) The historical data storage system shall index the storage media to enable rapid retrieval of data by date and time and be capable of event searches based on selectable criteria.

8.4.5 Alarms

(1) Audible alarms shall be provided to alert the operator to a problem requiring immediate action or attention.

(2) The nature of all audible alarms shall be accompanied with a corresponding message, providing details of the alarm, which is presented on the workstation display. When an alarm is initially received, a corresponding visual flashing indicator shall appear on the display. Once the alarm has been acknowledged the flashing indicator shall transfer to a permanent illumination.

(3) Provision shall be made to automatically provide the corresponding station diagram by clicking the alarm line.

(4) In the event of multiple events initiating audible alarms, only one alarm shall be broadcast at any time. The highest priority of alarm shall always take priority, even in the event that a lower priority alarm is already being broadcast. Once the higher priority has been acknowledged and muted, the next lowest priority of alarm shall initiate the alarm broadcast.

8.4.6 Access right

(1) Access to the SMS system shall be controlled. Access codes shall be granted to individual persons based upon their task and responsibilities.

(2) It shall be possible to modify the access security features only from the highest access level. The action of all login and log-out operations of the SMS system, as well as any configuration changes to the system, shall be recorded by date, time and the user's security access code as an event record.

8.4.7 Response Times

(1) The display of each process element shall require rapid updates of the workstation displays of the status and event data, together with a rapid response by the SMS system to control inputs. The status of any circuit breaker trip, protecting any critical equipment, shall also be identified on the workstations and recorded in the event record, within 4 seconds of its occurrence.

(2) Activation of a control command shall reach any critical systems in no more than 4

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seconds.

(3) Updating of displays shall ensure that no displayed data shall be more than 30 seconds old. No event shall take longer to be registered on a display than 5 seconds for urgent alarms and 3 seconds for emergency alarms. The display of non-urgent events shall take no more than 10 seconds after the occurrence.

(4) The normal operation of all the remote terminal units shall be verified by the SMS system at intervals not exceeding 30 seconds. In the event of any failure or malfunction of a remote terminal unit, a corresponding message shall be displayed on the appropriate workstations as a SMS system alarm.

8.4.8 Fault Locators

Fault Locators are devices by which short circuits in the cable routes can be localized. There two types of fault locators by mean of Single and Two-value fault locator. An SMS interface to the device shall be provided.

8.4.9 Equipment Requirements

(1) The SMS system configuration shall be designed to achieve very high system availability and to ensure that any single point failure of SMS equipment shall not cause a reduction in SMS system performance. Redundancy shall be incorporated, where failures cannot be tolerated, particularly when associated with critical systems. The SMS system shall be designed around small autonomous items of equipment but shall be commensurate with an economical overall solution.

(2) The SMS system shall be designed to accommodate future expansions of the Initial System and also to incorporate additional functions and facilities, such as additional data storage, interface input/output ports, condition monitoring etc., which may also be necessary in the future.

(3) All SMS equipment shall be fully protected against the effects of power supply surges and transients.

(4) The SMS equipment shall be fully protected against the effects due to lighting strikes in accordance with the requirements of internationally recognized standard.

END OF SECTION 8

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9 Passenger Information System

9.1 General

9.1.1 The Passenger Information System (PIS) shall allow the operators to send visual messages to the passengers while they are in the stations.

9.1.2 These messages shall fall into the following categories:

(1) Normal operating messages related to train arrival and departure, or reminder messages to make passengers aware of proper and safe procedures

(2) Special operating messages such as informing passengers about train service delay

(3) Emergency messages such as station evacuation when there are hazardous conditions in the station

9.1.3 Commercial messages, such as advertisements, may also be displayed on the display boards of the PIS.

9.1.4 The operating messages may also be able to be sent to the trains via the Radio System.

9.2 System Description

9.2.1 Messages to stations shall be sent from three different sources:

(1) The Station Controller (SC) in stations

(2) The Train Controller (TC) in OCC

(3) The Control Superintendent (CS) in OCC

(4) The Engineering Controller (EC) in OCC

(5) From the Signalling System interface.

(6) The Depot Controller (DC) in OCC

(6) A Commercial Information Workstation (CIW)

9.2.2 At the OCC, a Central PIS Controller and Workstation shall be provided for handling central message input and dispatch. The messages from the OCC shall be sent to the stations via the Data Transmission System. The Central PIS Controller will also interface with the Radio System to send out messages to the trains, which shall be an optional requirement.

9.2.3 The CS shall make use of this Central PIS Workstation to select pre-defined messages or type in instant messages for sending out to selected stations or to trains (option).

9.2.4 At stations, the control shall be via the Station PIS Controller (SPC). The Concessionaire shall integrate a PIS client software into the Station Management System (SMS) Workstation to be interworking with the SPC. This shall provide PIS functions for the SC to carry out the necessary operations.

9.2.5 Display boards shall be located in station public areas such as platforms, above ticket gates and at the entrances.

9.2.6 Display boards shall fulfill the viewing conditions, as well as be suitable for the environment and installation inside the stations. The boards and corresponding software shall support English and Hindi languages.

9.3 Performance Specification

9.3.1 Messages displayed on the Display boards shall be capable of being read by normal sighted

persons from any location in a station or on a train

9.3.2 The message transfer completion time defined as the interval between the operators clicking the "Send" button to the display of the message on the display boards shall be better than 0.5s.

9.3.3 The Central PIS Workstation and the Commercial Information Workstation shall have a user-friendly graphical Man Machine Interface (MMI) for the operators to perform the required PIS operations.

9.3.4 Pre-stored messages shall have normal and emergency priorities. Messages from different controllers shall also have different priorities.

9.3.5 Train arrival information and pass through warning at AMEL Line stations shall be automatically displayed on the corresponding platform display boards without operator invention. This shall be done by the PIS controller interfacing with the Signaling System to obtain the train arrival information. The display of this information shall be simultaneous with the PA system broadcast of same.

9.4 Technical Specification

9.4.1 The display boards shall meet the following minimum specification and shall be clearly visible on elevated station platforms:

(1)	Viewing angle:	160 degrees (horizontal and vertical)
(2)	Brightness:	1000cd/m² or better
(3)	Contrast:	1000:1 or better
(4)	Ambient temperature	50C

9.4.2 Types and quantities of display boards to be provided shall be as follows as a minimum requirement:

Location	Quantity	Type
Each Station Platform	2	Double Side
Each CAT Departure Hall	2	Double Side
Each CAT Arrival hall	2	Double Side

END OF SECTION 9

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10 Train borne Communications Systems

10.1 General

10.1.1 The Train borne Communications System shall provide the following audio and visual communications facilities on the trains:

(1) One-way announcement from the Train Operator (TO) to the passengers - using the train borne Public Address (PA) System

(2) Visual text messages from the TO to the passengers - using the train borne Passenger Information System (PIS) (option)

(3) Two-way conversation between the TO and passengers - using the Passenger Intercommunications (PIC) Unit

(4) Two-way conversation between the TO and the Traffic Controller (TC) in OCC - using the train borne mobile radio unit

(5) Two-way conversation between the TO and the Depot Controller (DC) in the depot - using the train borne mobile radio unit

(6) One-way announcement from the Control Superintendent (CS) in OCC to the passengers - using the train borne PA system and the Radio System

(7) Visual text messages from the CS in OCC to the passengers - using the train borne PIS, together with the Central PIS and the Radio System (option)

(8) Two-way conversation between the front and the rear cabs

10.1.2 The train borne PIS may also be used to display weather information, news headlines and the like for passenger interest. It may also be used to display commercial advertisements in the form of full motion video.

10.2 System Description

10.2.1 The Train Cab Communications Panel (TCCP) on the driving cab console shall enable the TO to make radio calls, train PA broadcast, initiate recorded audio announcement and visual messages, key-in instant text messages, answer calls from the PIC and carry out intercom call with the opposite cab. The TCCP shall be equipped with a handset, a monitor speaker, selection buttons and a visual display.

10.2.2 Noise sensors shall also be provided in the train saloon to detect the level of the ambient noise level and send the value to the CCU to regulate the output of the amplifiers so that the resulting sound level of the announcement shall be able to maintain at an intelligible and comfortable level.

10.2.3 Display boards for the train borne PIS shall be of the LCD type or other alternatives which shall fulfill the viewing conditions, as well as be suitable for the environment and installation inside the trains. Each passenger car shall be equipped with four display boards. (Option)

10.2.4 PIC units are provided to allow the passengers to call the TO for assistance. Each PIC unit shall have an activation pushbutton with a key switch and a microphone. PIC units shall be installed in a zigzag pattern with the train doors in each train car. The switching logic for all the PIC units in a car shall be handled by the CCU. The number of doorways per side per car is as follows:

(1) 2 for passenger cars of AMEL trains

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(2) 2 for baggage cars of AMEL trains

10.3 Performance Specification

10.3.1 The Concessionaire shall select equipment and cables with the appropriate specification to engineer and build a Train borne Communications System which meets the system performance standard in this sub-section.

10.3.2 The performance specification for the Train borne PA system shall be:

(1) Sound Pressure Level (SPL): 9 dB ± 1 dB above the ambient noise level in the same measurement location and height. This shall apply to all areas of sitting or standing positions in the train saloon at a height between 1m and 2m above the floor level. The maximum and minimum SPL along the length of each saloon shall not be greater than 3dB.

(2) Frequency Response: 300Hz to 7 KHz (0, -3dB).

(3) Distortion: < 1% at 1 KHz

(4) Signal to Noise Ratio : > 60dB

10.4 Technical Specification

10.4.1 Different types of communications functions on the trains shall have different priorities. The Concessionaire shall propose priorities at the initial stage of the engineering for the required priorities and implement the handling of coexisting communications functions according to the agreed priorities.

10.4.2 The selection of communications functions and the corresponding indications on the TCCP shall be easy to operate and recognize with user-friendliness to facilitate the TO to operate the Train borne Communications System.

10.4.3 The TO may make audio announcement and send visual text messages to the passengers on the train using the TCCP. Visual text messages can be a message instantly key-in by the TO on the TCCP or a pre-recorded message selected from the TCCP.

10.4.4 If required, pre-recorded messages selected by the TO shall be able to be sent out synchronously in both audio and visual forms, or in just any one form.

10.4.5 Routine messages such as "train door closing" reminder and the next station message shall be sent out automatically by the Vehicle Communications Controller (VCC). The VCC shall receive information from the Signaling System to carry out this automatic triggering of messages.

10.4.6 Each piece of pre-recorded audio and visual messages to be sent out to the train saloons shall be in both English and Hindi languages.

10.4.7 When a PIC request is made from a passenger, the identification number of the corresponding PIC shall be displayed on the TCCP and the door lamp outside the train corresponding to the location of that PIC shall light accordingly.

10.4.8 When the TO answers a PIC call from the passenger, it shall be made through the PA system only in the train car in which the PIC call request is made. After handling the PIC call, the PIC unit shall only be able to be reset by staff carrying the reset keys to terminate the communication path between the train cab and PIC unit.

10.4.9 When the train starts service, the driver shall enter the Train Service ID into his radio unit to allow the Central Radio System to identify the selected trains during OCC or depot to trains

radio communications.

10.4.11 whenever the TO applies the emergency brake, the status shall be sent via the radio system to the OCC.

10.4.12 The Train borne Communications System shall be equipped with the capacity for the expansion of the train fleet of the Design year, without any modifications.

10.4.13 Commercial advertisement to be displayed on the display units in the train saloon shall be loaded into the VCC using removable media.

10.4.14 Train borne communications equipment which will be visible to the passengers shall match aesthetically with the interior engineering of the train saloon. This shall include PIC, speakers and the display boards.

10.4.15 Train borne equipment shall be able to withstand the vibration, temperature and electromagnetic conditions that will be experienced on the trains.

ENDOF SECTION 10

Delhi Metro Rail Corporation Ltd.

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11 Office Automation and Information Technology

11.1 General

11.1.1 The Office Automation (OA) System shall provide the network infrastructure for the operators and other administration/maintenance staff to handle office administrative works.

11.2 System Description

11.2.1 All the OA servers, IT servers, OA/IT PCs and printers to be required for administration works of the railway operator are to be defined and provided by the Concessionaire.

END OF SECTION 11

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CHAPTER 7

AUTOMATIC FARE COLLECTION SYSTEM

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1 SCOPE OF WORKS

1.1 GENERAL

This Specification stipulates the performance requirements for the Automatic Fare Collection (AFC) System to be designed, constructed, commissioned and operated by the Concessionaire for the Airport Metro Express Line (AMEL)

1.2 Requirements

1.2.1 Devices that routinely interface with passengers shall be arranged to minimize their time in transit and inconvenience. The Availability of a device and the numbers provided at stations shall limit the queue lengths for a particular service (TVM's, Gates, TOM's etc.), to four customers at all times.

1.2.2 The AFC system shall be of modern, state-of-the-art design, in keeping with the design of the AMEL architecture and technology.

1.2.3 The AFC system control equipment shall be designed and supplied for a Design Life of 15 years. Associated wayside equipment shall be designed and supplied for Design Life of 30 years

END OF SECTION 1

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2 SYSTEM DESCRIPTION AND PERFORMANCE REQUIREMENTS

2.1 General

2.1.1 The AFC System for the Delhi AMEL has been planned as a Semi-closed System, meaning that IGI Airport Station shall have no fare gates. Passengers shall be able to exit from trains and move directly into the Airport without restriction. Conversely passengers departing from the Airport shall be able to board trains without passing through fare gates. Other stations shall have entry and exit gates to control passenger flow and validate their tickets.

2.1.2 Access to the Check-in facilities located at the Stations with City Airport Terminal (CAT) facilities shall be restricted to passengers holding tickets valid for travel to the Airport. Passengers who have used the Check-in facilities shall be permitted to exit the system and re-enter at a later time for travel to the Airport.

2.1.3 Passengers traveling from the Airport shall be able to either purchase their tickets from Ticket Office Machines (TOM) or Ticket Vending Machines (TVM) located at the Airport or to travel to their destination station and purchase a ticket from TOM or TVM machines there in order to exit the system. Use of the 'Ride First' option shall not be penalized.

2.1.4 Contact less ticket media shall be of an ISO/IEC 14443 type which is compatible with the Delhi Metro AFC system. Inter-operation with the Delhi metro is a requirement. The Concessionaire shall engineer the AFC system to inter-operate and interface with the DMRC Central Clearing House (CCH) system.

2.1.5 The operating features of the system shall be fully parameterized.

2.1.6 Notwithstanding Sub-clause items 2.1.1 to 2.1.3, the Concessionaire shall develop the AFC System to optimise revenue and the Business Rules Approved by DMRC.

2.2 Business Rules

2.2.1 The Concessionaire shall provide full and detailed business rules for DMRC.

2.2.2 The AFC system shall be able to support a fare structure based on zones, distance, time-of-day, special concessions, staff passes, and shall facilitate their modification and upgrade.

2.2.3 The Concessionaire shall observe the Fare Policy detailed in Volume II Section II. Article 6

2.2.4 When implementing the operating requirements, the Concessionaire shall ensure that all associated security / fraud problems are addressed.

2.3 Capacity

2.3.1 The Concessionaire shall provide passenger forecast data and shall engineer the AFC System suitable for the patronage forecasts of the Design Year of 2041.

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2.4 Calendar and Operating Day

2.4.1 A distinction shall be made between the calendar day and the operating day. A calendar day extends from midnight to midnight. An operating day starts from a parameterized number of hours after midnight, and extends through 24 hours. Hence the system shall support overnight operation for passengers who enter the system before midnight and exit the following day after midnight. The Concessionaire shall identify the start of the operating day in its Operation and Maintenance Plan.

END OF SECTION 2

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3. TECHNICAL REQUIREMENTS

3.1 Station Computer (SC)

3.1.1 Description

(1) Station Computer (SC) enables the overall control and monitoring of each item of AFC equipment within the station and transfer of data to the Central Computer (CC).

(2) The SC shall include the power and data communication links to each item of AFC equipment and CC system interface.

(3) It shall enable printing of reports at stations. The reports shall include accounting and statistical information. It shall include any other reports required for AFC operation.

(4) The SC shall be able to download data to the AFC machines individually or as groups.

(5) The SC shall receive maintenance data from AFC equipment and transmit the same to CC for monitoring and use of the same as an effective maintenance tool.

(6) The SC shall be able to monitor certain critical functions of the AFC system and collect data for warnings and alarms.

(7) If there is loss of communication between the SC and AFC equipment (Gates, TOM etc.) then the equipment shall operate in stand-alone mode utilizing the most recent data from the SC. AFC equipment (Gates, TOM etc.) shall store data up to seven days for transmission when SC communication is restored.

(8) In the event of loss of communication with the CC the SC shall utilize the most recent operational data received from the CC and shall be capable of storing at least thirty days of transaction data.

3.1.2 Equipment Control

(1) The normal method of control of the equipment shall be by the SC. The SC shall enable all AFC equipment control (put in service, taken out of service and initiated etc.) without the requirement for communication with the CC.

3.2 GATE

3.2.1 Gate Function

(1) Gate arrays shall be the normal-means of controlling entry to and exit from the paid areas. Control shall be by means of actuating a physical barrier on recognition of a valid ticket or card by the gate. The barrier may be a bi-parting leaves, centre flaps, end flaps or other configuration however the use of tripod or turnstile type gates is not acceptable. The gate shall be capable of operating either in normally open or normally closed mode.

(2) There shall be sufficient provision as part of each gate array in each station for

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passengers using baggage trolleys. Baggage gates shall also handle the requirements of wheelchair passengers.

(3) Where required, the Concessionaire shall provide fencing to separate paid and unpaid areas of the concourse. The fencing shall meet local public safety requirements and be aesthetically merged with station engineering.

3.2.2 Features

(1) Power Failure – In the event of a total power failure to the gates, the gates shall open to allow unrestricted passenger access. All latch gates shall automatically unlatch where electric locks are installed.

(2) Concourse Emergency Mode – All AFC gates shall open whenever the Concourse Operating Mode is in emergency. An Emergency Push Button independent of the SC shall be provided in each ticket booth.

(3) Ergonomics - The engineering of the gate arrays should be such that the passenger uses reader placed on the right hand side while passing through the gate. The display and Contact less Smart Card (CSC) reader associated with each gate shall be grouped such that they bias the passenger towards the aisle through which the passenger should pass.

3.2.3 Types of Gates

(1) Passenger / Baggage Entry Gate

The Passenger / Baggage Entry Gate shall control the entry of passengers into the paid area by validating the fare media.

(2) Passenger / Baggage Exit Gate

The Passenger / Baggage Exit Gate shall control the exit from the paid area by validating the fare media.

(3) Passenger / Baggage Reversible Gate

The Passenger / Baggage Reversible Gate shall combine the features of the Entry and Exit gates. It shall be capable of being switched by the Station Computer from entry mode to exit mode and vice-versa depending on the operational requirements of passenger flow.

(4) Staff / Emergency Gate

Normally situated adjacent to the Ticket Office and kept open during emergency situations.

3.2.4 Spacing

(1) Spacing for passenger gates shall be based on the following dimensional criteria:

(a) Gate centre spacing:-

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Standard gates Max. 880mm
Baggage / wheelchair gates Max.1,450mm

(b) Aisle width:-

Standard gates 465 - 580mm
Baggage / wheelchair gates 900 - 1,100mm

3.2.5 Gate Enclosure

(1) The gate enclosure shall be fabricated of stainless steel. The gate shall be finished to conform to the architectural requirements of the station.

(2) The degree of protection provided by the enclosure against dust, splashing, intrusion of foreign objects shall meet or exceed the standard IP54 (IP43 for token acceptor slot, if any), as defined by British Standards.

3.2.6 Tail Gating Prevention: Less than 20cm

3.2.7 Environment: Operation at ambient temperatures from 0 to +50 degrees Celsius.

3.3 Ticket Office Machine (TOM)

3.3.1 Function

(1) The TOM shall be installed at the ticket counter at all stations. This machine shall be operated by the staff and shall issue all types of tickets.

(2) The TOM function shall include the following:

(a) Sale of all kinds of tickets;

(b) Analyse tickets; and

(c) Add value to CSCs.

(d) Refund, Replacement, Surcharge, Cancellation.

3.4 Ticket Vending Machine (TVM)

3.4.1 Provision

The Concessionaire shall determine the viability of using TVM machines in the local environment by taking into consideration the fares to be charged, cash denominations available and the condition of commonly used bank notes. In the event that the use of TVMs is not deemed viable the Concessionaire shall propose alternative means of providing the functionality therein.

3.4.2 Function

(1) Enable passengers to purchase tickets for a single journey on the AMEL.

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(2) Allow passengers to add value to Stored Value tickets at any time in the life of the ticket.

(3) Allow passengers to check the value of Stored Value tickets at any time in the life of the ticket.

(4) The machines shall accept payment in the form of bank notes, coins and credit / debit cards and shall interact with the passengers via a touch screen display and receipt printer.

(5) A reject button shall be provided to enable a passenger to abort a transaction before a token issue cycle has commenced.

(6) The bank note reader shall accept notes inserted in any orientation (any way up or round) and change shall be provided via a coin re-circulating mechanism, which minimises the number of times the station staff need to replenish the machines with change.

3.4.3 Physical

(1) The TVM's shall be made from stainless steel and shall be freestanding or recessed into the walls of the TVM rooms as required by the station architecture. Separate tamper-proof coin boxes and note vaults shall be provided.

3.5 Central Computer System

3.5.1 A Central Computer (CC) System shall collect and analyze information received from the station computers. It shall produce network-wide revenue and traffic data and monitor the performance of all AFC equipment.

3.5.2 The Central Computer System shall generate the necessary management reports from the CST, CSC and transaction information received from the Station Computer Systems.

3.5.3 The CC shall hold and download CST and CSC parameters, Configuration Data (CD), AFC device software and fare table information to each SC from where they shall be distributed to the station AFC equipment.

3.5.4 The CC shall automatically collate all CST, CSC and usage data (UD) from the SC to provide accurate audit and traffic statistics for the line.

3.5.5 The CC shall be located in a dedicated computer room in the Administration Building or Operations Control Centre.

3.5.6 The CC shall communicate with the DMRC Central Clearing House (CCH) System for interoperability of Stored Value smart cards.

3.5.7 The CC shall maintain a blacklist of invalid tickets. Blacklisted tickets shall be rejected by the AFC Gates. The blacklist shall be manually entered or derived from the CCH interface.

3.5.8 The CC shall support a Fare Table with at least 256 stations.

3.6 Tickets

3.6.1 Types of Ticket

(a) The system shall provide, or be capable of processing, the following types of ticket:

(i) Single Journey Ticket (SJT)

(ii) Staff / Employee Pass (EP)

(iii) Stored Value (SV) (at least 16 configurable types)

(iv) Period Pass (PP)

(v) Other ticket types must defined by DMRC

(b) Each ticket type shall be capable of being associated with at least four fare tables (one full fare and three different concession fares).

3.6.2 Ticket Media

(a) CSC (for Stored Value, Employee Pass etc.)

ISO 14443 Type A, Desfire only.

CSC media shall be of a type and data layout compatible with the Delhi Metro System to permit inter-operation via the DMRC Central Clearing House (CCH).

(b) Other Media (for Single Journey Tickets)

Media for Single Journey Tickets shall be determined by the Concessionaire. Choice of SJT media shall take financial and usage constraints into account.

3.7 Security

3.7.1 Revenue Protection

(a) The AFC machines shall resist tampering by either passengers or unauthorized staff

3.7.2 Revenue Security

(a) The AFC machines and system shall provide a complete audit trail of all transactions, transfers of cash and other payments.

(b) Cash handling equipment and systems shall be an integral part of the audit trail.

3.7.3 Data Security

(a) In the event the SC fails, each item of equipment shall be able to operate autonomously without loss of data.

(b) Security of communications between the AFC equipment, SC and CC system shall ensure no loss of data in transmission.

END OF SECTION 3

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4. DESIGN DOCUMENTATION REQUIREMENTS

4.1 Engineering Process

The following engineering requirements shall be adopted by the Concessionaire in addition to those specified in the General Technical Specification of Schedule 'D'. The Concessionaire shall submit a Engineering Plan list of all engineering documents for review.

4.2 Engineering Plan

4.2.1 The Concessionaire shall submit the Engineering Plan for the Automatic Fare Collection System for review.

4.2.2 The Concessionaire shall adopt a structured engineering process, including in addition to the requirements of the General Technical Specification of Schedule 'D', but not limited to the following:

(1) Initial, Intermediate and Final engineering reviews, including, but not limited to:

(a) System architecture;

(b) Operation and maintenance philosophy; and

(c) Verification and test approach;

(2) Conceptual, preliminary, and final software engineering reviews with DMRC, including but not limited to:

(a) The software requirements specification;

(b) Software architecture;

(c) Logic flow diagrams; and

(d) Verification and test approach.

(3) Software Requirements

The Concessionaire shall demonstrate the correct application of the standards specifically detailing the allocation of software integrity levels for all software. The Concessionaire shall submit with the Engineering Plan for review a list identifying all software, which shall be maintainable and re-configurable during the Operations Period.

(4) Environmental

The Gates and TVMs shall be installed in open areas at some stations. The Concessionaire shall follow international standards for dust control.

(5) Engineering Documentation

The Concessionaire shall, in addition to the documentation requirements specified in the General Technical Specification of Schedule 'D', supply as a minimum the following

hardware and software engineering documentation:

(a) Engineering reviews

(b) Failure mode effect and criticality analysis (FMECA)

(c) Hardware adaptation report

(d) Result from simulation studies

(e) AFC layout

(f) Data preparation validation report

(g) AFC principles

(h) Installation engineering

(j) Systems Engineering Plan

The submission of the above documentation shall be included in the Submission Programme.

(6) Security Provisions

The equipment shall be engineered with features, which deter revenue losses from the following:

(a) Acts such as altering, copying or counterfeiting the tickets.

(b) Protection from unauthorized changes to the software.

(c) Protection from breaking the multi-pin locking concept or circumventing security access controls and PINs. The Concessionaire may propose alternative means to achieve the same objectives.

(d) Protection from falsification of records.

(7) Self-Diagnostics

Self-diagnostics shall be employed to the maximum extent possible to assure the highest possible availability.

(8) Software

(a) Downloading

Downloading of commands and parameters shall be accomplished remotely from the CC system.

(b) Software Use and Verification

(i) All software shall be complete and fully tested prior to shipment of the respective equipment. The software shall be fully programmed, debugged and updated. The Concessionaire shall provide the latest version of software source code and documentation for use during Concessionaire-conducted operation and maintenance training, and

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shall provide the finai software source code and documentation prior to revenue service for the first equipment.

(ii) All software source code, object code and documentation shall be provided on a CD-ROM in a format compatible with the computing equipment supplied.

(iii) Upon entry of the proper command into the service terminal, the AFC equipment shall generate a printed receipt showing the software part number and version of all installed software.

(9) Safeguards

The safety of all operating personnel using the equipment or performing their duties shall be an essential aspect of the AFC equipment engineering and fabrication. The Concessionaire shall provide appropriate safeguards.

4.2.3 Final Submission

The Final Submission shall be in accordance with the General Technical Specification requirements. The Final Engineering shall include any integration requirements with the DMRC works.

END OF SECTION 4

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Delhi Metro Rail Corporation Ltd.

CHAPTER 8

Railway Electrical and Mechanical Systems

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1 Scope of Work

1.1 Specification

This Specification stipulates the performance requirements for the Railway Electrical and Mechanical Systems to be designed, constructed, commissioned and operated by the Concessionaire for the Airport Metro Express Line (AMEL)

1.2 Reliability and Maintainability

1.2.1 The Railway Electrical and Mechanical Systems shall be engineered for a minimum operational life of 30 years with the exception of any consumables which shall have an operational life of at least 5 years.

1.2.2 The Concessionaire shall ensure that the equipment supplied shall achieve the availability and maintainability standards as laid down in the General Technical Specification Schedule D, Part III, Chapter 1, and shall always be under good repair within the environmental conditions prevailing where installed.

END OF SECTION 1

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2 Platform Screen Doors

2.1 General

2.1.1 The Concessionaire shall provide full height Platform Screen Doors (PSD) at each station platform. The PSD's shall comprise Platform Screen Doors (PSD), Manual Secondary Doors (MSD), Emergency Escape Doors (EED) and Fixed Screens (FS) to form a glazed barrier along the edge of the platform adjacent to the track. The configuration and location of the EED's and FS shall be such that PSD's shall correspond to the location of the train doors when the train has berthed in the Correct Stopping Position (CSP) at the platform.

2.1.2 The PSD's shall be entirely suitable for disabled access and shall comply with all relevant parts of the National Policy for Persons with Disabilities - 2006.

2.1.3 The Concessionaire shall demonstrate by means of a safety analysis that the combination and configuration of PED's, MED, EED's, and FS shall provide the required escape times from the trains for all emergency evacuation scenarios whether the train is at the station or stopped in the tunnel. This analysis shall include the scenario where the failed train has not aligned with the PSD's.

2.1.4 The Concessionaire shall provide the PSD's to accommodate the train consist for day 1 Operation, however the PSD's will be built with the final design aim in mind, which is to accommodate the train consist in the year 2041.

2.1.5 The PSD equipment shall be designed and supplied for a Design Life of 30 years.

2.2 System Description and Performance Requirements

2.2.1 The barrier formed by the PSD's shall be designed and constructed to screen the trackside deleterious environment from the platform area. The architectural finishes of the PSD's shall enhance the aesthetics of the platform area and the material selected shall be durable and require a minimum of maintenance.

2.2.2 In the closed position, each door shall be locked against passenger access from the platform.

2.2.3 PSD doorway width shall be determined by the width of the train doors and the permitted over and under-run distance specified in the Signalling Specification. The PSD doorway height shall not be less than that of the train doorway, above the platform

2.2.4 The PSD shall be designed to limit any noise transmitted from the trackside to the platform to NC45 when measured 1m from the edge of any platform.

2.2.5 The PSD structure shall accommodate the loading pressures that shall be placed on it from the tunnel and station ventilation systems, the forces associated with train movement and passenger /crowd loading impact pressures and environmental conditions in the case for above ground stations. Under extreme loading pressure, no structural elements or glazed sections (moveable or fixed) shall suffer permanent deformation or damage and no PSD door panel shall become detached from it's mountings.

2.2.6 The PSD structure shall be designed to accommodate the civil works tolerances experienced during installation. The structural support shall be located such that the glazed barrier formed by the PSD extends from the floor to the ceiling to provide a full height barrier

2.2.7 The interface between the vehicle and the PSD is not physical. The PSD shall be installed sufficiently close to the platform edge to restrict personnel access between a vehicle and the doors to prevent a small child being trapped between the outside of the PSD and the train.

2.2.8 Special attention shall be given to design arrangements to mitigate damage to the PSD

installation in the event that a train with collapsed suspension enters the platform.

2.3 Platform Screen Doors

2.3.1 Each door shall include glass panels, corresponding to those of the train. In case of breakage within a door panel, the glass must be capable of being replaced without removal of the door.

2.3.2 Doors shall be interchangeable, whether working right or left handed.

2.3.3 The bi-parting door operation equipment shall comprise the actuator, associated door drive mechanism and door suspension assembly all located within a PSD header box. All mechanisms and other components (e.g. wiring) that link each door together shall be made secure against access by the traveling public.

2.3.4 Door actuation may be either electric or pneumatic. The actuator, either electric or pneumatic, shall be controlled by a Door Control Unit (DCU) which shall include facilities to control position and speed of driven doors. For pneumatic operation the compressed air system shall be self contained and dedicated for PSD door operation. The compressor set for pneumatic operation shall be located in an equipment room in the non-public area of the station.

2.3.5 The PSD threshold plate shall have a slip resistance (wet or dry) value of greater than 45 measured with a 4S rubber on pendulum test and shall comply in all respects with the requirements of the National Policy for Persons with Disabilities - 2006.

2.4 Emergency Escape Doors

2.4.1 Where it is determined that EED are required, they shall have the ability to be opened from the trackside, as well as platform side. These doors shall be manually operated (push bar handle from trackside). EED shall also be capable of being opened on the platform side via special keys held by station staff.

2.4.2 The door shall be designed to swing open and to be held at an open position of 90°. Each EED shall be normally closed and locked with the status of each door monitored as part of the "PSD/EED closed" control loop.

The EED like the PSD shall be designed such that ingress and egress to and from the trains comply with the requirements for accessibility for the disabled..

2.5 Fixed Screens

2.5.1 Fixed Screens (FS) shall be used in an alternating pattern with PSD and EED (if installed). They shall also be used to make up the unused part of the platform during the initial phase of the project. Any gaps in the barrier due to civil tolerances shall be filled by fixed screen(s). The Concessionaire shall ensure that these fixed screens shall have a similar continuity of appearance as the working part of the PSD and be aesthetically acceptable from an architectural viewpoint.

2.6 Manual Secondary Doors

Manual Secondary Doors (MSD) typically, single leafed and opening out towards the platform on hinges nearer the head wall and tail wall, shall be provided at platform areas for trackside access. They shall be made secure against access by the traveling public. Operation of the MSD shall be the same as for the EED.

2.7 Door Locking Mechanism

2.7.1 The locking mechanism of PSD shall not engage in the presence of obstructions. Each PSD shall

be fitted, on the track-side, with an easily accessible manual release device to allow passengers leaving the train to disengage the automatic drive and open the door manually.

2.7.2 The manual release on each door panel (PSD/EED/MSD) shall be easily accessible from the platform side by use of a special keys held by the station staff.

2.7.3 Each door-set (PSD, EED, MSD) shall be equipped with a heavy duty locking arrangement which positively engages the door leaves. This shall secure the door closed and be fitted with a manual release device which shall override the remote operation of the door in an emergency by disengaging the lock and isolating the power from the door operator. This shall allow the operator to freewheel easily when manually opened.

2.7.4 Upon loss of power, PSD, EED, and MSD shall move to the power-off position (open or closed) as dictated by the emergency evacuation procedures.

2.8 Materials

2.8.1 Glazing Panels

All doors and screens shall be glazed, the design of the glazing shall take into consideration, the weight of each automatic door leaf which is dependent on the required speed of operation and also by safety requirements.

The Concessionaire shall design the system to comply with ANSI Z92-1 Specification and Method of Test for Safety Glazing Materials Used in Buildings and BS 6206 – Impact Performance Requirements for Flat Safety Glass and Safety Plastics for Use in Buildings. The Concessionaire shall state the design on which his glazing thickness is based.

The Concessionaire shall provide the factors of safety for particular elements attained in the structural calculations for the glazed panels which shall comply with the design loads as stated in clause 2.1.5. The design of the glazed system shall include an inclined ladder load, as used by one man for cleaning and maintenance purposes, at any point both inside and outside the PSD.

The platform side of the PSD assembly shall be 'flush' glass to glass to mullion/transom. Design details should be such that the gradual build-up of dirt and dust is prevented.

2.8.2 Doors and Panel Sealing

All seals used throughout the PSD system shall be of a material designed to provide for ease of maintenance, adjustment and replacement. The compression range of door and panel seals shall be sufficient to accommodate the total displacement of the frame from deflection, material tolerances and wear tolerances on components. Seals shall be securely fixed avoiding the use of loose fasteners or adhesives.

The sealing systems and methods of application shall provide resistance to gas transmission through the barrier.

2.9 Door Operation, Control and Detection

2.9.1 The Concessionaire shall provide full functional details of the door opening and closing procedure.

2.9.2 Door operation shall be provided remotely from the train driver console of a correctly berthed train or from a PSD Local Control Panel (PSL) located in the non-revenue platform headwall / Tail wall area. Driver confirmation that passengers are clear of the doors may be assisted by CCTV facilities.

2.9.3 Door control shall be provided via a Door Control Unit (DCU), PSD Central Control Panel (PSC) and PSD Local Control Panel (PSL).

2.9.4 Door operating and control arrangements shall be designed to fail in safe condition which, would typically be closed, but shall be as dictated by the emergency evacuation procedures.

2.9.5 Provision shall be made for an audible warning to be made prior to the doors closing. The intensity and the type of sound signal and voice generation system when doors are opening and closing must comply with the requirements of the National Policy for Persons with Disabilities - 2006. Similarly, a visual indication lamp clearly visible from any position on the platform shall illuminate above each doorway when a PSD door-set has not locked.

2.9.6 The door speed shall be variable. Opening and closing speeds shall be a function of the door size, velocities and the panel mass. Final value shall be dependent on the Concessionaire's design for dynamic safety.

2.9.7 The PSD system closure mode shall apply a positive closure force, which can be manually overcome in the event of trapping people or obstacles. Typically this shall be 150N per leaf.

2.9.8 Any PSD which has been manually released from track or platform side shall have a gentle re-closing force, against which it can be pushed or held open. This shall ensure that the door returns safely to the closed and locked position afterwards, without need for staff intervention. For powered doors, the time delay for re-closing shall be adjustable between 0 to 120 seconds.

2.9.9 The Door Control Unit (DCU) shall control the PSD motion profile. The profile is fully configured and by selecting different door speeds, opening/closing times and the distance at which the doors commence to ramp down from full speed to a slower speed, the appearance, speed and force can be changed.

2.9.10 Each powered door-set shall be provided with a manual door override key switch, located in the header box. The key switch shall be removable at the three positions; automatic, manual and isolated. The DCU shall also control the following functions: -

(1) Obstacle detection

(2) Automatic re-opens

(3) MSD/EED Interlock Override

(4) System Failure

2.9.11 A PSD Central Control Panel (PSC) shall provide a central connection point at each station for all control and monitoring signals within the PSD system. One PSC shall be provided for each PSD installation.

2.9.12 The main functions of the PSC shall be as follows: -

(1) Provide automatic operation of the PSD when the train is proven to be at a standstill.

(2) Allow local control via the PSD Local Control Panel (PSL)

(3) Provide all doors closed monitoring and alarm signals to the Train Control System.

(4) Provide a display of the status of all alarms inside its memory.

2.9.13 A PSD Local Control Panel (PSL) shall be provided on each platform located in the non-revenue area of the platform and accessible only by the train and station staff.

2.9.14 The main functions of the PSL shall be: -

(1) Manual opening and closing of PSD individually or collectively.

(2) Indication of door system status and interlock override function.

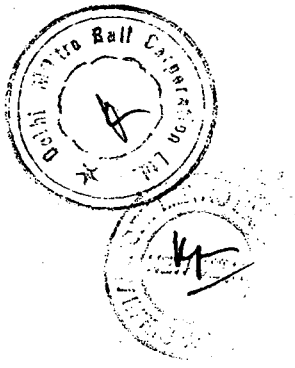
2.10 PSD Emergency Power Supply

2.10.1 Back-up power to the PSD shall be provided via a UPS which shall be capable of providing 30 minutes of quiescent load to all DCUs plus at least two complete door Open/Close cycles by all doorways. In the case of pneumatic operation of the doors, the compressor set accumulator capacity shall be sized to provide the same standby door operation.

2.11 Electrical Protection

2.11.1 All elements of the PSD shall be grounded to the station earth.

END OF SECTION 2



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3 Tunnel Ventilation

3.1 General

3.1.1 Tunnel Ventilation System (TVS) shall be designed and provided to all the underground tunnel sections of the AMEL, in conjunction with the PSD installations on each platform of the underground stations, as follows:

i) New Delhi Railway Station to the portal at Buddha Jayanti Smarak Park including New Delhi and Shivaji Terminal Stations';

ii) the cut and cover tunnel sections between Palam Siding and NH8 Station;

iii) the cut and cover tunnel section between NH8 Station and IGI Airport Station; and

iv) tunnel section between IGI Airport Station and Dwarka 21 Station.

v) Tunnel connection from mainline tunnel at Dwarka to Dwarka Depot.

The Concessionaire shall conduct engineering studies to establish appropriate TVS arrangements, including any requirement of mid-tunnel ventilation building between Shivaji Stadium Station and the portal at Dhaula Kuan. The studies shall state all assumptions and address each underground section of the alignment; study reports shall be submitted to DMRC for Approval.

3.1.2 The TVS shall be used for cooling of the tunnels under congested operating conditions and/or extreme climatic conditions and for emergency smoke control in the event of a fire. Tunnel ventilation fan capacities shall be designed to maintain minimum tunnel face velocity allowing for the effects of hot smoke and induced draughts from adjacent tunnels.

3.1.3 Natural ventilation shafts shall be designed and constructed as part of the DMRC works and shall connect to the running tunnels at each end of each of the stations. The shafts shall provide for draught relief/tunnel ventilation exhaust and fresh air intake. With PSD installed at the stations, all natural ventilation shafts are open to atmosphere. This allows for the free exchange of air between the running tunnels and atmosphere.

3.1.4 The Concessionaire shall equip the natural ventilation shafts with dampers such that in open mode air exchange caused by train movement in the running tunnels shall be via the natural ventilation shaft to atmosphere. In closed mode dampers shall divert the airflow to and from the running tunnel via the tunnel ventilation fans to atmosphere.

3.1.5 In designing the TVS the Concessionaire shall take note of the System Technical Requirements – Schedule D, Part III, Chapter 1 to provide uniformity and interchangeability in the capacity and type of the tunnel ventilation fans.

3.1.6 Principal operating modes for the TVS shall be: -

(1) Normal Operation when trains and passengers are moving freely through the system.

(2) Traffic Congested Operation when one train per ventilation section has been brought to a stand in a running tunnel.

(3) Emergency Fire Operation when there is exceptional heat loading and/or smoke due to a train fire anywhere in the system.

3.1.7 The TVS shall also be available for maintenance operations during engineering hours when the system is closed to normal traffic, but may be occupied by work trains

3.1.8 The control system shall be designed and programmed to configure and operate the TVS, including the dampers, in line with the operating scenarios developed from the Concessionaire's ventilation computer model.

3.2 Tunnel Ventilation - Principles of Operation

3.2.1 The design of the TVS shall be based on the following operations: -

1) Normal Operations

Normal operations prevail when trains run through the tunnel system unimpeded at normal operating speeds in accordance with the normal service timetable. Normal operations shall be undertaken with open draught relief shafts.
During normal operation the Concessionaire must consider three issues in his tunnel ventilation design. These are, the flow velocities produced through Platform Screen Doors (PSD) when they are open, the air temperatures arising

from the dissipation of energy in the tunnels and the transient pressures generated by train movements through the tunnel system. Design parameters for these criteria are given in the table in paragraph 3.6.

When trains come to rest and the doors open, airflows are produced through the PSD's by the train induced flows in the running tunnels. The flows can affect the comfort of the passengers and staff. The system design shall ensure that they are not excessive. These flows shall be alleviated by the natural ventilation shafts connected to the running tunnels.

Tunnel air temperatures increase during normal operations due to significant quantities of heat being deposited into the tunnel by the train. This arises from the traction energy required to overcome aerodynamic and mechanical resistances, inefficiencies within the power units, energy losses due to braking, power transmission losses, lighting, the metabolic rate of passengers and the auxiliary equipment on the trains including the air conditioning.

The level of energy dissipation varies with the intensity of the train service throughout the day. As a result, the train pattern with the level of passenger occupancy needs to be simulated. The effect of hot air drawn in through the natural ventilation shafts from outside has an important effect on the tunnel air temperatures. The hottest conditions occur during situations when there are sustained periods of high daily ambient temperature. It shall be demonstrated that acceptable environmental conditions exist in the system for both the design summer ambient temperature and heat wave conditions. The Concessionaire shall ensure that the tunnel temperatures likely to exist during these conditions shall not damage the function of the vehicle air conditioning systems.

Roof mounted ACUs, facility inverters, traction voltage inverters or braking resistors are employed at Trains. The use of a system to remove the heat from above and below the trains shall be proposed as indicated in the Specification, section for ECS, Ventilation of Public Areas. This system shall be employed as appropriate to augment the role of the natural ventilation shafts to achieve acceptable tunnel environment temperatures when the train is in the station.

Positive cooling in the running tunnels such as the use of evaporative cooling, refrigeration and chilled water cooling add to both the capital and running costs and shall not be offered.

2) Traffic Congested Operations

During traffic congestion in the running tunnels caused by operating difficulties and equipment failure, high condenser-on temperatures and unacceptable temperatures and humidity levels arise within the vehicles. Heat from the hot traction and braking equipment, the metabolic rate of the passengers and the energy dissipated by the onboard equipment (lighting and air conditioning) all add to the heating of the environment around and within the trains.

Forced ventilation from the TVS shall be provided to ensure that satisfactory temperatures are maintained in the tunnels. For an air conditioned train the external temperature should not be allowed to exceed a temperature which may impair the operation of the vehicle air conditioner.

During traffic congestion, the main tunnel ventilation fans shall be activated to provide ventilation if the temperature of the air in a particular section of tunnel exceeds a pre-set limit. During the congestion mode, the dampers in the natural ventilation shafts shall be closed to allow fan discharge to atmosphere.

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Control of the tunnel temperatures during congested operations is dependent on the prompt switching on of the TVS fans. Any delay to do so shall cause tunnel temperatures to rise above the maximum allowable temperature. The control system should therefore be designed for rapid response in such a situation, with preference being given to a system of automatic control from temperature sensors located in the running tunnels.

3) Emergency Fire Operations

A basic requirement for the TVS during emergency fire operations is to establish clean air routes to allow fire-fighting crews to approach the fire and passengers to escape to safety through airflow uncontaminated by smoke. To do so, it is necessary to ensure that the ventilation system is capable of providing an airflow, which exceeds the critical velocity for back layering. Back layering being the condition where the smoke generated by the fire flows against the imposed airflow causing dangerous conditions for fire fighting crews and evacuating passengers.

Where there may be difficulty in generating the necessary critical air velocity to prevent back layering, for instance at tunnel portals and cross over with or without pocket track, the use of additional jet fans shall be considered.

For a train fire in a section of the running tunnel, the tunnel ventilation fans, fore and aft of the train shall be operated typically in a push pull mode to drive smoke away from the train. The operator at the route control room shall configure the tunnel ventilation fans to drive the smoke in the appropriate direction depending on the position of the fire, the location of the nearest escape route and the circumstances of the incident.

In the case of a fire on a train in a station platform tunnel, the main tunnel ventilation fans and track way exhaust fans (OTE) shall be run in the most appropriate direction to establish clean air routes through the open PSD's for passengers to escape through the station to street level.

The Concessionaire shall provide coherent TVS operation strategies and the relevant fan configurations for train fires in various locations both at stations and between stations. For preference these operational modes shall be presented in tabular form. These operational modes shall be included into a pre-programmed sequence of automatic operation of the TVS in response to selected scenarios.

3.3 TVS for Maintenance

Where forced ventilation is required during maintenance to maintain satisfactory levels of air quality and where diesel powered equipment is involved during the maintenance operation, protection to the fans and their attenuators shall be provided.

3.4 Ventilation Shafts

3.4.1 Draught Relief Shafts

Natural ventilation/forced ventilation shafts shall be sized to reduce to acceptable levels, the flows through PSD and for limiting system temperatures. See paragraph 3.6 for these parameters.

Natural ventilation/forced ventilation shafts shall be elevated to at least 3m above street level and protected by dense double layered grids to prevent penetration of dangerous substances. Openings shall be 40mm x 50mm with 200mm between grids. Shafts shall be sized to minimize pressure losses and shall be designed to accommodate a rain water drain. There shall be no interaction between the flows at the atmospheric ends of the shafts and adjacent buildings.

Draft relief/forced ventilation shafts shall have a 2-hour fire resistance rating except where there is any other structure in their vicinity when they shall have a 4-hour rating. They shall comply with NFPA 130; 2007 standards, 90A, 92B and other relevant standards.

3.4.2 Emergency Exit Shafts

Emergency exit shafts shall be provided where it is not possible to utilize cross passages for emergency evacuation. Emergency exit shafts shall be designed in accordance with NFPA 130; 2007 standards, be equipped with doors that isolate the shafts from the running tunnel during normal operations and be provided with a pressurization system. The doors shall be fire rated door with design considerations for pressure transient effect during normal operation. The stairways shall be designed to comply with NFPA 101.

3.5 Computer Simulations

3.5.1 The tunnel ventilation design shall be carried out by the Concessionaire using an accredited tunnel ventilation computer simulation program to provide aerodynamic, thermodynamic and fan performance data at elevated temperatures.

3.5.2 Using this program the tunnel ventilation airflow requirements in each of the three operating modes indicated in paragraph 3.2 shall be calculated from the ventilation computer software. The results from these simulations shall also confirm the sizes of the draught relief shafts and calculate tunnel and train heat flows.

3.5.3 In addition, three-dimensional computational fluid dynamics simulations shall be undertaken to demonstrate the effectiveness of the ventilation system in controlling the heat and smoke from train fires. Simulations shall be performed for the following scenarios: -

(1) A train fire in a below ground station, with the PSD open and closed.

(2) A train fire in a typical mid-station segment of the running tunnel

(3) A train fire in dissimilar sections of running tunnel between all underground stations.

3.5.4 The Concessionaire shall carry out computational fluid dynamic simulations to analyse the effects of the pressure transients caused by the high-speed trains, in particular at the tunnel portals. If the magnitude of the pressure transients violates the permitted value for trains, pressure control strategies and/or measures shall be employed at the Concessionaires cost and coordinated with Civil Contractors to reduce the effects of the pressure transients to an acceptable level.

1.1.1 3.6 Design Parameters and Standards

3.6.1 Typical design parameters for the tunnel ventilation, which shall be applicable across the whole ventilation system design, are indicated in the table below. They shall comply with NFPA 130:2007 standards.

Table 3.6 Design Criteria

ITEM	CRITERION	VALUE	NOTES
1.	External Air Velocities from Ventilation Shafts		
a.	Where the public are exposed to the airflow	2.5 m/s	
b.	Weather louvres	2.5 m/s	Face velocity
c.	Other openings	5 m/s	
2.	Station and Tunnel Air Velocities		
a.	Maximum public area air velocity	5 m/s	
b.	Maximum public area air velocity in emergency mode.	11.2 m/s	NFPA 130; 2007 standards.
c.	Train/tunnel annulus critical velocity in emergency mode	15MW - for Metro stock	Heat release rate to be specified by Concessionaire
d.	Maximum Airflow Velocities through open PSD.	5 m/s	Except Emergency
3.	Station and Tunnel Temperatures		
a.	Maximum tunnel air temperature for normal and congested running	46°C	

ITEM	CRITERION	VALUE	NOTES
b.	Maximum temperature in escape routes in emergency	60/49°C	NFPA 130; 2007 standards.
c.	Design outside air temperature	43°C	Summer temperature
d.	Design station temperature	26°C	Non tunnel side of PSD
4.	Transient Pressures		
a.	Maximum transient (isolated) pressure pulse	0.7 kPa/1.7s	Requirements of 4a and 4b are mutually exclusive
b.	Maximum repeated pressure pulse	0.41 kPa	

3.7 Tunnel Ventilation Fans

3.7.1 Main Tunnel fans

Two or more fans shall be provided per forced ventilation shaft located in a ventilation plant room. Sufficient flexibility shall be provided in the system design such that, in the event of the loss of one fan, the design performance of the various responses of the TVS shall be maintained.

Fans shall be direct drive reversible axial flow type with a capability of starting, stopping, or reversing the direction of flow at any time. Provision for manual adjustment of the pitch of the individual fan blades shall be provided.

Fan-motor unit performance shall be rated for the airflow and total pressure at a maximum air density of 1.2 kg/m3. The fan efficiency shall not be less than 65% and fan motor efficiency shall not be less than 90%.

Fans shall be capable of operating continuously at specified design points for forward and reverse flow. Fans shall not operate in stalling range of fan performance curve during parallel operation (forward or reverse direction).

Fan performance shall not deviate more than 10% between forward and reverse flow.
Fans shall be capable of starting from a standstill to full speed, in not more than 20 seconds, and shall be capable of reversing to full speed from either direction of airflow within 60 seconds after energizing of the motor for the reversed rotation.

The fans shall be rated for continuous operation at a temperature of 250°C for one hour. The cables used for the feeders from the essential bus to the fan motor control centre and including all inter connecting feeder cables from the station control centre to the motors shall be considered as fire survival cables and tested at 950°C for 3 hours. Cables shall be of the FRLSOH type and comply with the relevant International Standards.

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3.7.2 Jet Fans

Where jet fans are installed, the entire jet fan-motor and sound attenuator assemblies shall be constructed such that they withstand the environmental changes caused by the passing of subway trains. Support systems shall be selected to ensure that the operating weight and axial thrust generated by fan on their supports does not exceed the maximum acceptable limit indicated by the Concessionaires design calculations.

Fan units shall be of the axial-flow type, direct-driven by internally mounted single speed motors which are capable of delivering air in both the forward and reverse direction of airflow when the motor rotation is reversed.

For emergency operation the entire jet fan-motor-sound attenuator assemblies including the fan hangers, supports, emergency stop button and cables etc., shall be rated for continuous operation at 250°C for a period of one hour.

Fans shall be capable of satisfactorily withstanding the effect of all stresses and loads under starting, operating and reversing conditions.

Fans shall be capable of developing the requisite thrust and exit jet velocity, in either direction of motor rotation

Fans shall be capable of reversing airflow in sixty seconds or less, from full speed forward to full speed reverse or vice versa with a maximum de-energized period of 30 seconds between reversals. This capability shall include reversing airflow direction several times during any one hour of continuous operation with an airflow temperature of 250 °C.

3.8 Motorized Dampers

3.8.1 Dampers shall be provided to control air flows from the main tunnel fans for the various modes of operation including emergency and congested operation. Pneumatic operated dampers are recommended, suitable for installation in either a vertical plane or a horizontal plane, as required. The dampers shall be closed from open status (or vice versa) within 60 sec.

3.8.2 The damper and its motor assembly shall be rated for continuous operation at 250°C for one hour. Damper limit switches shall be similarly rated. Cables shall be rated as for the TVS fans as indicated in paragraph 1.7. Dampers and components shall be capable of withstanding the stresses caused by pressure transient pressures from train piston action and by reversal of airflow and thermal shock caused by temperature changes of from 0 to plus 250°C during this period. The dampers shall maintain the same fire resistance property as the wall where they are mounted on when the dampers are in closed status.

3.8.3 Damper and motor assembly shall be capable of continuous operation for a minimum of 100,000 cycles.

3.9 Control Systems

3.9.1 Tunnel ventilation system controls shall have provisions for automatic, manual, local and remote control. The tunnel ventilation fans shall operate in automatic mode in conditions of traffic congestion. The ventilation system shall be operated and monitored through the SMS system.

3.9.2 Features of the system shall include: -

(1) Operation of the fans centrally from the OCC

3.9.3 The control system of TVS shall be provided with the following control requirements:

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Control location	Mode control function	Individual equipment control function	Level of control priority
Workstation at OCC	√	-	1
VCP	Congested and Emergency modes only	√	2
Workstation at SMS	√	√	3

Remarks: The control location with higher level of control priority (e.g. level 1) shall be able to override the control commands given from another control location with lower level of control priority (e.g. level 3)

3.9.4 The Concessionaire shall provide mode diagrams showing the operation of all fans and dampers for all operating conditions (normal, congestion, emergency and maintenance) as described in paragraphs 3.2 & 3.3.

3.10 Noise Parameters

3.10.1 Sound attenuators shall be installed in the TVS to control the noise due to the operation of the fans and mechanical equipment. Mechanical equipment and systems shall be designed so that maximum noise levels generated and transmitted by the systems shall comply with the relevant International Standards and the Local Codes of Practice for the Environment.

3.10.2 External radiation of the sound shall be calculated by square law radiation modified for source directivity, ground absorption, temperature inversion and any obstructions by a method based on ANSI S12.8-1987.

END OF SECTION 3

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CHAPTER 9

BUILDING SERVICES SPECIFICATIONS

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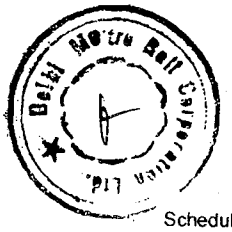

1 General

1.1 Specification

This Specification stipulates the performance requirements for the Building Services to be designed, constructed, commissioned and operated and maintained by the Concessionaire for the Airport Metro Express Line (AMEL)

1.2 Reliability and Maintainability

1.2.1 The Building Services shall be engineered for a minimum operational life of 20 years with the exception of any consumables which shall have an operational life of at least 5 years.

1.2.2 The Concessionaire shall ensure that the equipment supplied shall achieve the availability and maintainability standards as laid down in the General Technical Specification Schedule D, Part III, Chapter 1, and shall always be under good repair within the environmental conditions prevailing where installed.

END OF SECTION 1

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Delhi Metro Rail Corporation Ltd.

2 ELECTRICAL SERVICES

2.1.1 General

The electrical power design shall comply with the relevant current International Standards, Local Codes and Statutory Requirements

The Railway E&M equipment shall be classified into Essential equipment and additionally supported by UPS and Diesel Generator set, and Non-essential equipment. Essential equipment shall comprise the Metro Railway System safety and operationally critically facilities.

The LV power system shall comprise of 415 V, 3 phase, 4 wire supplies derived from the 33/0.415 transformers of the HV Auxiliary System ring, provided by the Concessionaire.

Emergency backup supply shall be supplied in the form of a UPS system and a Diesel Generator at each station.

The LV power supply system shall include: -

(1) MCC/LV switchboards / distribution boards and associated cabling

(2) All LV supply routes for designated services, systems and cable galleries / ways in the stations and tunnels including brackets and trays.

(3) Lightning protection

(4) Normal lighting

(5) Emergency lighting for stations and tunnels

(6) Automatic Power Factor Correction System to 0.95 lagging

(7) Earthing and Bonding System

(8) Lightning Protection System

A power system analysis shall be provided to verify that all equipment chosen is rated for the voltage, current and fault duty to which it is exposed. The information to be considered shall include: -

(1) Equipment and component sizing e.g. MCC's, panel boards, switchboards, transformers and cables.

(2) Load flow analysis e.g. load study calculations, power factor correction, protection co-ordination, short circuit calculations, voltage drop and regulation.

(3) Earthing and Lightning Protection System e.g. earthing / current resistance, lightning protection, step and touch voltages.

(4) Cable ducting and trunking including cable tray sizing, conduit/tray fill calculations, manholes/ draw box sizes.

(5) Indoor lighting calculations, outdoor lighting calculations and emergency lighting calculations.

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(6) Circuit breaker rating and sizes, wire and cable sizes

2.1.2 Low Voltage Distribution

The power supplies shall be distributed at either 415V three phase and neutral or 230V single phase and neutral as necessary. Where any other voltage is required for a particular piece of plant, the conversion shall be carried out via dry type transformers to allow the use of power from this source.

The distribution system shall be designed to supply power with a variation of +/- 10% in the worst case, including regulation of the transformer. All equipment, cables and components comprising the distribution system shall be designed to operate at a nominal temperature of 50°C.

All cables shall comply with IEC 331-1. All cables for the TVS shall be classified as fire survival cables as defined in section 1.1.5.

The distribution system shall comply with national and international standards with respect to electromagnetic compatibility, corrosion protection, stray current corrosion and radio frequency interference (RFI) criteria EN 50122-2, EN 50081 and EN 50082 for electronic equipment and CENELEC EN 50121 for fixed power supplies.

The 415V 3 phase 50Hz power supply shall be connected to the main distribution board (MDB) room at each station. From there it shall be distributed as required and include the provision of feeders to the plant rooms from the station UPS as required.
Power panels, emergency lighting panels and normal lighting panels in the MDB room shall also be provided and cabled to sub (lighting and power) distribution boards in the vicinity of the rooms concerned.

2.1.3 Switchgear

All assemblies of switchgear and control gear shall comply with EN 60439-1 or approved equivalent

2.1.4 Circuit Breakers

Circuit breakers shall comply with IEC 890, IEC 947, and EN 60947 or approved equivalent. Any circuit breakers shall have the design uninterrupted current rating (when enclosed in its operating environment with its rated operational voltage) the same as that specified for the switchboard. The circuit breakers shall also meet the fault conditions specified for the board.

Low voltage air break switches shall comply with IEC 408 with an uninterrupted rated duty and utilisation category, AC 23A.

Miniature Circuit Breakers shall be in accordance with IEC 898, BS 5486-12 or equivalent, the current rating and type of unit shall be appropriate to the application with nominal voltage to earth of 230V. The minimum category of duty for units of 50 amps and below, shall be 9kA (M3) and for all others Moulded Case Circuit Breakers (MCCB) shall be used.

All MCCB shall have a 50kA rupturing capacity. When necessary, feeder circuit breakers shall incorporate reverse current tripping.

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All switches and isolators shall be lockable in the OFF position. Switches for 'emergency', 'essential' and 'semi-essential' shall, where necessary to maintain the service, also be lockable in the closed (ON) position.

Contactors shall comply with IEC 947-1 (5.5.4) and be of the break type having an uninterrupted rated duty and utilisation category AC3.

2.1.5 Switchboards

Switchboards shall comply with IEC standard 439/1.

Switchboards shall be located in dedicated electrical equipment rooms, battery rooms and closets. Switchboards shall have sufficient space to house switchgear, control gear and components, sufficient spare space capacity shall be provided for possible future expansion. Adequate degrees of protection shall be provided for the equipment dependant on their location Typically these would be: -

- IP 54 for outside installations but installed within an enclosure rated to IP 65
- IP 54 for installations at mid section.
- IP 54 for installations at platforms.
- IP43 for installations at concourse level or in plant rooms.

The short time withstand current of the switchboards shall be 50kA for 1 second and have a fault withstand classification of Class 3 for a supply voltage of 415V AC between phases, at 50Hz.

Switchboards shall be installed in technical rooms with fire suppression systems as indicated in Specification sections relating to ECS, Gas Flooding and Fire Detection and Suppression.

2.1.6 Cabling

All cabling materials and installation shall comply with the requirements of IEC 331-1 and for fire resistance use shall comply with IEC 60331 and BS 6387 Category CWZ. In addition they shall comply with NFPA 130; 2007 standards.

Cables shall be selected after full consideration has been given to duties, which they shall be required to perform, and the conditions to which they shall be exposed. They shall be rated to carry the continuous current required by the system design and carry the short circuit currents applying to the scheme design. The ratings applied to any circuit shall be determined by the most onerous installation condition of any cable route.

The layout of the cabling and associated trunking and tray work shall be designed to minimise the effects of temperature. Cables shall not be installed in either exposed or surface mounted air plenums, which may carry air at elevated temperatures during fire emergency conditions. All conductors shall be enclosed in their entirety in armour sheaths, conduits, cable trays, boxes or cabinets which shall be capable of being subjected to temperatures up to 50°C for 1 hour. Sufficient spare capacity shall be provided for all cable trays, trunking, cableways and brackets for future expansion.

Cables for use on the 415V AC system shall be multi stranded copper cored. Cables within underground sections and stations shall be of fire retardant, low smoke, halogen free, FRLSOH type to IEC 60754-2 and smoke density to IEC 61034. Cables for above ground, open areas may be of XLPE type.

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Armoured XPLE insulated underground cables shall comply with BS 6346. Heat resisting cables shall comply with BS 6007.

All cables that have a voltage to earth exceeding 60V applied to them (except from welding transformers to welding electrodes) shall have a metal sheath and/ or armour which shall be continuously and effectively earthed.

All cables that have a voltage to earth exceeding 12V but not normally exceeding 60V shall be of a type that is insulated and sheathed with a general purpose or heat resisting elastomer.

Flexible cabling to mobile or transportable equipment where the cable is subject to flexing shall be designed in accordance with one of the following specifications depending on the duties imposed on it: -

BS 6708 - Flexible cables for use in Mines and Quarries

BS 6500 - Rubber insulated cables for electric power and lighting

BS 7375 - Distribution of electricity on construction sites

In the case of flexible or trailing cables, the earthed sheath and/or armour shall be in addition to the earth core in the cable.

Wire and cable used in operating vital power circuits to tunnel ventilation and other emergency fans, lights, equipment etc., shall conform to the flame propagating criteria of Type Test of Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations (Institute of Electrical and Electronic Engineering IEEE, page F-9, 1974 Edition, Table 2.5). The fire survival cables shall be tested as per IEC-331 for integrity under fire conditions for a period of 3 hours at 750°C.

Cables shall be installed with adequate clearance from any equipment or pipe work including lagging with other services. Cables shall be installed such that one cable can be removed without the disturbance to cables from other circuits in the same route. Power cables shall be separated from control, signalling and telecoms cables for interference purposes.

2.1.7 Protection Circuits

Interlocking and protection schemes shall be provided which shall be appropriate to the desired operation.

Protection circuits shall be provided for all main and sub circuits against: -

- Excess current
- Under and Over voltage
- Residual current
- Earth faults

The protective devices shall be capable of interrupting (without damage to any equipment or the mains or sub circuits) the short specified maximum short circuit.

Discrimination shall be in accordance with BS 88, BS EN 60898, BS 7375 and any other applicable Standards.

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Separate current transformers shall be provided for each protection device and for instrumentation. Thermal overload protection devices shall not be provided in fan motor control circuits for high temperature rated fans.

Current transformers shall be capable of withstanding the maximum short time withstand current for the value of duration specified for the assembly within which it is mounted.

Test links shall be provided in the secondary connections of all current transformers to facilitate testing of instruments, meters and protection devices.

2.1.8 Metering

Metering units shall be located in a metering room.

All instruments and meters shall be completely segregated in instrument compartments.

2.2 Station and Tunnel Lighting

2.2.1 General

Lighting design shall take into account efficiency, symmetry, applications, glare, glare to CCTV or signage, computer screen environments, maintainability and long life.

The type and quantity of fixture and their luminous intensity shall relate to the space being illuminated and take in account the effect of the architectural concept and colour scheme. Specifically the lighting levels shall be varied as follows: -

(1) At station entrances where passengers enter from sunlit streets a graduation of the lighting level shall be provided.

(2) Escalators and stairways shall be well illuminated.

(3) At platform level lighting shall be compatible with that of the train vehicle. A reduced intensity shall be provided at platform ends (particularly the leading end) to reduce the glare to the driver on entering the station. The need to highlight information panels shall be taken into account and to illuminate the train surface for the ease of passengers when alighting the train.

(4) Track way and Tunnel lighting shall be sufficient to define a path for the prompt safe and orderly movement of patrons, employees and Emergency Services required evacuating the system under an emergency.

(5) When CCTV is being used, particular care shall be taken as to the type and distribution of light fittings.

(6) Luminaries in Control Rooms shall be positioned so that no reflected glare from dials or monitor screens interferes with the operator's vision.

(7) Outdoor lighting shall be provided as required outside stations.

(8) Lighting design shall take into consideration the use of daylight as far as possible for energy conservation purposes and suitable controls shall be provided accordingly.

(9) Multi purpose wall lighting and feature lighting shall be provided to illuminate signage, advertisements and specific areas such as help points and/or Designated Waiting Areas (DWA)

Luminaries shall have the degree of protection dictated by their location. Where luminaries are subject to excesses of dust and water a high degree of protection typically IP 65 shall be

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employed. Mechanical protection of luminaries against damage from impact where ever the risk occurs, shall be provided in the form of wire guards or other such devices.

The light fittings shall not emit toxic gases in the case of fire

Any required illumination shall be arranged such that any failure of any single lighting unit shall not leave the area in total darkness.

In general the luminaries shall have a minimum down light output ratio of 70%.

Lighting levels shall be uniformly distributed throughout as far as possible and be designed to prevent glare, dark recesses and areas of poor lighting levels. The point to point method shall be used for calculations.

2.2.2 Lighting Standards

The lighting system requirements shall comply with following standards: -

BS 5266 - Emergency Lighting

EN 13201- Road Lighting

BS-EN 60598 - Luminaries

Recommended Practice of Illuminating Engineering Society (IES) of North America

Code of Practice for Interior Lighting (CIBSE) and CIE recommendations for Glare Control

NFPA 101 Code for Safety to Life in Building Structures.

2.2.3 Emergency Lighting

Emergency lighting shall be defined as lighting that is provided for use when the LV power supply fails.

Emergency lighting shall comply with the relevant International Standards.

The emergency lighting shall be supplied by normal supplies, through an automatic changeover switch via a UPS. The output of the UPS is channelled through separate circuits to feed each area.

The cabling shall be fire survival type rated for 3 hours at 750°C flame test or equivalent. Emergency lighting shall be provided in all public areas, on escalators and stairways, escape/exit routes including the tunnel walkways, tunnel escape shafts (if installed), tunnel cross passages, control rooms and plant rooms.

In each room at least one luminary shall be connected to the emergency supply. The minimum levels of illumination shall be maintained for at least three hours during the failure of the normal supply of electricity.

2.2.4 Escape Lighting

Escape lighting shall be defined as the lighting for designated escape routes in stations, running tunnels and escape shafts within the underground sections of the AMEL. Escape lighting shall be in accordance with the standards given above in paragraph 2.3.

2.2.5 Illumination Levels

The following table is indicative of the design illumination levels that the Concessionaire shall provide for both normal and emergency lighting levels.

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Lighting levels should not be less than those shown in the table and are indicative only.

Areas	Normal Level Average in Lux	Emergency Lighting Average in Lux
ECS/TVS plant rooms	200	30-45
Signalling & Comm. rooms	200/300	30-45
Electrical switch rooms	200/300	30-45
TSSs & SSSs	200/300	30-45
Escalators and Lifts	150/200	30
Passenger Help Points (DWA)	200/300	30
Operations/control rooms	300/500 (panel face)	30
Running tunnels and escape routes and stairs	20	8-10
Platform (Edge)	250	37.5
Platform (General)	200	30
Concourse	250	37.5
Subways/Passageways	150	15-22.5
Ticket Barriers	200/300	30
Mezzanine	200	30
Staff rooms	150/250	30
Toilets	75/100	15
First Aid room	300	45

2.3 Small Power

Single phase metered power supplies shall be provided, if required, for various areas of the station for the use of retail outlets comprising of vending machines etc.

Provision shall be made for plug sockets and power points for power and lighting in the tunnel and stations areas. Low voltage plugs, sockets and couplers shall be provided for all maintenance power tools, lead lamps etc. and be colour coded in accordance with BS 7375 and constructed to conform to BS EN 60309.

In the tunnel sections provision shall be made for task lighting and socket outlets for maintenance purposes.

2.4 Earthing and Bonding

2.4.1 General

Earthing and bonding shall be provided to: -

(1) Protect personal and equipment from electrical hazards

(2) To achieve a reduction in potential to the systems neutrals.

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(3) Reduce or eliminate the effects of electrostatic and electromagnetic interference on equipment arising from auxiliary electrical systems.

An earth mat shall be provided at each station. Earthing and equipotential bonding shall be provided by the Concessionaire for all electrical installations, to prevent the possibility of dangerous voltage rises and to ensure that faults are rapidly cleared by the installed circuit protection.

The earthing shall be designed to comply with the Local and International Building Regulations to ensure safety of persons. In particular passengers and staff shall be protected from the possibility of high potential to structural earth potentials and carrying fault current to earth. Other design requirements of the earthing systems are to ensure correct operation of breakers and tripping devices and limitation of damage to plant, equipment or system failure and protection against interference. The provision of equipotential bonds shall ensure that touch voltages (between conducting components accessible to persons) during a fault condition do not exceed 60V and to avoid electrolytic corrosion of metal parts and structural elements.

Earthing systems shall be designed to comply with: -

(1)	BS 7671:1991	Requirements for Electrical Installations 16th Edition 1991 issued by the IEE
(2)	BS 7430: 1991	Code of Practice for Earthing
(3)	BS EN 50122-1	Protective Provisions relating to Electrical Safety and Earthing
(4)	BS EN 50122-2	Protective Provisions against the effects of Stray Currents on DC systems
(5)	BS 7375:1996	Code of Practice for Distribution of Electricity on Construction Sites.
(6)	IEEE S 80:	Guide for Safety in AC Substation Grounding – 1986'
(7)	IEEE 1100	Recommended Practice for Powering and Grounding of Sensitive Electronic Equipment

2.4.2 Earthing

One common System Earth shall be provided at each station for the station power supplies. The system provided must ensure that in the event of an earth fault being generated it shall not affect any signalling circuits.

Earth bars/ strips shall be used as common points for all earthing in equipment rooms to which all mechanical and electrical services shall be earthed. Earth connections shall not be made to any other point. Equipment that requires a power supply in running tunnels may be earthed via the firemain which shall be bonded throughout its length.

Armouring and metallic sheaths of all cables emanating from the equipment rooms shall be earthed to the System Earth for that room otherwise they shall be insulated from earth throughout their length. Enclosures and frames of equipment shall be earthed to the metallic sheath or armouring of cables supplying them or to a separate insulted earth cable.

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2.4.3 Main Equipotential Bonding

Incoming service to the stations in metal pipe work or armoured cable shall be fitted with isolating joints as close as possible to the point of entry. On the station side of the joints, the pipe/armour shall be bonded to the main System Earth with earthing cables or tapes. On the incoming side of the joints, the Concessionaire may need to consider whether the pipe/armour should be connected via an earth limiting device to mitigate stray current.

2.4.4 Supplementary Bonding

All sinks, wastes and all metallic connections to sanitary equipment shall be bonded to earth by means of a minimum 10mm earth cable. Bonding shall comply with the requirements of BS 7617. All ceiling space equipment shall be bonded to earth and the final bond taken to the local sub distribution board earth.

2.5 Lightning Protection

2.5.1 General

Lightning protection shall be provided to: -

(1) Protect above ground structures, stations and ancillary buildings from direct lightning strike.

(2) Protect the equipment located within the zone of protection.

(3) Protect personnel working within the zone of protection.

2.5.2 System Design

The lightning protection system shall comprise a network of air terminals at roof level, interconnected with horizontal tapes. The whole air termination system shall be connected to down conductors which shall run outside the building. The down conductors shall be bonded to the buildings main system earths. The bond shall be mechanically and electrically effective and protected from corrosion and erosion by the operating environment.

Any protrusion from the sides of a structure, which obstructs the vertical path of the down conductor, shall be sleeved to allow the conductor to pass through.

The earthing system shall consist of copper or stainless steel earth mats, or a network of specially drawn copper clad steel rods bonded together to give the necessary low impedance.

The whole of the earth termination network shall have a combined resistance to earth not exceeding the recommended designed value in ohms, without taking in account of any bonding to other services.

The lightning protection system for the surface structures of the station shall include air tapes and down conductors and an earth rod/mat system.

Preventative measures shall be taken against side flashing from the lightning protection system.

The lightning protection system shall be designed to comply with: -

BS 6651 – Code of Practice for protection of Structures against lightning

BS 7430 – Code of Practice for Earthing

BS 7671 – Wiring Regulations for Electrical Installations in Buildings.

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2.6 UPS and Batteries

2.6.1 General

UPS systems shall be provided at all stations, and the Depot. Dependant on their location, the UPS systems shall supply some or all of the systems that require high security of supply listed in section 1.6.9.

In the event of a power failure, the UPS shall automatically and immediately commence autonomous operation to maintain the supply of power to the high security loads. Assuming that it is available, the standby generator shall start-up and shall then provide a supply of power to the UPS. In this case, the UPS shall be powered from the generator set. In the event that a generator set is not available, the UPS shall continue to support the high security loads for 30 minutes of autonomous operation.

Although the precise details of each UPS systems shall vary between locations the same basic system operation and functionality is required. Control panels shall be uniform in appearance to assist the station staff in system operation, training and maintenance.

The Concessionaire shall submit a UPS design for the various UPS systems. Within this report, the Concessionaire shall clearly state his design criteria and the assumptions made in deriving them.

The system shall be hierarchical allowing local autonomous operation.

All equipment shall be installed so that it is easily accessible for replacement purposes and terminals are also easily accessible for field cabling. All connection wiring, etc shall be so designed and arranged to minimise the risk of fire and any damage resulting from fire.

2.6.2 Design

The design of the UPS systems shall be based on the most recent proven technology to meet the requirements as outlined in this specification. All system hardware shall be of a type already widely used for this field of application with full service and support facilities available.

The various subsystems to be maintained in the event of a power failure will have different operational requirements in the event of power failure. The Concessionaire shall therefore provide either a centralised UPS or separate UPS systems for various associated systems within stations, depots, sidings, substations, ancillary buildings and control centres as required.

The UPS shall be a dual redundant, on-line type (i.e. output power shall be taken from the batteries at all times other than when a bypass is in operation).

The station UPS systems, (excluding batteries), shall be designed for a service life of 30 years. The batteries shall be designed for a service life of 10 years.

Sufficient installed spare capacity shall be provided to enable the UPS systems functionality to be increased to maintain a further 20% load for the period of required autonomy, for each of the Control and Communications subsystems it supplies. The Control and Communications subsystems shall also be sized and configured such that it shall be capable of efficiently handling all necessary functions required for the initial design with a 100% expansion capability for the future.

The rating of each half of the dual redundant UPS shall meet the following requirements:

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Output	-	To suit the Concessionaires Design Calculations
Duration of autonomous operation (at rated output)	-	30 minutes
Input supply	-	415 V ± 20%, 3 phase
Input supply frequency	-	50 Hz ± 5%
Input power factor	-	0.92
Steady state output voltage	-	415 V ± 1%, 3 phase,
Steady state output frequency	-	50 Hz ± 0.1% (free-running)
Output voltage adjustment	-	± 3
Overload capacity	-	150% for 10 seconds 128% for 10 minutes
Efficiency	-	Better than 90% for loads in excess of 25% of rated load and a power factor between 0.8 (lagging) and unity
Noise generation	-	50dB(A) @ 1.5 m from the UPS cabinet

The UPS systems shall be suitable for continuous operation allowing for a minimum system availability of 99.9%. The system reliability shall be better than 99.9%.

All equipment enclosures located within control rooms and equipment rooms shall meet or exceed a rating of IP54.

The radio interference level from the UPS shall be equal to or better than suppression degree "N" as defined in VDE 0875.

2.6.3 Codes and Standards

The UPS shall be designed to comply with the following standards: -

ANSI S12.34/36Survey methods for Determination of Sound Power levels of Noise Sources

BS 88 Fuses

BS EN 60076 Power Transformers

BS EN 55014 Part 1 Radio Interference Limits

BS 3535 Isolating Transformers

BS 6290 Sealed Lead Acid Rechargeable Single Cells

BS 6387 Specification for performance requirements for cables required to maintain circuit integrity under fire conditions

BS EN 61000 Electromagnetic Compatibility

BS 7671 Requirements for Electrical Installations IEE Wiring Regulations

BS 60146 Semiconductor Converters

BS EN 60529 Specification for degrees of protection provided by enclosures (IP codes)

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IEEE S 519	Recommended Practices and Requirements for Harmonic Control in Electric Power Systems
NEMA ICS-1	General Standards for Industrial Control and Systems
NEMA ICS-1.1	Safety Guidelines for the Application, Installation and Maintenance of Solid State Control
NEMA ICS-2	Industrial Control Devices, Controllers and Assemblies
NEMA ICS-3	Industrial Systems
NEMA MG1-12.54	Efficiency
UL S 508	Industrial Control Equipment
AIEC 285	Alkaline Secondary Cells and Batteries – Sealed Nickel Cadmium Cylindrical Rechargeable Single Cells

2.6.4 Batteries

The battery selected shall take into account, as a minimum, the following criteria: -

(1) Autonomy;

(2) Battery recharging period, following a complete discharge;

(3) Service life.

The batteries shall be either maintenance-free sealed gas recombination lead acid type, nickel cadmium or any other type of battery that shall meet a service life requirements of 10 years with low/no maintenance. The selection of the battery type shall take into consideration the Local Environmental and Health and Safety Regulations.

Batteries shall be suitable for the following charging duties: -

(1) A fully discharged battery shall be charged to 75% of its rated capacity in 5 hours under float charge conditions.

(2) A fully discharged battery shall be charged to 100% of its rated capacity in 10 hours under boost charge conditions.

6.5 Rectifiers

Duplicate rectifiers shall provide a smooth output with filters to remove harmonics. Harmonic voltage distortion presented to the mains supply shall not exceed 5%.

The rectifiers shall have both constant current and constant voltage charging characteristics dependant on the state of charge of the batteries.

The rectifiers shall cease operating when the mains supply falls below the minimum viable input voltage.

Each rectifier shall be rated to meet the full load of charging the batteries together with powering the inverter while operating at rated output.

2.6.6 Inverters

The output of the inverters shall be a sine wave having less than 1% total harmonic voltage distortion content for linear loads, and less than 5% for 100% non-linear loads with a crest factor up to 3:1.

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Each unit shall have a dynamic response such that application or removal of a 100% step load causes an output voltage transient of less than ± 2% with a recovery time of less than 4 ms.

The inverters shall be capable of delivering its rated power into a load with a power factor between 0.92 lagging and unity.

2.6.7 Indications and Controls

A front panel mimic display shall be provided showing the UPS and bypass mode of operation.

The monitoring and diagnostic system shall provide an audible alarm to provide warning and fault indication.

Battery voltage measurement points shall be provided such that faulty groups of batteries can be detected.

Volt-free contacts shall be provided from the UPS systems in order to provide key status information remotely to the Station Management System (SMS).

2.6.8 Static Bypasses

The following static bypasses shall be provided:

(1) Changeover to reserve – this shall operate in the event of inverter failure (or manual operation) to transfer the UPS output to the reserve inverter.

(2) Changeover to mains – this shall operate in the event of UPS failure, inverter overload (or manual operation) when the mains supply is live, to transfer the UPS output to the mains.

(3) Maintenance bypass – this shall be a manually operated switch to take the entire UPS out of service, whilst the UPS loads continue to be supplied directly from the mains supply.

2.6.9 Interfaces with other Subsystems

The design of the UPS systems shall interfaces with the following high security subsystems in the event of loss of main supply. These interfaces shall vary dependant on where the UPS is located e.g stations, ancillary buildings, OCC building or Depot. Such sub systems shall include, but not be limited to: -

- Emergency exit signage
- Emergency lighting
- PSD
- Safety equipment
- Fire detection
- Control and Communications
- PA system
- CCTV system
- SMS system
- Master clock system
- AFC systems

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- Help point system
- FIDS
- Radio system
- Station telephones
- Control centre equipment.

2.7 Diesel Generator

2.7.1 General

The stations and depot shall, if required, be provided with a permanently installed Diesel Generator (DG) set to provide back up supplies. The DG shall be installed either in an underground chamber or an enclosed part of the stations and depot.

The DG shall provide a 415Volt 3 phase, 50Hz, power supply in the event of a loss of supply from the Electrical Supply provider.

The Concessionaire shall size the DG to satisfy the emergency load requirements for all aspects of the stations and Depot operations. This shall include such items as computers, controllers, lighting, ECS, drainage pumps etc.

Average power factor shall be maintained at 0.95 lagging. The engine and alternator shall have an overload capacity of 10% for one hour.

The DG shall be rated for maximum ambient operating conditions shall be during conditions of over 46°C.

The diesel generator set shall be able to start automatically in all climatic conditions and shall take full load within 30 seconds of failure of the normal supply through an automatic change over switch. On resumption of the supply, the changeover to the normal supply shall initiate automatic shutdown.

An Automatic Mains Failure panel shall be connected and provided with suitable interlocking arrangements to avoid any incident of paralleling of normal power supply to the generator set.

The DG sets shall each include alternator, LV switchboard, cooling system, ducted radiator air cooling arrangement, silencer, exhaust system, fire protection and suppression, lighting and an underground fuel supply for 12 hours operation The exact supply may vary from area to area.

Care shall be taken to prevent any ingress of material or debris into any of the outside ducts or louvers.

2.7.2 Design

The generator set shall be designed to provide the following: -

- Low specific fuel consumption
- Low weight (kg) to kVA capacity ratio.
- Low space (sq.m) to kVA ratio.

The diesel engine which may be a two or four stroke either air or water cooled direct injection diesel shall be constructed to BS 5514.

The engine shall be fitted with heavy duty dry type air filters with replaceable elements suitable for operating in a dust laden atmosphere.

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Engine cooling shall be by air blast cooling via a pusher type fan through motorised louvers to atmosphere. A separate oil cooler shall be used for the engine oil.

The alternator shall be 4 pole, 3 phase, salient pole, revolving field, brushless type, self regulating, continuously rated and manufactured in accordance with IEC 60034.

Output shall be 415 Volt. The alternator shall be screen protected, fan ventilated and vertical drip proof to not less than IP 21.

A floor mounted generator control panel shall be provided located within the DG chamber.

The panel shall be complete with all necessary switchgear, alarms, indications and controls. Status and safety alarms shall be provided to relay data to the station control rooms and the OCC.

Wire mesh shall be provided across the air louver inlets to prevent penetration by any objects or debris which may harm the operation of the DG. Guards shall also be provided to prevent accidental contact with the high temperature air.

A suitable fuel storage tank shall be provided for 12 hours operation of each DG set at rated load. Two fuel pumps to transfer the fuel to the day tank inside the DG chamber shall also be provided.

2.7.3 Noise and Vibration

The noise and vibration from the DG sets shall comply with the regulations and standards given in the System Technical Requirements Schedule D, Part III, and Chapter 1.

2.7.4 Automatic Testing

When the DG is on automatic control and has not been run for 7 days, the set shall actuate an alarm, be started and run for a pre-determined period on no load conditions at idle speed.

2.7.5 Design Standards

The following construction standards shall apply as relevant: -

BS 7698	Internal Combustion Engines for AC Generators
BS 5000 part 99	Rotating Electrical Machines for Miscellaneous Applications
BS 2757/IEC 85	Determining the thermal classification of electrical insulation
BS 2869	Fuel oil for non marine use
BS EN 60051	Electrical indicating instrument
BS EN 60255-6	Electrical protective relays
BS 5514	Engine Power Performance
BS 799/2594	Fuel Storage Tanks
BS 4552	IC Engine Fuel Filters
BS 5486-11	Fuse boards (EN 60439-1)
BS EN 60034-22	AC Generators
NFPA 130	Guidelines for Fixed Guideway Transit System

END OF SECTION 2

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3 Environmental Control System (ECS)

3.1.1 General

Ventilation and air conditioning shall be provided for all public areas and ancillary spaces of each of the stations and facility buildings of the AMEL. Platform Screen Doors (PSD) shall be installed at the stations and the heat gain from the running tunnels through the PSD should be taken into account when calculating the cooling load for each station. The Concessionaires own ventilation computer model shall provide data on the airflow rates and temperature rise in the running tunnels to calculate the heat gain from this source.

Temperatures in the station areas occupied by passengers should be maintained at comfortable levels compatible with a modern metro system built in a similar location. Design conditions of 26°C and 55%RH (max) are currently envisaged. This temperature should be compatible with the environment to be maintained inside the trains by the on board air conditioning system. The Concessionaire should note that high ambient temperatures are common in Delhi during the summer months and that heating may be required when station temperatures falls below the design conditions during the winter months.

Building services design for the various fan capacities for supply and exhaust air systems shall take account of the maximum and minimum temperatures, rainfall, wind speed, sunshine hours and relative humidity provided by the ASHRAE fundamentals handbook. The design cooling load shall be based on a maximum cooling requirement of the ASHRAE data and the peak hourly average station occupancy plus afternoon peak operation of trains.

Total cooling load shall also take into account the heat outputs of the fixed equipment (e.g. lighting, transformers, rectifiers, control panels etc.), the heat rejected by trains in stations through the Platform Screen Doors (PDS), outside air infiltration, fans, plant rooms and the tunnel design temperatures. For the purpose of this calculation the Concessionaire shall assume a situation whereby the trains shall be a heavy metro.

Calculations for the required capacities of building services equipment shall generally comply with methods given in the latest editions of the CIBSE guide or ASHRAE handbooks. Ducting design shall also follow good practice as stated in these guides and take into account the velocity and pressure drop design criteria given. Typically the ducting shall be designed to Heating Ventilation Air-conditioning (HVAC) standard DW 144.

The design process shall include failure analysis to demonstrate that acceptable conditions can be maintained by the system in the event of a system failure.

The fan controls for the main Air Handling Units (AHUs) for temperature controlled air supply and extract shall be connected to the Local Sequential Controller (LSC), Ventilation Control Panel (VCP), Station Management System (SMS) and Operations Control Centre (OCC) for remote monitoring of the performance and operation of the units.

In addition to the station air conditioning and ventilation systems, a strategy shall be developed for control of a potential fire in the station and its effects, which may include a smoke control system.

3.1.2 Ventilation of Public Areas

Public areas of a station comprise the entrances from street level to concourse, the paid and the unpaid areas of the concourse, and the platforms.

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AHUs shall provide temperature controlled air for the public areas of the station. The AHUs shall be installed in plant room(s), located in the station box. The plant room(s) shall contain air-handling units AHUs for the supply and return of the temperature controlled air, together with fresh air supply fans to provide a percentage (typically 10%) of fresh air to the AHUs.

A system of ductwork and dampers shall be used to provide ventilating air to, and return air from, the station public areas. These supply and return air ducts shall extend continuously throughout the length of the station.

The AHUs plant room(s) shall be connected to atmosphere by ventilation shafts, a supply shaft that admits fresh air to the plant room for distribution within the station and an exhaust shaft for discharge of used air and/or emergency smoke discharge to atmosphere. Shafts shall be elevated to at least 3m above street level and protected by dense double layered grids to prevent penetration of dangerous substances. Care shall be taken that any emergency smoke discharge does not interfere with the fire fighting and emergency evacuation activities at ground level.

The use of PSD shall isolate most of the air exchange and heat gains from the train and tunnels. The Concessionaire shall however take account of the infiltration and heat load from the PSD wall and allow for a correspondingly larger proportion of the ventilating airflow to the platform areas. The Concessionaire shall consider in his design a system to remove the heat from above and below the train in the station tunnel when it is stationary at the station, to reduce this heat infiltration through the PSD. He shall be required to demonstrate that his design shall work both in theory and in practice.

The Concessionaire shall include for a system of ventilation airflow out of the station to provide a temperature gradient between the street and the station to reduce the thermal shock experienced by passengers on entering and leaving the AMEL and reduce the infiltration of dust into the station.

3.1.3 Ventilation of Ancillary Spaces

The ancillary spaces comprise Station Control Room (SCR), staff accommodation, technical rooms such as LV/HV switchgear rooms, signalling and communication equipment rooms, plant rooms, emergency escape routes, cleaners rooms, toilets, sprinkler plant/tank room and sumps.

The SCR, staff areas and technical rooms shall be provided with temperature and humidity controlled filtered air via supply and return ductwork installations from the AHUs with the necessary percentage of fresh air. An exception shall be technical rooms containing safety critical equipment such as signalling and communication equipment rooms. These shall be maintained at positive pressure supplied by filtered fresh air but with separate air conditioning units to maintain the required designed conditions for the particular equipment. Condensate from the drain pan for these units shall be led to discharge into the nearest gully.

Extract air from the above rooms shall be discharged to atmosphere via the emergency smoke extract shaft/grill, which shall include leaked or used gas used for the fire suppression system. See also Specification, section Fire Detection and Suppression. When smoke is detected in any of the ancillary spaces, the supply and extract fans shall shut down and indicate an alarm condition in the Station Control Room (SCR), Motor Control Centre (MCC) and Fireman's Panels.

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Ancillary spaces other than those defined above shall be provided with fresh air ventilation only. Ventilation supply air in these cases shall be carried out via a ducted system with fresh air supply fans drawing fresh air from the ventilation supply shafts. Extract ventilation air shall be provided via a similar ducted system with the extract fans discharging the used air via the emergency smoke extract shaft/grill. Where both supply and extract air is provided, the extract fans shall be interlocked with the corresponding supply fans.

Such ancillary spaces are listed below: -

(1) Emergency Escape routes

Emergency exit stairs, lobbies and escape corridors shall be pressurised by dedicated fresh air supply fan providing filtered air to keep these areas clear of smoke infiltration.

(2) Cleaners rooms

Cleaners rooms with no false ceilings shall have supply and extract air provided via sidewall registers.

(3) Toilets

false ceiling and/or in the station ventilation plant rooms. The fans shall extract air by ceiling mounted extract grilles, and discharging vitiated air to atmosphere via the emergency smoke extract shaft/grill.

The extract system shall be arranged such that the toilets are held under negative pressure

(4) Sprinkler Plant/Tank Room

The sprinkler plant room and tank rooms where used, shall be provided as a minimum, with a vent to atmosphere.

(5) Sewage/ Seepage Sumps

Sewage/ Seepage sumps shall be provided as a minimum with a vent to atmosphere to compensate for sump level changes. Methane detection shall be provided where there is likely to be methane contamination of the seepage water. Similarly, radon gas detection shall be provided.

3.1.4 Station Smoke Control

The requirement for smoke control in the stations shall be determined as part of the overall station fire control strategy as described in the Specification, Section for Tunnel Ventilation. The design, installation and operation of any smoke control system proposed by the Concessionaire shall be subject to the approval of the Local Fire Authorities.

Stations shall be considered on an individual basis to ensure that the station geometry and aerodynamic characteristics always provide airflow along the escape route. This detailed examination of stations combined with the three dimensional fluid computational dynamic simulations shall demonstrate which shall be the preferred method of smoke control.

Smoke control fans shall extract from the concourse area through smoke extract ducting which may either be a separate duct or be used as the return air duct to the main AHUs. Appropriate smoke control dampers shall be provided to control and direct these contaminated airflows if the latter option is considered.

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The station smoke control system shall be designed using any relevant design procedures given in ASHRAE: Design of Smoke Management Systems, 1992, and NFPA 130; 2007 standards, NFPA 90A and NFPA 92B.

(1) Smoke Control at Platform Level

The principal fire load at platform level is the train. The tunnel ventilation emergency fire control system shall be designed to cope with such a train fire as described in Specification section for Tunnel Ventilation.

The ventilation strategy for a smaller size platform fire should aim to remove the smoke from the platform level to induce airflow down through the station and the escalators, to provide conditions of clean air for the evacuation of the passengers to the surface and for the subsequent intervention of the emergency crews.

3.1.5 Gas Flood Extract Systems

Where a dedicated fire suppression gas flood extract system is installed in technical rooms including sub-stations at stations, each system shall comprise a ducted exhaust system with extract fan discharging to atmosphere via the corresponding emergency smoke extract shaft.

Make up air shall be introduced via dampered air inlet grilles. And the extract openings shall be at the appropriate level for the density of the gas being used.

The operation of the gas flood system shall be either by means of automatic fire detection or by manual means. A fireman's switch at the entrance to each of the rooms shall be the manual means by which the gas flood extract fan can be operated. The extract fans can also be energised automatically via a room oxygen sensor and radon gas sensors installed in each room. Activation of the fire detector shall deactivate the supply and extract ventilation fans in all rooms where gas flood systems are installed.

The Concessionaire shall ensure that he includes adequate provisions for gas retention and prevention of gas migration via the ducting. This shall include the sealing of all M&E equipment penetrations with approved fire resistance materials.

The Concessionaire should note that the requirement for a gas flood system does not apply to panel protection systems.

3.1.6 Air Handling Units

All AHUs shall contain cooling coils in addition to the filters and fans. They shall also include a mixing chamber for the fresh air supply and the return air. The coils handle chilled water, provided by refrigeration plant, to cool and dehumidify the ventilating airflow to obtain the required temperature and humidity. Additional equipment shall include sound attenuators that control the noise generated by the fans to acceptable levels. Filters shall be provided that remove dust from the fresh air drawn into the plant room, and also from the air returned to the plant room from the public areas on the station side of the PSD. All the supply and return airflows in the plant rooms shall be ducted.

3.1.7 Chilled Water Refrigeration Plant

A chiller/cooling tower systems with a minimum of 2 x 50% chillers shall provide chilled water to the air handling units for the station air supplies and to fan coil units where required for individual rooms. There shall be provision for water treatment for the cooling tower for health reasons and treatment of the chilled water for corrosion control. Make-up water supplies shall be provided, as shall an expansion tank for the chilled water circuit.

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Chilled water cooling towers shall comply with BS EN 4485 or equivalent international standard.

Where air cooled condensers are used and mounted outside buildings they shall have weatherproof fan motors and shall discharge air vertically upwards. If specified to discharge horizontally, then they shall be protected by an integral wind deflector or purpose-made baffle.

Heat exchangers shall be designed for the necessary heat transfer capacities but shall include additional capacity to account for fouling condition.

The cooling towers shall be selected to meet the specified peak heat rejection rate, based on the entering and leaving water temperature and the maximum extreme ambient wet bulb temperature. The Cooling Tower Institute shall certify the heat transfer capacity.

Where the water requires treatment prior to use it is the Concessionaires responsibility to fulfil the requirements of the Local Authorities.

Materials used in the construction of the refrigeration plant shall withstand the corrosive effects of the water and prevent the build up of calcium and lime deposits. Where the cooling tower is to circulate treated wastewater effluent or brackish well water, all components must be capable of withstanding their corrosive effects. Measures shall also be taken against insect and fungus attack.

The water distribution system shall be easily cleanable to minimise collection of deposits and growth of algae, which might encourage the growth of "bacteria", and also be protected by a strainer.

Water distribution pipe work shall follow the applicable requirements in the Specification for Plumbing and Drainage Section. Pipe unions shall be fitted where necessary to facilitate maintenance in addition to those required for erection purposes.

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3.1.8 Noise

Sound attenuators shall be provided in air distribution ductwork as required to reduce the airborne noise due to the operation of the mechanical equipment. Mechanical equipment and systems themselves shall be designed so as to minimise the noise levels generated and transmitted by the systems.

Typical noise criteria which are to be expected are given below: -

Area	Noise Criterion	Equivalent A-Weighted Sound level dB(A)
Ticket Booth	NC-45	53
Locker Rooms	NC-45	53
Terminal Station	NC-45	53
Office and Staff Rooms	NC-40	44
Toilet Rooms	NC-45	53
Communications Equip. Room (Note 3)	NC-50	58
Signalling Equipment Room	NC-50	58
Computer Room	NC-45	53
UPS Room	NC-60	67
Station Retail Areas	NC-45	53
Meeting Room	NC40	44
Maintenance Room	NC-45	53
Plant Room Equipment (Note 1)	NC-75	83
Plant Room Ventilation (Note 2)	NC-65	73
Check-in areas	NC-40	44

Notes:

1. Refers to noise from equipment located in plant room such as large fans, compressors, etc., measured 1.5m above floor and 1.5m from equipment casing.

2. Refers to noise from the ventilation system for the plant/equipment room itself. Measured 1.5m above floor.

3. Refers to rooms used primarily for computer and communications equipment. Rooms with desktop PCs are to be treated as "Offices".

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Besides considering the indoor environment, any plant/equipment noise to the outdoor shall also be evaluated. The noise shall not exceed the relevant noise limits stipulated in the documents.

3.1.9 Controls and Instrumentation

All central air conditioning systems shall be provided with a control systems which as a minimum shall indicate and annunciate normal/abnormal operating conditions in the local control panels, including temperature (supply, return, outdoor), humidity, and pressure (system or filters). The control systems shall be connected to the SMS. Remote control of the system for operation and/or monitoring both and/or for maintenance shall also be provided through the SMS system from the OCC.

All items of control equipment for the station air conditioning system shall be compatible with and interface with, other associated control systems on the project.

END OF SECTION 3

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4 Fire Detection and Suppression Systems

4.1 General

4.1.1 The Concessionaire shall propose an Intelligent addressable fire detection and fire alarm system including smoke, heat and linear detectors, remote indicator, fire remote I/O, a fire services control panel (AFA panel), fire workstation, printer and all other necessary accessories for AFA system. The complete associated electrical works and accessories, for the proper operation of the system and all the relevant interfaces including if required direct telephone link to fire services, and any other relevant services.

4.1.2 The Concessionaire shall propose a fire suppression/control system for the public and ancillary spaces all of the stations which may also include a smoke control system. Systems that might be considered would be the use of sprinklers or smoke control fans or both. The relevant fire fighting system is to be designed in accordance with the NFPA – 130, 13 and 14, local codes and relevant International Standards.

4.1.3 Where sprinkler are proposed to suppress a fire at either concourse and/or platform level, their design, operation and activation shall be dictated by the codes and standards contained in section 1.4 and the Local Fire Authorities. The Concessionaire shall also design the station sumps and pumps to contain and remove the quantity of discharged water from such sprinklers.

4.1.4 Other fire suppression systems shall include firemains, fire hydrants, hose reels, and sprinkler systems gas flooding for electrical rooms.

4.1.5 The fire suppression, hydrant and hose reels system shall comply with the following standards:-

(1) BS5306: Part 1 Fire Extinguishing Installations and Equipment on Premises, Hydrant systems, Hose Reel and Foam Inlets.

(2) NFPA 10 Placement and Selection of Portable Fire Extinguishers

(3) NFPA 14 Installation of Standpipe and Hose Systems

(4) NFPA 20 Installation of Centrifugal Fire Pumps

Gas flooding fire suppression systems shall be used in technical rooms as indicated in section 1.5 where protection by conventional water systems would be unacceptable.

Portable fire extinguishers shall be located where recommended and be of the type recommended, by the Local Fire Authorities.

4.2 Firemains

4.2.1 The design of the firemains shall comply with the Local Fire Authorities Regulations and NFPA 130; 2007 NFPA 13 and 14 standards.

4.2.2 There shall be a firemain in each tunnel and at each station, with fire hydrants every 50 metres. The firemain and hydrants shall be fed with water supplied from the local mains supply via storage tanks, with separate supplies for each tunnel. The two tunnel firemains shall be interconnected at the cross passages. Isolation valves shall be installed at these connections to allow feed to either tunnel in the event of damage to any section of the firemain.

4.2.3 Isolation valves shall also be installed in each tunnel firemain at the limits of each local mains supply from the stations. The Local Fire Authorities should be consulted as to whether interconnection between adjacent parts of the firemain is required.

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4.2.4 The Concessionaire shall seek assurance that the water supply to the firemain from the local mains shall be sufficiently reliable not to necessitate a dual supply and/or the use of storage tanks.

4.2.5 The hydraulic design of the fire main and hydrant system shall comply with the NFPA 14 in respect of flow and pressure requirements for the maximum simultaneous operation of 2 hydrants.

4.2.6 Booster pumps shall be installed where there is the likelihood of the supply water pressure falling below the regulation pressure required at the furthest hydrant point. Booster pump(s) and tanks if installed, shall be arranged at each station to start automatically on sensing a low residual pressure in the firemain. However a sudden loss of pressure due to pipe failure shall inhibit an automatic start of the booster pump(s) until the damaged section of pipe has been isolated.

Booster pumps shall comply with the requirements of NFPA 20.

Each firemain shall be fitted with a motorised isolation valve at the centre point of the cross passages. There shall also be motorised isolation valves at the delivery point to each station. These valves are to be controlled from the station control room. Their purpose is to isolate any sections of the firemain in the event of an accident or damaging to a section of the firemain and the resultant flooding of the station or tunnel.

4.3 Fire Hydrants and Hose Reels

4.3.1 Hydrants shall be located at every 50m and supplied from the firemain. The station hydrants shall be evenly spaced and shall govern the setting out of the tunnel hydrants. In addition hydrants shall be located at every cross passage. In order to locate hydrants at the cross passages a maximum distance between hydrants of 50m is permitted between the cross passage hydrant and the adjacent hydrant in the running tunnels.

4.3.2 The tunnel hydrants shall be located above the walkways and accessible from the walkway. Station hydrants shall be accessible from the platform.

4.3.3 Each hydrant shall comprise a hose connection and a standard bronze gate valve.

4.3.4 Hydrants and hose systems shall comply with NFPA 14.

4.3.5 Hose reels shall be installed in the stations as required by the Local Fire Authorities. Hose reels shall provide a minimum flow of 45 l/min at a pressure of not less than 2 bars.

4.4 Sprinklers

4.4.1 Where sprinklers are proposed as part of the fire control strategy in both the public and ancillary spaces of the underground stations, the sprinkler installations shall be a wet pipe type installed in accordance with the requirements of the Local Fire Authorities. Certain types of escalators may also require the installation of a sprinkler system inside the truss.

4.4.2 Sprinkler systems shall be designed to comply with the following requirements:-

(1)	NFPA 130-2007	Installation of Sprinkler Systems
(2)	NFPA 13 and 14	Installation of Sprinkler Systems
(3)	Loss Prevention Council	Rules for Automatic Sprinkler Installations

All risk hazards shall be graded in accordance with the above design codes.

4.4.3 The layout of the sprinkler heads shall take into account the structural profile of the building, and shall be integrated with all other services such as lighting, high level drainage, ductwork

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and general services. Sprinkler supply pipes which pass through un-sprinkled areas shall be protected with a minimum one hour fire resisting material.

4.4.4 The installation valve set including all valves, gauges and alarms shall be installed strictly in accordance with the requirements of the above design codes. In addition to the main isolation valve, there shall be a branch isolation valve and flow switch actuated alarm / annunciation for each area of the sprinkler system manifold.

4.4.5 All sprinkler heads shall be either of the open sidewall or pendent or upright pattern bulb type as dictated by the layout of the installation, and shall be approved by the Local Fire Authorities. Heads shall be of the quartzoid type with glass bulb and with a suitable temperature rating. Where fitted below false ceilings they shall be of the miniature type, chrome plated and fitted with ceiling plates and rosettes.

4.4.6 Sprinkler head guards shall be provided where necessary which, typically would be in store rooms, plant rooms / false ceiling / false floor gallery etc.

4.5 Gas Flooding

4.5.1 The gas flooding system shall be designed to comply with NFPA 130-2007 – Clean Agent Fire Extinguishing Systems. The type of gas shall be determined after consultation with the Local Fire Authorities.

4.5.2 Gas flooding systems shall be of the total flooding type with high pressure open-ended piping installation on the distribution side. The Concessionaire must provide adequate personnel safety features such as pre-discharge warning alarm/signal system, manual abort function and room isolation procedures in compliance with NFPA 130 - 2007.

4.5.2 The automatic gas release mechanism shall be operated either by means of fire detection units in the protected compartment or manually by a pull handle or push button. Fire detectors of sufficient number and suitably positioned to give duplicate coverage of the whole of the protected area shall be connected in zones so that smoke or heat generated in any part of the area shall activate two zones. The fire detection control panel and the detectors shall be compatible.

4.5.3 Activation of a detector on one zone shall cause alarm bells to sound. Activation of detectors on two zones shall cause a siren or horn to sound to warn that if the system is in the automatic mode the extinguishing agent shall be released. These warnings shall also be activated by operation of the manual release.

4.5.4 The gas for gas flood systems shall be stored in rechargeable cylinders at ambient temperature. Cylinders shall be assembled into banks of the required number securely mounted in a frame arranged so that external parts may be readily accessible and corrosion cannot occur. Each cylinder shall be fitted with an automatic pressure release device for over pressure protection of the cylinder. Each cylinder shall be complete with gas valve/actuator, pressure gauge, flexible hose, check valve and all other necessary accessories.

4.6 Hand Held Portable Fire Extinguishers

Portable fire extinguishers shall be located at strategic positions as agreed with the Local Fire Authorities. The type of fire extinguishers shall be appropriate for the risk at that location. Portable fire extinguishers shall comply with NFPA 10.

END OF SECTION 4

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5. Elevators

5.1. General

5.1.1 Passenger convenience elevators shall be provided to allow independent access for passengers finding it difficult to use escalators. They shall comply with all parts of the National Policy for Persons with Disabilities – 2006.

5.1.2 During a fire situation, the use of elevators shall be prohibited.

5.1.3 Elevators shall be electric traction type with the traction drive motor and controls mounted on the top of the Elevator to minimise the height required above the Elevator and achieve the architectural perspective required.

5.1.4 Elevators shall comply with BS-EN 81 and other appropriate International Codes and Standards and relevant statutory requirements. They shall be suitable for service as public service/goods elevators and shall be rated for a minimum of 240 movements/hour.

5.1.5 Elevators shall be type Class A for passenger loading. And comply with NFPA 101 Fire Life Safety requirements

5.1.6 Elevator access may have either single side access or double access from either side they shall have minimum opening dimensions of 900 x 2100 mm and rated for a minimum 1000 kg load. Elevator doors shall be heavy duty and all accessories are of the "anti vandal" type. An intercom system shall be provided between the Elevator and the Station Control Room (SCR) for emergency communication.

5.1.7 Elevators with single access shall include a laminated framed safety mirror in the rear panel of at least half of the elevator height, to ease of reversing of wheel chairs from the elevators

5.1.8 The preferred control system shall be microprocessor based to control the Elevator position and operating sequence logic and have the facility for transmitting function and fault data. Monitoring and control of the Elevator operation shall be through the Station Management System (SMS) systems.

5.1.9 Operating panel buttons shall be a minimum of 50mm diameter and shall also have the operation of the button superimposed on it in Braille. A ventilation opening or duct topen air shall be provided at the top of each Elevator shaft.

5.1.10 The ventilation openings shall have a minimum free area of 0.3m² or, 3.5 % of the cross-section of the Elevator shaft, whichever is greater.

5.1.11 Applicable Codes and Standards, are as follows:

IS: 14665;

IS: 15330;

IS: 7759;

IS; 1860;

CPWD Guidelines;

Circular No 822; dated 07 12 01. Issued by the Ministry of UD and Poverty Alleviation

END OF SECTION 5

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6 Escalators

6.1 General

6.1.1 Escalators shall be provided at all stations to assist vertical passenger traffic flow between street level, concourse and platforms. The number of escalators required shall be established through patronage calculations for each station which shall be calculated in accordance with the Fire and Life Safety section of the Architectural performance specification.

6.1.2 Escalators also shall be used during an emergency for station evacuation. They shall therefore be designed for use as stairways when stationary. All escalators for all the Project shall be of a standard pattern having a minimum tread width of 1000mm with a width at hip height of 1200mm. They shall have four (4) flat treads at entry and exit and be equipped with double safety brushes on either side.

6.1.3 Escalators shall be reversible. Monitoring and control of the operation shall be through the SMS systems. Refer also to the Control and Communications performance specification.

6.1.4 Escalators shall be designed for continuous operation in either direction for a period of not less than 20 hours per day, seven days per week, for 30 years with temperatures varying between 5^0C and 46^0C.

6.1.5 Where the escalators start from outside the station they shall be exposed to high ambient temperatures and dusty and dirty conditions. Materials of construction for such escalators shall be suitable for these aggressive conditions.

6.1.6 Escalators shall comply with BS-EN 115. They shall be suitable for service as public service escalators /passenger conveyors. The angle of inclination of the escalators shall be not more than 30^0 to the horizontal with two tread band speeds of 0.5 and 0.65 m/s. During periods of no occupancy, the speed shall automatically reduce to 0.2 m/s and come to halt if not occupied for 5 minutes.

6.1.7 Access shall be provided to the escalator underside for cleaning purposes.

END OF SECTION 6

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7 Water Supply System

7.1 General

7.1.1 The water supply shall include all the incoming water supplies and the systems they supply, which shall include: -

(1) Cold Water Supply

(2) Hose Reel Supply

(3) Sprinkler Supply

(4) Make up Water for the Chilled Water Refrigeration Plant

7.1.2 The station cold water supply shall be provided from the local mains supply which shall provide the necessary security of supply standby storage tanks shall be provided where required. Public Health requirements shall dictate the necessity for break tanks for supplies to cover both staff and public rooms, passenger and staff toilets, pump rooms, other rooms where maintenance is carried out and local hand washing facilities. No water supply shall be provided to electrical rooms.

7.1.3 The Concessionaire shall design his station cold water supply system based on the number of projected passengers and staff based at each station, the station cleaning water requirement and an allowance for wastage.

7.1.4 Hot water for the staff rooms, washrooms and passenger / staff toilets shall be, provided by local electrically heated storage tanks or instantaneous water heaters. The type of heating system shall depend on the number of basins to be supplied

7.1.5 Should the sprinkler supply require a dual supply, the two supplies shall be taken from different parts of the local mains supply subject to approval from the Local Fire Authorities.

7.1.6 Details for the chilled water refrigeration plant are indicated in Specification section for ECS

7.1.7 The water supplies shall be designed to comply with the following standards: -

(1) NFPA 13 Installation of Sprinkler Systems

(2) NFPA 14 Installation of Standpipe and Hose Systems

(3) NFPA 20 Installation of Centrifugal Fire Pumps

(4) NFPA 22 Standard for Water Tanks for Private Fire Protection

7.2 Pipe work and Fittings for Water Supply System

7.2.1 The water supply pipe work for the cold water, chilled water refrigeration and fire fighting services shall be galvanised steel and welded with expansion joints as necessary. Pipe work with ring joint ends for use with victaulic couplings may also be proposed for the tunnel firemain subject to correct design procedures for expansion and support.

7.2.2 All sprinkler pipes shall be hot-dipped galvanised to BS EN ISO 1461 to achieve a galvanising thickness of 100 microns. The pipe and fittings shall be designed for a minimum pressure of 16 bars. Fittings shall have wall thickness not less than those of the pipes. All sprinkler pipe work shall have approved identification bands, lettering and direction of flow indication at intervals not exceeding 5.0 metres and at valves and branches.

7.2.3 Where the pipes have to be connected to items such as valves, welded flanges shall be used.

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7.2.4 Electrically insulated flanged joints shall be installed at each station mains supply off take (and return if any). All connections within the water system by flange joints or flanged valves shall be fitted with continuity bonds from the main station earth.

7.2.5 Isolation valves may be either butterfly type of the wafer pattern in accordance with BS 5155 with corrosion resistant disc and stainless steel shaft or gate type complying with BS 5150 with resilient covered disc.

7.2.6 Check valves shall comply with BS 5153 and shall be of the swing type suitable for vertical use.

1.2.7 Automatic air relief valves shall be provided with an isolation valve for maintenance.

7.3 Plumbing Pipe work and Valves

7.3.1 The Concessionaire shall provide a water piping systems that shall be durable, easy to maintain and run in such a manner that shall look aesthetically pleasing where it is exposed.

7.3.2 Piping materials shall be stainless steel, galvanised steel or copper dependant on the application and the appearance required. Sanitary pipe work shall be either chromium plated or stainless steel in certain locations such as toilets and washrooms.

7.3.3 Joints for galvanised steel plumbing pipe work shall be screwed. Copper plumbing joints shall use soldered fittings in preference to compression fittings.

7.3.4 The local storage/break tanks for the station cold water supplies to staff room's passenger and staff toilets shall be of heavy duty material protected from corrosion. The local tanks shall be complete with ball float valves of the high pressure equilibrium type complete with arm and copper ball float, with an outlet and overflow connections. Urinal water tanks shall be ceramic, with automatic discharge arrangements. The main storage tank if required, shall be galvanised steel

7.3.5 Automatic valves of the adjustable hydraulic flow control type shall be used to feed the urinal cisterns.

Isolation valves shall be installed so that that the station water supplies can be sectioned to allow any section to be isolated for repair and maintenance.

7.3.6 All plumbing fixtures and drains connected to soil and waste sewage system shall be provided with traps. The traps shall be heavy-duty metal type of two piece construction with a minimum of 50 mm deep water seal

7.3.7 Drinking fountains for the station staff shall be provided. They shall be of the chilled, bottled type with a power supply taken from the single phase supply.

7.4 Pipe Supports

7.4.1 All pipe work for the firemain, water and drainage services shall be adequately supported in accordance with best industrial practice by means of clips, hangers, and brackets and in such a manner as to permit free movement due to thermal expansion and contraction.

7.4.2 Sprinkler pipe work shall be supported to the requirement of the Loss Prevention Council (LPC)

7.5 Pumps

If pump sets are required, they shall be designed and provided by the Concessionaire. They shall meet the relevant International Standards and Codes of Practice.

END OF SECTION 7

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8 Drainage System

8.1 General

Separate storm water and foul/sewage drainage systems are provided for the stations. All water entering the tunnels and from the station shall be discharged into the storm water system. All waste from the station toilets shall be discharged to the foul/sewage drainage system.

The Concessionaire shall coordinate, for sump sizing purposes, with the DMRC Works contractor, who will design and build the station/tunnel sumps.

The DMRC Works contractor will provide the necessary pipe work from the Government storm water drain and foul/sewerage drain to "agreed" positions within the stations. The "agreed" positions shall be coordinated with the Concessionaire. All other drainage pipe work shall be designed and installed by the Concessionaire.

The Concessionaire shall size the sump pumps accordingly, taking in to consideration discharged water from sprinkler systems, hose reels and Hydrants etc.

Cooling tower wastewater must have the approval of the Local Authorities prior to discharge into the foul/sewage drainage system.

The storm water and sewage/foul drainage systems shall be designed to comply with the following requirements: -

(1) BS EN 752 Drains and Sewer Systems outside Buildings

(2) BS 8301 Building Drainage Station Drainage

8.2 Drainage Sumps

8.2.1 Station Drainage and Sewerage

The drainage in the station shall comprise the water from following sources: -

(1) Seepage

(2) Station concourse/platform areas sprinkler operation (if installed)

(3) Fire hydrants and hose reel operation

8.2.2 Station drainage will be to two sumps located at either end of the station which will be constructed as part of the DMRC Works. The track between ends of the platform is flat and drainage channels and falls will be provided to ensure that any water in this area drains into either of the station sumps. The Concessionaire shall design, supply and install pumps sized to remove water from the sumps.

8.2.3 The main flow in to the sumps will be from the operation of the fire fighting equipment or flood water drainage from station entrances and which ever is the greater shall be the design basis for the pumps. Due to the large margin between maximum and minimum flows to these sumps, three pumps shall be installed on a duty/assist/assist basis

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(1) Main Station Sumps

The main station sumps shall be at or near the ends of each station. The main station sumps, which also take the track drainage, should have an oil interceptor to take out the oils and greases before the sump.

The sumps shall contain 3 pumps on duty/assist/assist basis.

(2) Sanitary sumps

Station toilet wastes shall go direct to a separate sewage sump, which shall discharge the waste direct into the local foul/sewage system

Toilet sewage sumps shall be located in the stations so as to minimise pipe runs. The sumps shall contain 2 pumps on duty/assist basis. The waste shall be discharged direct to the local sewage/foul system.

Pump operation and control shall be via the SMS.

8.2.4 Tunnel Drainage

The drainage from the tunnel shall comprise the water from following sources

(1) Seepage

(2) Fire hydrants and hose reel operation

8.2.5 Sumps

Tunnel Sumps

Sumps will be provided between stations at all the low points in the tunnels.

The sumps shall contain 3 pumps on duty/assist/assist basis.

Wherever possible the water shall be discharge direct to a local sewage/foul system, but if this is not possible the water shall be discharged to the nearest station sump. Oil interceptors shall be provided to take out the oils and greases before the sump.

8.3 Submersible Pumps

8.3.1 Pump sets shall be provided by the Concessionaire for the sump locations and duties as required. They shall meet the relevant International Standards and Codes of Practice.

8.3.2 The pump sets shall be of the sewage or dirty water types in accordance with their duty requirement. The sewage pumps shall be of the non-clog type with open impellers. The station and tunnel water (seepage/fire fighting) pumps shall be of the closed impeller or vortex type.

8.3.3 The efficiency of the pump set at duty point shall be between 65% - 95% of the maximum efficiency for the pump.

8.3.4 The pumps shall be of the centrifugal type vertically mounted close coupled to their fully submersible electric drive motors. Pump impellers shall be cast iron and conform to ASTM 35B or stainless steel. Shaft, studs, nuts, screws and washers shall be stainless steel grade 304, S15.

8.3.5 A lifting chain with shackles rings etc. shall be fitted to each pump, which shall support the weight of the pumps during installation and removal from the sump. The chain shall be hot-

dipped galvanised. The pump sets shall be complete with boltless self-aligning duck-foot assembly, which allows removal of the pumps without disturbing the pipe work, Guide rails on which to raise and lower the pumps shall be of galvanised steel and complete with all fittings and support brackets.

8.3.6 The submerged cable shall be multi-core and fully insulated LSOH. The cable shall be sealed and glanded into the motor and the cable junction box sealed from the outside. Cables shall be supplied long enough to reach the starters. For all low point tunnel sumps where the starters are a distance from the nearest station the cable shall go into a waterproof isolation socket, which shall be cabled to the starter.

8.3.7 The method of motor starting shall be selected according to the characteristics of the pump.

8.4 Pipe work for Drainage Services

8.4.1 Drainage Pipe work

The storm water drainage discharge mains shall be galvanised steel and welded. The drainage discharge main shall be sized to ensure that in an emergency all drainage pumps shall deliver their design quantity.

The Concessionaire shall establish the design pressure for each pumped drainage system to establish the pressure rating for the pipe and fittings. The fittings shall have wall thickness not less than those of the pipes.

8.4.2 Sewerage Pipe work

The pumped discharge main for the sanitary sump shall be either in ductile iron or heavy duty Polyethylene. The pipe work material proposed shall meet a system design life of 30 years when exposed to the water and conditions at site.

The Concessionaire shall establish the design pressure for each sewage discharge system (either gravity or pumped discharge), to establish the pressure rating for the pipe and fittings.

Ductile iron pipes and fittings shall be supplied with either flanged or spigot and socket joints. The joint rings shall be manufactured in a material suitable for sewage and in accordance with the relevant International Standards. All ductile iron pipes and fittings shall be lined internally with a lining of high alumina cement mortar in accordance with BS EN 598. Where zinc coating is proposed for the external finish it shall be in accordance with BS EN 598 and be followed by an epoxy finish. This shall include the internal surface of the socket

Flanged pipes shall comply with BS EN 545. Flanged joints including all necessary gaskets and jointing materials shall be provided. Ductile iron flanges shall have the dimensions given in the relevant tables in BS EN 1092-2. Joint gaskets for flanges shall in accordance with the relevant Standards. All bolts and nuts for flange joints shall be of at least grade 4.6 of BS 4190 and shall be hot-dipped galvanised in accordance with the requirements of BS EN 1461.

8.4.3 Pipe Supports

All pipe work for the drainage services shall be adequately supported in accordance with best industrial practice by means of clips, hangers, and brackets and in such a manner as to permit free movement due to thermal expansion and contraction.

END OF SECTION 8

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CHAPTER 10

DEPOT AND WORKSHOP

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Delhi Metro Rail Corporation Ltd.

1 Specification

1.1 Dwarka Depot

This Specification stipulates the performance requirements for Dwarka Depot and Workshops at Dwarka Sector 21 and Siding at Palam to be designed, constructed, commissioned and operated by the Concessionaire for the Airport Metro Express Line (AMEL)

The Depot shall be designed, constructed and all maintenance plant tools and equipment provided for the stabling of Rolling Stock and the performance of maintenance activities for the AMEL, by the Concessionaire. The Works to be constructed by the Concessionaire shall include all structures and civil works, architectural finishes, landscaping, Fixed E&M and Rolling Stock equipment and workshop plant, tools and equipment. The Fixed E&M equipment includes, but not limited to the trackwork, signalling, traction OHLE and utility power, communications, building services and office equipment

The Siding to be provided at Palam shall accommodate off-line stabling for failed passenger rolling stock and on-line maintenance vehicles. The Siding and associated structures shall be secured against unauthorised access, provide accommodation and amenities for Operating Staff, similar to the Depot. The Concessionaire shall coordinate road access and utilities with the Municipal Authorities.

1.2 Definition

Subject	Definition
Maintenance	An activity including visual inspection, adjustment, replacement or repair carried out on equipment, sub-systems or systems which results in the item undergoing attention, being preserved within or returned to its design tolerances.
Downtime	The time from when equipment, sub-system, or system becomes unavailable for use due to maintenance attention until the time it becomes available for use again.
Spares	Components, assemblies or sub assemblies, which are not in operational use, but which are in an operational condition, enabling it to be used immediately to replace items in operational use
Bogie Turntable	Workshop facility to turnaround vehicle bogies
Lifting System	A vehicle or unit lifting system which is installed in a floor slab in such a manner that there is a flat floor when the system is not in use. The vehicles or coupled vehicles are lifted from under their wheels to an ergonomic working height, to facilitate bogie disconnection. The body of the vehicle is supported by body supports at specific locations points where the bogies are removed.
Under-floor Wheel Re-profiling Machine	A machine, which is installed in a foundation and is used for re-profiling the steel wheels of rail vehicles while the wheels remain in-situ under the vehicle.

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Test Equipment	Equipment whose sole function is to test another piece of equipment or component and to ascertain whether it is functioning within its design parameters.

1.3 Requirements

1.3.1 The Depot infrastructure shall be designed and constructed for stabling and maintaining the Rolling Stock fleet for the Design Year (2041).

1.3.2 The sub-ballast elevation shall not be less than the 100 year flood plane level.

1.3.3 The DMRC Designated contractor shall provide the Electric High Voltage substation located in the Depot, providing Traction and Auxiliary Systems power for the revenue line and Depot. The Concessionaire shall coordinate with DMRC Designated contractor for connecting to the 33 kV 3 phase Auxiliary power and 25 kV 1 phase for the Traction System Overhead Line Equipment.

1.3.4 The Depot Plant and Machinery equipment shall be designed and supplied for a Design Life of 30 years. Civil and Structures shall be designed for a Design Life of 120 years and fabricated buildings for a Design Life of 60 years.

Depot E&M equipment shall be designed and supplied for similar Design Life as the revenue line similar equipment.

1.4 Systems Assurance

The Reliability of the Depot systems shall be as follows:

(a) Failure of a train to be available for revenue service at its scheduled time shall be limited to one each month; and

(b) The Service Affecting Failures of the Depot Systems equipment greater than 2 minutes shall be limited to 1 failure within any continuous period of 120 days

END OF SECTION 1

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2 Engineering Specification

2.1 Depot Site

The Depot area of approximately xxxxxxx square meters, as indicated in the DMRC Reference Drawings, Schedule I,.

The Concessionaire shall coordinate Depot Link Line slab foundation sub-ballast level with DMRC Designated Contractor AMEL-C7.

The Depot site shall be laid-out for trackwork geometry, load bearing capacities and building dimensions, sized for maintenance of the Railway System equipment for the Design Year of the AMEL. The Concessionaire shall demonstrate in his design optimises the Depot Operations.

2.2 Depot Facilities

The Depot design shall accommodate but not be limited to the following principal functions:

- Stabling of passenger and works trains
- Exterior and interior cleaning of vehicles
- Light maintenance of vehicles
- Re-railing and recovery of vehicles from all areas of the Transit System
- Heavy maintenance of vehicles;
- Wheel profiling; and
- Repainting, repairs and modifications of vehicles

2.3 Maintenance Scope

Repair and maintenance of railway engineering infrastructure such as, but not limited to the following:

- Civil engineering provisions;
- Trackwork systems;
- Signalling and train control systems;
- HV power supply, traction and overhead line and auxiliary power supply;
- Communication and control systems;
- Automatic Fare Collection systems;
- Fixed and movable M&E equipment; and
- Depot Performance Requirements.

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2.4 Depot Operating and Maintenance Plan

As defined in the Operations and Maintenance Requirements of Schedule L, the Concessionaire shall submit an Operating and Maintenance Plan (O&M Plan) for review by the DMRC during Initial Design Submission. The AMEL O&M Plan shall include the Depot Operations and Maintenance Plan and detail all functions to be provided by the Depot, how the requirements will be satisfied and those engineering facilities required for the operations and maintenance of the AMEL.

Under normal operating conditions, the Depot shall be able to operate as an independent entity, without any interference with revenue line operations. Abnormal operating conditions in the Depot, which have the potential to interfere with main line operations, shall be identified in the O&M Plan, and mitigation measures provided.

2.4 Depot Layout

Facilities in the Depot shall be ergonomically designed and arranged in a logical manner in order to optimise the routine workflow and the capability for coping with abnormal situations.

The Depot track layout shall be designed to achieve a minimum of shunting movements. Alternative routes shall be provided to the largest reasonable extent, to relieve congestion and ensure availability of the Depot.

All stabling, servicing and light maintenance facilities shall accommodate the maximum revenue service train configurations permitted, without the need for separation of train consists.

Test track facilities shall be provided on the revenue line, with the capability of permitting operation under all revenue line conditions. Vehicle testing shall be undertaken during non-revenue periods.

Depot facilities shall allow access by road vehicles and mechanical handling equipment, including emergency service vehicles and equipment, and delivery of Railway System vehicles. As far as possible, access shall avoid conflicts with train movements.

The Depot layout shall facilitate security considerations for pedestrian and vehicular access and perimeter protection.

2.5 Stabling

The number and arrangement of stabling sidings shall be such that when all the AMEL serviceable trains are berthed, adequate spare tracks shall still be available in the Depot for shunting movements' necessary, and contingencies.

Operation and maintenance staff shall have safe access to all stabled trains.

2.6 Exterior Washing

Facilities shall be provided for routine exterior washing and for periodic, more intensive washing of revenue vehicles. The vehicle profile shall be washed effectively, including the driving cab fronts and the vehicle roofs.

During the routine washing operation the maximum train consist shall not need to be separated. If required for flexibility of train movements, a queuing space for vehicles awaiting attention may be provided and/or bi-directional operation enabled.

Water shall be recycled to the maximum possible extent.

2.7 Interior Cleaning

Revenue vehicle interiors shall routinely be cleaned before entering revenue service, as

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required by the quality objectives in the Operation and Maintenance Functional Specification. Facilities shall be provided for both routine and periodic heavy cleaning of revenue vehicle interiors.

Routine cleaning may be undertaken in stabling sidings.

Cleaning personnel shall be adequately protected against inclement weather.

Cleaning facilities shall enable the use of mobile cleaning equipment and disposal of residue.

2.8 Servicing and Light Maintenance

The light maintenance facility to be provided shall at least enable:

- routine servicing;
- testing and investigation;
- routine preventative maintenance;
- corrective maintenance; and
- Quality assurance testing.

The light maintenance facility shall be protected against inclement weather.

The light maintenance facility shall be arranged to optimise work flow.

In recognition of the short duration and high throughput nature of servicing and light maintenance activities, a one-way flow for vehicles through the facility and a queuing space for vehicles awaiting attention shall be considered.

Safe access to vehicle mounted equipment shall be provided.

Access to roof-mounted equipment shall be interlocked with the isolation of the overhead traction supply of the track(s) within reach.

Pit tracks shall be provided to enable access to undercarriage equipment.

Supplies and services necessary such as electricity, sand and compressed air, special test equipment and interfaces to the maintenance management system shall be provided at suitable locations.

Lifting facilities provided shall be capable of accessing the entire train length and shall be interlocked with traction power supply.

2.9 Heavy Maintenance

The Rolling Stock heavy maintenance facility to be provided shall at least enable the following:

- periodic overhaul;
- modification and replacement of major components;
- collision damage and major breakdown repair, and
- quality assurance testing

Mechanical, electrical and electronic workshops shall be provided for the overhaul and quality assurance testing of railway equipment.

The heavy maintenance facility shall be protected against inclement weather.

The heavy maintenance facility shall be arranged to optimise work flow.

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Plant and machinery provided shall be capable of fully supporting the entire workload of the workshop.

Safe access to all vehicle mounted equipment shall be provided.

The overhead traction supply equipment shall be interlocked with potentially hazardous activities and shall be retractable where necessary. Testing and movement of vehicles shall be possible without connection to the overhead traction system where necessary.

Supplies and services necessary, special test equipment and interfaces to the maintenance management system shall be provided at suitable locations.

2.10 Repainting

It shall be possible to prepare and fully or partially paint vehicle body shells and components in a fully enclosed Depot facility.

2.11 Wheel re-profiling

An under-floor wheel re-profiling machine shall be provided for trueing wheels while in-situ under a vehicle, without the need for separation of train consists.

The machine shall be capable of simultaneously re-profiling all four wheels of any bogie, on all types of rolling stock used on the Railway System, and shall be capable of re-establishing the correct wheel profile.

Positioning of vehicles in the facility shall be under the direct control of the re-profiling machine operator.

Wheel re-profiling and regression in wheel diameter shall be automatically recorded on the Depot maintenance management system.

2.12 Turning vehicle bogies

Facilities shall be provided in the workshop to turn vehicle bogies, to balance the wear on wheel flanges for optimising the life of wheel sets.

2.13 Train Recovery Equipment

Equipment shall be provided for recovery of damaged, derailed or otherwise disabled rail vehicles from all areas of the Railway System.

Transit System Support and Maintenance

Management and equipment for the routine and corrective maintenance support of the Transit System facilities, such as structures, permanent way fixed M&E, systems, shall be centred in the Depot.

2.14 Maintenance Management System

A Maintenance Management System shall be provided for maintenance records coordinated from the Depot. Access to the Maintenance Management System shall be possible from appropriate locations in the Depot, revenue line and the central control facilities of the Integrated Electronic Control Centre and Stand-by Control Centres. The facilities of the Integrated Electronic Control Centre and Stand-by Control Centres. The system shall address but not be limited to the following items:

- data exchange with trainborne systems;
- failure recording and analysis;

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- maintenance manual and diagnostic;
- maintenance planning and recording;
- staff schedules;
- stock control; and
- Interface to the Asset Database.

2.15 Storage

Centralised storage shall be provided for the Transit System with appropriate facilities and associated handling equipment. Capacity provided shall consider planned maintenance activities and contingencies for unplanned repair.

2.16 Offices and Amenities

Suitable office and staff amenities shall be provided for personnel based and/or working in the Depot, such as:

- management and administration;
- engineering;
- operations (drivers and control);
- maintenance;
- training; and
- Security.

END OF SECTION 2

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3 Performance Specification

3.1 Site Constraints

The Depot shall be located in the suburb area of Dwarka Sector 21 on land allocated for this purpose within the limitations of the acquired site

3.2 Depot Layout

The layout of trackwork and adjacent facilities shall be in accordance with the Alignment Design Criteria specified in the Alignment Design Criteria and Track System Performance Specification.

3.3 Groundwork and Civil Engineering

3.3.1 Groundwork

The DMRC Designated contractor shall charge the site to sub ballast level to be clear of the 100 year flood level. Sub-ballast material and treatment shall:

- minimise the harmful effects of any unequal settlements;
- avoid contamination of ground water and the environment;
- minimise the effects of stray current; and
- Diversion of utilities shall not disrupt the services provided.

3.3.2 Civil Engineering

All civil structures shall comply with the current building laws, codes and standards of the Republic of India.

Fabricated building structures shall be designed for a life expectancy of 60 years.

Design of all structures shall mitigate against any seismic ground settlement which may occur.

Design of buried structures shall be compatible with the EMI environment of the area.

3.3.3 Drainage

Ballasted tracks shall be free-draining and rainwater shall be conducted away from the load-bearing track formation by grading the formation and drainage layers and discharged into the existing storm water drains.

3.3.4 Sewerage Disposal

Foul water shall be discharged into the adjacent Municipal Sewerage System. The Concessionaire shall obtain approval from the Municipal Authority before connecting the drain.

3.3.5 Under-track Crossings

All buried services shall be protected underneath the Depot tracks and shall enable future replacement of services. Protection shall be capable of supporting the loads of the corresponding track.

As far as reasonably practicable, under-track crossings shall be aligned so as to pass under the track at right angles to the rails, and shall enable safe separation of electric cable ducts and the track work.

Under-track crossings shall terminate in an access pit, outside the swept path of the transit systems vehicles where possible.

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3.3.6 Walkways

The walkways shall be positioned to prevent personnel from inadvertently coming in contact with moving rail vehicles or from straying into a position where they might be struck by a rail vehicle. The Concessionaire shall give particular thought to the positioning of walkways crossing the tracks to ensure that personnel moving about the Depot always have a clear view of moving rail vehicles.

Walkways shall provide safe surfaces under all weather conditions, adequate electrical insulation properties where necessary, and enable track maintenance where adjacent to ballasted track.

3.4 Architecture

3.4.1 Architectural Design Philosophy

The Architectural Design Philosophy for the Facilities shall be based on a design, which reflects the functionality of the facility, is responsive to the context and is aesthetically pleasing and interesting. All building structures shall have a consolidated and coordinated design. All exterior storage areas shall be covered. Building structures shall be designed to be energy efficient. The quality of design and material used for any additional buildings or renovations to establish buildings required during Concession period, shall be equivalent to those initially constructed.

3.4.2 Special Requirements

(1) Accessibility

The Concessionaire shall establish the extent of the Depot Facilities, such as the administration building, parking area, etc., which shall be accessible to people with disabilities as required by The Persons with Disabilities (National Policy for Persons with Disabilities) 2006 Act .

(2) Security

The Depot shall be secured by means of perimeter fence fitted with a security lighting and CCTV camera coverage. Pedestrian and vehicular access shall be controlled.

(3) Fire/Life Safety

All Depot Facilities shall be built according to the India National Building Code.

3.4.3 Facilities - Architectural Criteria

(1) Structure Clearance

Structures shall be clear of the track in accordance with the "Swept Envelope" design criteria specified in the Contract.

(2) Facilities Sizing

The Concessionaire shall develop a room program for each facility, for the DMRC review. The program shall include room definition, size, location and required furniture and equipment.

(3) Roof Design Criteria

The Depot being a wide spread area with relatively low buildings, and being overseen by (future) high-rise buildings and (future) highway ramps, the major visual element will be the roof-scape. The architectural design shall look at the Depot Facilities as one entity,

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with interconnection between the roofs and combination of adjacent buildings under a single roof resulting in maximisation of covered and protected areas. All exterior areas used for storage shall be covered using a uniform design. The roof design for larger buildings shall incorporate natural light elements such as skylights or roof and eaves glazing to allow for natural light penetration into the centre of the open work spaces. Arched, sloped, cantilevered or saw-tooth roofs over large spans are preferred as opposed to flat roofs. Eaves, cornices, brackets and exposed bracing are encouraged. Mechanical equipments, antennae, ducts, cooling towers, reservoirs, elevator penthouses, etc. shall be an aesthetically integrated part of the roof design, as opposed to an add-on.

(4) Façade Design Criteria

Facades of different Facilities shall be coordinated together yet reflect each buildings' functionality. External bracing, trusses, exposed structural systems are encouraged. All facades (except for storage and service rooms) shall include windows for natural light. The distribution of windows around the building shall take into account the heat load balance to insure optimum energy saving. All buildings shall have a main façade including main entrance door for personnel, protected by a canopy. The lower part of all facades shall be protected from vehicular damages either by using durable, scratch and impact resistant material to a certain height or by introducing sidewalks or bollards along the buildings.

3.4.4 Yard Landscaping

(1) Planting

Trees, shrubs and ground covers shall be used all around the perimeter green strip surrounding the outside of the Depot, where possible. Trees and shrubs shall also be used around the administrative building, parking areas, traffic islands, Depot entrances, etc. Low shrubs and ground covers shall be used along the fences on each sides of the India Railway corridor, without obstructing the view for the train passengers' view.

(2) Paving

Internal Depot vehicular roads shall be suitable paved. Pathways through the Depot, along buildings or accessing buildings shall be raised sidewalk where possible, with unit pavers. Main entrance, parking areas and access to administration building shall also be paved.

Where roads and pathways cross ballasted track, the crossings shall be designed to permit maintenance of the track with the minimum of disturbance to the Depot operation.

3.4.5 System wide Element

(1) Lighting

General Depot lighting shall provide safe and efficient levels of lighting in order to maintain 24-hour operations. Only administration area and Depot entrances shall have public street quality lighting standards. All other areas of Depot shall have industrial type lighting with uniform lighting level. Ultimate care to be taken to avoid glare or light pollution from inside the Depot boundaries to outlying areas, other than what is necessary for perimeter security.

The entire Depot site shall be illuminated to provide for secure and safe operation, 24

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hours a day and during inclement weather.

Where used high lighting masts shall allow for lowering of hoisted light rings for ease of maintenance.

Heavy-duty, protected fixtures shall be used to light pits, bridges and gangways.

Movable lighting, on motorised or tracking rigs may be used in order to provide flexible and movable high intensity illumination to accompany night work crews along stabling, and other outdoor maintenance tasks.

(2) Overhead Line Equipment (OHLE)

OHLE and electric cables shall be designed in an efficient layout in order to limit the number of catenary poles. Catenary pole design shall be the same as the revenue line pole design.

(3) Signage

Depot Signage shall be developed as part of the overall System Signage and shall include the following signs and graphics in the Facilities and in the Yard:

(a) Directional
(b) Information
(c) Identification
(d) Accessibility
(e) Safety
(f) Emergency
(g) Regulatory
(h) Operational

3.4.5 Materials and Finishes

(1) General

In order to maintain a high level of aesthetic and functional consistency among all Facilities, and to reduce maintenance requirements, it is essential to establish a range of acceptable materials and finishes appropriate for the Depot.

(2) Safety

All materials shall be selected with the highest regard for safety and security. They shall be non-combustible and non-toxic, and conform to all applicable India codes and standards.

(3) Durability

Design life expectancy for Materials and Finishes shall be 60 years. Materials shall be selected for their wear, strength and weathering qualities that resist abrasion, impact, humidity, temperature changes and sunlight. Colour and appearance shall be retained throughout the design life of the material.

(4) Maintenance

Materials shall be stain resistant and non-water absorbent. Materials shall be easily cleaned in a single operation with standard cleaning equipment and agents. Ease of repair and replacement shall be considered in selection of materials.

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3.5 Fixed E&M Equipment

3.5.1 Track System

The minimum design life for all trackwork, including rails, shall be not less than 40 years.

(1) Rails

Rails shall be compatible with those used on the revenue line.

(2) Rail Fastenings

Rail fastenings shall be of proven type. Rail fastenings, resilient pads and insulating spacer blocks shall be capable of rapid removal and replacement using specialist tools only.

(3) Traffic Signalling System

The Concessionaire shall submit the road signalling system design and equipment specifications for the Depot entrance/exit to the DMRC for review during the Intermediate Design phase.

3.5.3 Depot Signalling

The Depot signalling system shall control movements of the trains within the Depot up to the limits for transfers with the revenue line signalling system. As a minimum, a vital two aspect line side signal system shall provide route setting and holding with indications of train locations displayed on a mimic panel and shall be controlled from a Depot Control Centre (DCC) which shall be provided.

Signalled routes shall be interlocked against conflicting train movements without compromising operational requirements.

A facility shall be provided on the transfer berth(s) for trains entering the revenue line from the Depot, to establish the correct mode of driving and train run data.

A facility shall be provided for trains leaving revenue service at the Depot entry transfer berth(s) to change to Depot operation mode and to download train identification and condition data. This need not require the vehicle to be stationary.

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A warning system shall alert staff working in workshop areas of approaching vehicles.

3.5.4 Test Track

A section of the Revenue Line in proximity to the Depot shall be designated for the test track for the testing of trains during non-revenue periods.

The section of track selected shall have minimum impact to the adjacent urban area.

The Test track area shall be equipped with revenue line Continuous Automatic Train Control System facilities, similar to those of the revenue line, for testing train and train borne equipment. The Test track shall include ATO stop facilities.

3.5.5 Electric Power Supply and Traction System

The Concessionaire shall design the Auxiliary Supply System and Traction System for full redundancy.

The DMRC Designated contractor shall provide two diverse supplies for a 33kV 3phase Auxiliary Supply ring main supplying each station and the Depot, and the 25 kV Traction System OHLE for the revenue line and Depot. The Concessionaire shall connect to the Substations for the 33kV 3phase Auxiliary Supply System and 25kV 1phase Traction System OHLE.

(1) Depot Low Voltage Electric Power Supply

The Concessionaire shall design and construct LV Sub-stations and provide the HV/LV equipment for the 33/0.415 KV 3 phase reticulation. The HV switching and protection equipment shall be of similar design and equipment to that of the Revenue Line.

Power supply switching and metering shall be controlled by a Power SCADA System from the OCC.

(2) Overhead Traction System

The Traction System switching and protection equipment shall comply with the AC Traction Manuel (ACTM) of India Railways and be of similar design and equipment to that of the Revenue Line.

The OHLE shall be appropriate for the Depot operating speed.

With the exception of certain maintenance tracks and works sidings, where appropriate, all tracks in the Depot shall be fitted with overhead traction supply; sectionalising shall enable the isolation of areas for O&M purposes. Energising of the overhead traction supply shall be interlocked with overhead lifting equipment and roof access platforms where applicable.

(3) Segregation from the Link Line

Traction supplies (OHLE and traction return system) shall be arranged such that the Depot traction system shall be normally segregated from the Link Line connecting to the revenue system. However, the substation arrangement may have the flexibility to couple the Depot to the Link Line during Depot supply outage conditions.

It shall not be possible for a train entering or departing the Depot to couple the OHLE supplies to the Link Line or vice versa. The interface shall be designed to mitigate the risk of arcing and Neutral Zones isolating trains.

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(4) Supply Capacity and Security

The Depot traction supply shall be designed such that adequate spare capacity is included to permit the Depot to meet the planned increases in demand for the AMEL Design Year.

(5) Electrical Sectioning

The Depot OHLE system shall be sectionalised to support maintenance and to mitigate system failures.

Remote controlled switches shall be provided for isolating sections of the Depot OHLE, controlled from the OCC.

(6) Workshop Traction Supplies

Traction supplies provided in the workshops shall be a locally controlled OHLE or 'stinger' system. Control panels shall be conveniently located and equipped with status indication and safety interlocking.

Electric traction power system supplies shall be provided in the heavy maintenance workshop for testing purposes and shall be locally controlled.

The traction status of workshop tracks shall be indicated to staff by signage that is clearly visible from all relevant locations.

(7) Wash Roads

Traction power supply for wash roads shall allow unimpeded operation without compromising safety.

(8) Earthing and Bonding

Earthing and bonding system provided shall comply with EN 50122-1 Railway Applications – Fixed Installations – Part1: Protective Provisions Relating to Electrical Safety and Earthing and the ACTM.

The traction return system shall be bonded together in areas corresponding with the sections of the OHLE.

The traction return system in the workshops shall be connected to Earth and isolated from the rest of the Depot track.

3.5.3 Depot Control and Communication Systems

(1) Performance

All Control and Communication systems provided for the Depot shall comply with the requirements for:

- Design Criteria
- Spare Capacity and Expansion
- Performances
- Environment
- EMC
- Power and Telecommunications Consultative Committee (PTCC)
- Implementation in accordance with the Control and Communication Systems Performance Specification.

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(2) Communication Systems

The Control and Communications facilities shall be provided, as follows:

a) CCTV

CCTV cameras shall be located to monitor roads and access to the Depot. Monitors shall be provided in the DSO and OCC

b) Communication Network

The system-wide communications backbone network shall provide a node within the Depot. This system shall carry voice, data and video communications between the OCC, revenue line and the Depot.

c) Fire Detection System

Fire detection and fighting system shall be provided in the Depot for the automatic control of fire. Automatic and manual fire detectors shall be provided in buildings and supervised from a fire alarm control panel located in the Depot Security Office (DSO). Alarms shall also be routed to the OCC via an DMS for the Depot.

An interface between the fire detection and prevention system and the CCTV equipment shall automatically enable viewing of the incident area from the DSO and OCC, where available.

d) Clock System

Slave clocks shall interface with the Signalling System, Communication Systems, Security Systems, DMS and Power SCADA Systems to provide a common time reference and shall include display units at least in the DCC and DSO.

e) Intercom

An intercom system shall be provided between the DCC and workshop areas.

f) Radio System

The Operator Radio System shall include a base station and antenna for providing radio communications within the Depot for communications between the DCC, DSO, train and mobile operation and maintenance staff, and the OCC.

The Concessionaire shall ensure that Emergency Services radio systems can be used in all areas of the Depot.

g) SCADA System

A SCADA System shall be provided for the automatic control of the Depot power supply and traction system and its remote control from the OCC.

h) SMS System

An SMS System shall be provided for controlling and indicating of Fixed M&E equipment of the Depot.

i) Telephone System

A telephone sub-exchange of the PABX System shall be provided in the Depot. The PABX shall provide the O&M requirements for voice connection with the revenue line facilities and Public Telephone System, as specified in the Control and Communications Specification.

3.5.5 Depot Security Office

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A Depot Security Office (DSO) shall be provided at the Depot main entrance. It shall be designed to provide automated security systems as follows:

- Vehicular and pedestrian access control and recording entrance and exit with the Depot;
- Fire alarm control panel;
- CCTV covering the Depot site, buildings and perimeter fencing; and
- Access control to offices, technical rooms, stores.

3.6 Mechanical and Electrical Services

Building service installations, including electrical services, fire services, plumbing and drainage and environmental control system shall conform to the appropriate regulations and shall be provided in accordance with the requirements of the Contract.

A waste-water treatment and recycling plant shall be provided for storm water and water from train washing and cleaning, and shall be located within the Depot.

Reticulated electrical services shall be provided from the Depot substation, supplemented by a standby generator, to support the DCC, DSO facilities and yard emergency lighting, as specified in the Contract.

3.7 Workshop Equipment and Machinery

Workshop equipment and machinery shall be provided to undertake the work identified in the Depot Operations and Maintenance Plan.

The Concessionaire shall submit the workshop equipment and machinery designs and/or specifications to the DMRC for review during the Design phase.

END OF SECTION 3

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CHAPTER 11

CITY AIRPORT TERMINAL (CAT) SYSTEMS

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Delhi Metro Rail Corporation Ltd.

1.1 Specification

This Specification stipulates the performance requirements for the City Airport Terminal Systems (CATS) to be designed, constructed, commissioned and operated by the Concessionaire for the Airport Metro Express Line (AMEL)

1.2 Reliability and Maintainability

1.2.1 The CATS shall be engineered for a minimum operational life of 30 years with the exception of any consumables which shall have an operational life of at least 5 years.

1.2.2 The Concessionaire shall ensure that the equipment supplied shall achieve the availability and maintainability standards as laid down in the System Technical Requirements Schedule D Part III, Chapter 1, and shall always be under good repair within the environmental conditions prevailing where the Check-in Facilities will be installed.

1.3. Engineering Documentation Requirements

The final engineering, risk and hazard analysis of the CATS to form complete, safely operable and reliable installations shall be the responsibility of the Concessionaire. The Concessionaire shall perform all analytical and engineering activities necessary to support performance compliance with the Contract for the complete CATS. The Concessionaire shall also refer to the System Technical Requirements Schedule D Part III, Chapter 1 for further details relating to design drawings and documentation requirements.

END OF SECTION 1

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Delhi Metro Rail Corporation Ltd.

2 Check-in Counter

2.1 General

2.1.1 This Specification covers the requirements for Check-in Facilities, comprising at a minimum; Check-in Counters, Out of Gauge baggage Counters (OOG), Ticket Counters, Excess Baggage Payment Counters, and Information Counters and all associated fittings and accessories.

2.1.2 The Concessionaire shall provide the complete Check-in Counters, OOG Counters, Ticket Counters, Excess Baggage Payment Counters and Information Counters consisting of various, counter-heads, cupboards, and signage and the means of mounting the units either to the floor or counter tops, ceiling or wall as the case may be for New Delhi and Shivaji Stadium Stations

2.1.3 The Concessionaire shall provide the complete Check-in Counters, Ticket Counters, and Information Counters consisting of various, counter-heads, cupboards, and signage and the means of mounting the units either to the floor or counter tops, ceiling or wall as the case may be for Dhaula Kuan Station.

2.1.4 The Concessionaire is also required to take into consideration the engineering and functionality of the Check-in Counters, OOG Counters, Ticket Counters, Excess Baggage Payment Counters and Information Counters being procured and installed at the Departure Level of the Main Terminal Building of the new IGI Airport by the Airport Contractor, and to engineer and install the same or similar at the Departure Halls of New Delhi, Shivaji and Dhaula Kuan Stations.

2.1.5 The extent of the Works shall also embrace related architectural works, where applicable, in connection with the installation or mounting of the furniture at the locations indicated on the Architectural Drawings.

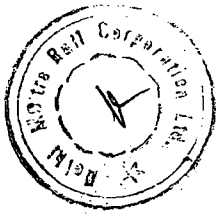
2.1.6 All the necessary power supplies for the Check-in facilities shall be provided. Also the general lighting of the check-in facilities and for the various signages including LCD, or the like. In this regard, all wires and cables shall be protected against physical damage, and shall comply with the latest provisions of the approved regulations and International Standards. Detailed cable lay-out drawings and wiring diagrams shall be submitted for approval before work commences.

2.1.7 The Concessionaire shall carry out all testing and Commissioning, Integrated Tests and Tests on Completion as required for the completion of whole of the Works and obtain the written approval at or before the time of completion.

2.2 Summary of Works

2.2.1 The Check-in counters shall consist, but not necessarily be limited, to the following item:

(1) Check-in Counters
(2) Out of Gauge (OOG) Baggage Counters
(3) Ticket Counters
(4) Excess Baggage Payment Counters
(5) Information Counters



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2.2.2 Provisions for the installation of CUTE facilities shall be part of the Works. Details of the necessary provision shall be obtained by the Concessionaire through coordination with the Airport Authority of India / AIMS contractor for the new IGI Airport.

2.2.3 Passengers and their baggage are required to pass security check, in accordance with DMRC regulations, before entering the paid area of a station (and CAT area). The Concessionaire shall supply the necessary security equipment for passenger and baggage security.

2.3 Information

2.3.1 Adequacy of Given Information

(1) The information in the tender documents is merely for the guidance of the Concessionaire to enable him to gain an overall concept of the extent of the work involved. They are not necessarily complete in reflecting the full scope of work, particularly in respect of details.

(2) The onus shall fully rest with the Concessionaire to ascertain the information given as to its sufficiency and correctness prior to arranging for fabrication of the joinery units and related components. The Concessionaire shall at his own cost make site measurements as he deems necessary to check on the correctness or adequacy of the information supplied. No claims will be accepted on the ground of insufficiency or incorrectness of information given or of ignorance of the conditions under which the work will be executed.

(3) Unless otherwise agreed to in writing by the DMRC or otherwise shown in the Drawings, all items which are to be floor, ceiling or wall mounted shall be mounted flush to the surface with the fixing screws / bolts or corrosion-resistant material of sufficient number as to render the structure firmly held in place, stable and free from being toppled. In this regard also, all exposed or visible screws / bolts and other fasteners shall be stainless steel or heavily chromed brass or galvanized steel. Ordinary mild steel screws, bolts and nuts, and such like fasteners that are not corrosion resistant shall not be permitted.

(4) No materials, fitting or accessory shall be shipped or delivered to site until the shop drawings, amendments thereof (if any) and other details are approved by the DMRC.

2.4 System Description and Performance Requirements

2.4.1 General

The Check-in facilities to be provided at New Delhi and Shivaji Terminal Stations shall enable the Concessionaire to provide full airline check-in services and baggage handling services to those airlines contracted. For Dhaula Kuan Station Check-in and issuing of airline boarding passes only, are to be provided by the Concessionaire, space is to be provided to accommodate baggage handling facilities at a later date. The functions to be provided and their functionality shall be the same as those to be provided at the check-in facilities at the new IGI Airport.

2.4.2 System Description

(1) Check-in Facilities

Sufficient linear type check-in counters, etc., shall be installed for the designated operators of the check-in facilities at the Stations, to enable adequate check-in services, including but not limited to the following:

(a) Issuance of boarding passes

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(b) Issuance of baggage tags

(c) Acceptance of check-in baggage

(d) Conveyance of baggage to the train through the Baggage Handling System

The Concessionaire shall define from the railway forecast patronage figures, the numbers of Check-in Counters, OOG Counters, Ticket Counters, Excess Baggage Payment Counters and Information Counters required for day 1 operation.

The Concessionaire shall also take into consideration the future space provisions within the Check-in Departure Areas and define based on the forecast patronage figures, that the space provisions provided are adequate for his needs until the year 2041.

(2) The CUTE facilities shall be installed at the check-in counters to support check-in services, including but not limited to the following:

(a) Computer Monitor, keyboard and CPU

(b) Boarding pass printer

(c) Baggage tag printer

(d) General Purpose printer

Power point and network cabling or peripheral connection cabling will be required for each CUTE facility. Necessary cable ducts, pipes for protection of those cabling shall be provided by the Concessionaire for installation of the above equipment.

Further to the above, equipment shall be installed by the Concessionaire as follows:

(a) Telephone

(b) Conveyor control panel for Baggage handling system

(c) Baggage weighing scale

Other equipment to be provided by the Concessionaire for Check-in, is as follows::

(a) Common User Terminal Equipment;

(b) Airport Information Management System; and

(c) Flight Information Display System.

(3) Out of Gauge Baggage Counters

OOG Baggage Counters shall be installed beside the check-in counters. The required number of OOG Baggage Counters and the locations of which shall be proposed by the Concessionaire in the course of his initial Design Submission.

The CUTE facilities shall be installed by the Concessionaire at the OOG Baggage Counters to support the OOG baggage services. The equipment shall include but not limited to the following:

(a) Computer Monitor, keyboard and CPU

(b) Baggage tag printer

(c) General Purpose printer

(d) Telephone

Power points and network cabling and peripheral connection cabling will be required for each

CUTE facility. The necessary cable ducts, pipes for protection of those cables shall be provided by the Concessionaire for the installation of the above equipment.

Further to the above, the following equipment shall be installed by the Concessionaire:

(a) Baggage weighing scale

(b) Flight information display

(c) Counter assignment display

The Concessionaire shall coordinate with those suppliers for the installation of the equipment, power receiving, cabling and cable ducting or piping works.

(4) Excess Baggage Payment Counters

The required number of Excess Baggage Payment Counters and the location of which, shall be proposed by the Concessionaire in the course of his initial Design submission.

The Concessionaire shall coordinate with AAI and Agents to establish any special equipment to be provided. The Concessionaire shall procure and put to work all equipment necessary for the payment of Excess baggage.

Power point and network cabling or peripheral connection cabling will be required for each of the above facilities to be installed by the designated operators. Necessary cable ducts, cables, pipes for protection of those cabling shall be provided by the Concessionaire for installation of the above equipment.

Further to the above, following equipment shall be installed by the Concessionaire.

(a) Telephone

(b) Counter assignment display

The Concessionaire shall coordinate with those suppliers for the installation of the equipment, power receiving, cabling and cable ducting or piping works.

(5) Information Counters

The required number of Information Counters and the location of which, shall be proposed by the Concessionaire in the course of his initial Design submission. The information counters shall be able to accommodate facilities to be installed by the operator, including, but not limited to, the following:

(a) General Purpose printer

(b) PA System with paging system

(c) Telephone System

(d) Master Clock System

(e) Display System

Power point and network cabling or peripheral connection cabling will be required for each of the above facilities to be installed by the designated operators and system wide. Necessary cable ducts, cables, pipes for protection of those cabling shall be provided by the

Concessionaire for installation of the above equipment.

(6) Security Screening Equipment to shall be located at the entrances for the concourse area from all road and rail connections. The Concessionaire shall install passenger security check equipment and baggage security check equipment, including all power supplies, cabling, cable containment etc for the complete installations. The Concessionaire shall define the types, quantities and locations of the passenger and the baggage security equipment taking into consideration the passenger forecasts for day 1 opening and the future requirements.

(7) Mock-Up

The Concessionaire shall produce a full size "mock-up" of the Check-in Counters, prior to the production of the goods. The Concessionaire shall supply and demonstrate to DMRC for approval:

(a) One full size mock-up of a check-in counter complete with all accessories, fittings and mounting screws to be incorporated in the Works.

(b) One full size mock-up of a sign complete with lighting, screed acrylic text plate and mounting material.

(c) One full size mock-up of non-illuminated sign completely screed and provided with mounting material if applicable.

(d) One full size mock-up of the airport name sign, complete with neon-lighting and mounting material if applicable.

After approval the Mock-up can be used for the Concessionaires Works,

(8) After installation, the prototype Check-in counters and their associated components and accessories shall, in all respects, be equal to or better than the specimen mock-up and the representative samples of the components submitted. Any Counter and Sign or component that has been installed and found to be not in compliance with the Specifications / Mock Up shall be immediately replaced.

2.4.3 System Performance Standard

(1) The Check-in Counters shall be engineered, procured and installed to the relevant International Standards and Codes of Practice, (ie India Industrial Standards (IIS), the Japanese Industrial Standards (JIS), British Standards (BS) and American Standards). However, should the Concessionaire wish to propose other internationally recognized standards, then the Concessionaire must demonstrate to the satisfaction of the DMRC that the proposed Standards are equal to or better than those listed above.

(2) The Concessionaire shall select equipment and cables with the appropriate specification to engineer, procure and install the Check-in Facilities which shall meet the system performance standard in this sub-section.

(3) The Check-in Facilities shall be compatible with those being installed at the new IGI Airport.

(4) The level of the security checks for passengers and their baggage shall determined by the relevant authorities, e.g. Central Industrial Security Force (CISF), or other relevant authorities concerned.

END OF SECTION 2

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3 Baggage Handling System

3.1.1 General

The Baggage Handling System (BHS) of the Airport Metro Express Line (AMEL) shall handle outbound airline passenger baggage check-in at New Delhi, Shivaji and Dhuala Kuan Stations. Baggage shall be transported from New Delhi and Shivaji Stations to the IGI Airport Station on the Airport Express Line trains, where it will then be handed over to the Airport Handling Agencies for delivery to the IGI Airport BHS.

Under the Concession Agreement the Concessionaire shall carry out engineering, supply, installation, testing, commissioning, operation and maintenance and all associated work for the principal equipment forming the Baggage Handling System.

3.1.2 Summary of Works

The works of the Baggage Handling System shall include the following:

(1) Baggage Conveyor System

The Concessionaire shall engineer, manufacture, deliver, install and commission the baggage conveyor system in accordance with the Drawings and this Specification. The Works shall include, but not be limited to:

(a) Weigh Conveyors

(b) Dispatch Conveyor

(c) Collector Conveyors

(d) Inclined Conveyors

(e) Vertical Conveyors

(2) The system shall include all control equipment, maintenance equipment, accessories and spares.

(3) The Concessionaire shall be responsible for the design of the conveyor systems to suit the projected passenger patronage and baggage forecasts. Typical layout drawings for the conveyor systems at New Delhi, and Shivaji Stations are shown on the Architectural Drawings.

(4) The Concessionaire shall check and define his baggage car requirements and include these in his rolling stock design and/or Operations Plan.

(5) For Dhaula Kuan Station where the passenger patronage is expected to be low at the start of Revenue Service, it is foreseen that no Baggage Handling Facilities will be provided. However space provision will be provided which may allow future installation of a Baggage Handling System if the Concessionaire so desires.

(6) Baggage Conveying System

At New Delhi, and Shivaji Stations, a baggage conveying system shall carry the passenger bags from the check-in counters to the secure Baggage Handling Area. Within the secure Baggage Handling Area (BHA) the baggage shall be stuffed into containers and the containers transferred from the secure BHA to the secure BHA at platform level, loaded in to the train baggage car and transported to the new IGI Airport Station. The containers shall be off loaded at the secure BHA at IGI Airport station

platform. The baggage will be de-stuffed from the containers and conveyed to a secure sorting area, were the Airport Handling Agents shall sort the baggage and then deliver to the new IGI Airport Baggage Handling System. The Concessionaire shall coordinate with the Airport Handling Agents to interface the systems for a seamless transfer of passenger baggage.

(7) Container Handling System

a) The Concessionaire shall engineer, manufacture, deliver, install and commission the container handling equipment for New Delhi, and Shivaji Stations. The works shall include but not be limited to;

(i) Baggage container transfer

(ii) Baggage Tracking System

(iii) Empty container stock area "Stage Area"

(b) The System shall include all necessary equipment, power, and controls. The Concessionaire shall liaise with Rolling Stock to achieve full compatibility of his engineering for the container handling system within the train baggage car.

(c) The Concessionaire shall identify the number of containers required to operate the BHS. The containers shall be fire and blast proof.

(d) The Concessionaire shall include provision for future extension such that the development from the initial phase to the final phase can be achieved without disruption to the baggage handling operation.

(8) Baggage Tracking System

The Concessionaire shall design and engineer the requirements for a Baggage Tracking System, to enable the secure tracking, location and time of any bag or container along the travel journey.

(9) The Concessionaire shall provide enough number of baggage trolleys and handling of the trolleys.

(10) The Concessionaire shall provide helpers for passenger with baggage.

3.2. System Description and Performance Requirements

3.2.1 General

This Specification contains a description of the Baggage Handling System and its performance requirements. The Concessionaire shall ensure that all Works undertaken by him shall be able to achieve the system performance requirements of Clauses 2.2 and 2.3 of this Specification.

Prior to the commencement of any detailed engineering work or selection of equipment the Concessionaire shall review the Drawings and Specification and shall satisfy him that the system performance requirements can be achieved. If at that time or during subsequent equipment selection or engineering, the Concessionaire finds that any element of the specified works could adversely affect the performance of any part of the system, then the Concessionaire shall immediately notify the DMRC.

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3.2.2 System Description

The facilities to be provided within the Contract for the Baggage Handling Equipment (BHE) shall provide for the full system of check-in, baggage and container systems from New Delhi and Shivaji Stations to IGI Airport Station. Airline passenger Check-in only is to be provided at Dhuala Kuan Station.

Provision shall be made in the engineering for progressive enlargement of the system to meet future demands up to the capacity of the Design Year of 2041.

3.2.3 Check-In

At New Delhi, Shivaji and Dhuala Kuan Stations Check-in counters shall be provided by the Concessionaire to accommodate Common Use Terminal Equipment (CUTE). Airport Information Management Systems (AIMS), Flight Information Display System (FIDS) and Security Check equipment.

3.2.4 Baggage Handling

The baggage handling system shall convey the baggage from the check-in desks to the BHA.

3.2.5 Baggage Transfer and Container Handling

When the bags arrived at the stuffing point in the BHA, bags will be stuffed into containers. The containers will be transferred from the BHA to the platform BHA to await loading onto the train baggage car.

The Concessionaire shall size the containers to accommodate passenger baggage in accordance with its passenger patronage forecasts.

3.2.6 Baggage and Container Tracking

A system of tracking for the baggage and containers within the stations, trains and station off loading areas shall be established, to enable the historic tracking of baggage, full containers and empty containers carried within the system to be available. At the IGI Airport baggage hall, whilst de-stuffing baggage containers, the Concessionaire shall scan the bags out of the Tracking System. Data of bags delivered to IGI Airport shall be transmitted to the IGI Airport BHS.

3.2.7 Transportation by Train

The Concessionaire shall define the baggage car requirements to enable the containers to be moved in a safe manner for the duration of the journey.

3.2.8 Transfer of Baggage at IGI Airport

At IGI Airport Station, the Concessionaire shall de-train the Baggage Containers, hoist them to ground level for transportation to the IGI Airport Baggage Hall. The Concessionaire shall provide suitable road vehicles and transport the Baggage Containers to the designated reception in the Airport Baggage Hall. The Concessionaire shall return the empty Baggage Containers to IGI Station platform.

3.2.9 Container Return

Empty containers will be returned via train baggage cars to New Delhi and Shivaji Stations to be re-entered into the system.

The Concessionaire shall determine the requirements for containers storage facilities at the stations.

3.3 Performance and Safety Standard

3.3.1 The Concessionaire shall ensure that the system can achieve the following performance criteria;

(1) Early baggage check-in can be achieved

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(2) Baggage containers can be loaded to and unloaded from the train baggage car within a 4 minute period.

(3) The Concessionaire shall determine and coordinate the time period for transfer of baggage from the CAT to the IGI Airport Baggage Handling area, which shall enable airlines to conduct their Security checks in-accordance with the Bureau of Civil Aviation Security requirements.

(4) BHA areas are secure from unauthorized entry

3.3.2 Baggage to be handled

(1) The system engineering shall acknowledge the many differing types of baggage and that their straps, handles, wheels and labels etc., shall not be damaged or otherwise become jammed in the system.

(a) Baggage sizes to be accommodated are:

(i) Standard Maximum Baggage Size

Length	900mm
Height	750mm
Width	450mm
Weight	50kg

(ii) Standard Minimum Baggage Size

Length	300mm
Height	200mm
Width	150mm
Weight	2kg

(iii) Out of Gauge Maximum Baggage Size

Length	1600mm
Height	450mm
Width	450mm
Weight	90kg

(iv) The system shall be capable of handling suitcases in leather, aluminium, plastic, boxes, trunks in wood or steel, rucksacks, travel bags, holdalls, suite-bags

(2) Safety

(a) System Safety

(i) All control methods, circuitry, mechanical equipment and operating/maintenance procedures shall be engineered to provide maximum safety for operating and maintenance personnel. Engineering shall minimise potential damage to the equipment and to the contents or covering of the baggage being processed. As an engineering goal, failsafe techniques shall be engineered to prevent the occurrence of unsafe conditions which could result from an equipment failure or improper implementation of the operating procedures.

(ii) As employed herein, the failsafe principle shall be interpreted as follows:

In the event an equipment failure or external influence such as improper operation, high temperature, power failure, or other adverse conditions affecting the proper function of a system or element involved with the safety or life or health, the said system or element shall revert to a state known to be safe to all personnel interfacing with the equipment.

(iii) All furnished and installed equipment shall meet all applicable International Safety Requirements.

(iv) The operation of the system shall be safe to use, and control functions to be performed shall be simple to minimise possible errors. Effective means for emergency system shutdown shall be provided.

(v) The system shall provide adequate means for insuring the safety of maintenance personnel.

END OF SECTION 3

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Airport Communications Systems Interface

4.1 General

This Specification stipulates the communications system linking the CATs' with the IGI Airport and the airline check-in management facilities to be designed, procured, installed and Operated and Maintained by the Concessionaire for the AMEL.

The Concessionaire shall construct an Airport Communications Equipment Room (ACER) at each station and provide all necessary Building Services to support the Airport Communications Equipment.

4.2 System Description and Performance Requirements

4.2.1 General

1. A Data Transmission System employing a dedicated Fiber Optic cable ring main, shall provide all communication's between the IGI Airport and the CAT's at Dhuala Kuan,Shivaji Terminal and New Delhi Stations.

2. The IT Systems providing the airline check-in data, CAT management and flight information for AMEL passengers are as follows:

   a) Common Use Terminal Equipment (CUTE). The CAT System shall be networked to the similar system at the IGI Airport to enable the Concessionaire to provide airline passenger check-in and issue of boarding cards and baggage labels.

   b) Airport Information Management System (AIMS)

   The AIMS System shall be networked to the similar system at the IGI Airport, to enable the CAT manager to allocate Check-in desks for airlines and display airline logos and flight details.

   c) Flight Information Display System (FIDS)

   A subsidiary system of the AIMS, the FIDS shall provide flight arrival and departure data for airlines, Check-in counters, arrival and departure times and landing.

3 Airport Radio System

The Concessionaire shall design, provide and put to work, a compatible IGI Airport radio base station and LCX cable system at IGI Airport Station, to ensure adequate radio coverage at all levels of the underground Station. The DIAL contractor shall provide the high bandwidth fiber link between the Airport Terminal Building and the Airport Communications Equipment Room (ACER) at IGI Airport Station.

4. Fire Alarms

The Fire Alarm Systems of IGI Airport Terminal Building and IGI Airport Station are to be overlapped, such that an incident in one location is alarmed in the other, to enable passenger management.

The Concessionaire shall supply and install suitable interface hardware and software (if required) for the interface in the ACER. The DIAL contractor shall provide the physical connection from the Airport terminal Building to the ACER.

5. Customs surveillance CCTV on CAT Security inspection areas: The CCTV coverage of the Security Inspection areas at each CAT Station entrance shall also be repeated in the IGI Airport Customs Office. The Concessionaire shall interface this facility at the ACER of IGI Airport Station.

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4.2.2 System Performance

1. Data Transmission System (Airport Systems)

The Fiber Optic Cable shall use diverse routes to minimise the possible loss of communication due to damaged cable.

The Fiber installed shall have sufficient capacity to handle all planned data communications and 50% spare capacity. A minimum of 24 fiber cable shall be provided.

The Concessionaire shall coordinate with DIAL for the fiber optic cable specification.

The Data Transmission System shall be engineered and perform similar to that Specified in Volume 3 Schedule D Chapter 6 Section 2.

2. CAT Systems for IT

The CUTE and AIMS/FIDS hardware and software shall be fully compatible with those of the IGI Airport. The Concessionaire shall coordinate with DIAL contractor for the integration and commissioning of the Systems.

END OF SECTION 4

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Chapter 12

Operations Control Centre Specification

Table of Contents

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1.0 General

1.1 Scope of Document

This Specification stipulates the performance requirements for the Operations Control Centre (OCC) facilities to be designed, constructed, commissioned and operated by the Concessionaire for the Airport Metro Express Line (AMEL).

1.2 DMRC Requirements

1.3.1 The OCC shall monitor and control all aspects of the AMEL Revenue Line during all aspect of its Operations. During periods that the OCC is not available, operation of the AMEL systems shall fall-back to facilities to be provided for that purpose. The fall-back control facilities shall provide the minimum facilities for operation of the Railway System

1.3.2 During an Emergency situation, the OCC will provide centralized supervision of the incident in accordance with the recommendations of NFPA 130:2007. Standard For Fixed Guide-way; Transit and Passenger Rail Systems'

1.3.3 Access to the OCC building shall be fully secured. Access to the Operating and equipment rooms shall be controlled to permit the entry of authorized people.

1.3.4 The OCC must be accessible to people with disabilities.

1.4 RAMS Requirements

1.4.1 General

The System engineering shall be planned and managed in accordance with the requirements specified in Schedule D Part III Chapter 1, General Technical Specification.

1.4.2 Reliability Requirements

(1) Each of the system-wide engineering systems central computers shall be duplicated. Pairs of computers shall be fully redundant and the off-line unit maintained in hot-standby mode. The central computers' for the revenue line shall be engineered for a minimum useful life of 15 years, based on the equipment being continuously in operation, and shall achieve an MTBSAF of 200,000 hours between any failures affecting the revenue train service.

1.4.3 Availability

(1) The system-wide engineering systems central equipment shall be engineered for a minimum operational life of 20 years based on the equipment being in continuous use and achieving a minimum Service Affecting Availability of 99.995%.

(2) Loss of any System-wide computer or peripheral equipment shall be transparent to the operation of the Revenue services.

1.4.4 Maintainability

(1) The Concessionaire shall undertake a Maintainability analysis to asses the maintenance requirements to assure the Availability targets of the systems.

(2) The equipment to be supplied by the Concessionaire must be engineered for minimum maintenance wherever possible. Maintenance activities required must be capable of being performed with minimum or no impact on the planned train service.

(3) To optimise speedy corrective maintenance, techniques employing automatic diagnostics test points, and rapid repair facilities shall be provided.

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1.4.5 Safety

(1) Safety Rules to be developed for the Operation and Maintenance of the AMEL during Normal working and Emergency situations. Operating Rules and procedures shall be based on NFPA 130; 2007 and shall be submitted to the DMRC for Approval.

(2) Risk Assessment

a) The Concessionaire shall demonstrate that the OCC equipment can be operated and maintained safely. The Concessionaire shall prepare a Risk Assessment Report identifying the risk to people and property. The Assessment may be based on a comparison of System features and operating practices with other comparable railway systems for which risk levels are known.

b) The Concessionaire shall demonstrate that risk to passengers, members of public, including trespassers is low as reasonably practicable. Residual risk shall be recorded in the HAZARD Log and Operator Rules and Procedures developed to mitigate them shall be proposed by the Concessionaire, for Approval of the DMRC.

1.5 Control Centre Overview

1.5.1 Operating Room

The OCC operations room is foreseen to consist of work-stations, as follows:

1) Control Superintendent providing all communications facilities and monitors to oversee the status of the Signalling and Engineering Systems. In the event of an Emergency, the Control Superintendent shall directly control the situation until the correct Emergency service is on site.

2) Train Service Regulator supervising train movements via the Signalling and Train Control System. A mimic panel shall display the status of the Revenue Line for each train by ID and location, routes set and on hold, point and signal indications and alarms.

3) Engineering Controller supervising the HV and LV electric power systems, Traction Power System, Tunnel Ventilation Systems and Building Services supporting Station, tunnel and on-line equipment rooms, via the SCADA and SMS Systems. A mimic panel shall display the status of the equipment.

4) Communications Controller supervising the voice, data and video communications of the AMEL provided by the Control and Communications Systems, as follows:

- Telephone system;
- Radio communication system;
- Emergency services radio system
- Passenger help point system;
- CCTV system;
- Public address system;
- Passenger Information system;
- Master clock system;

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The Communications Controller shall manage passenger enquiries and monitor their movements via the CCTV system.

If required during the attendance of the Emergency Services at an incident, the Communications Controller shall patch the AMEL voice communications systems with those of the Emergency Service.

(5) Security Coordinator.

(6) A Fault and Works Coordination office with communications and OA&IT facilities shall be provided. The fault and Works Coordinator shall coordinate Operations activities with Maintenance staff during failure situations and non-revenue hours.

1.5.2 Staff amenities and meeting room shall be provided.

1.5.3 Equipment Room

The Equipment room shall house the system-wide engineering systems central computer equipment and associated power supply units and maintenance engineers workstations.

Recorders and printers shall be connected to each system to record operations and failures or historical records, failure trend analysis and re-creation of all events.

1.5.4 It is recommended that the AFC Engineers Workstation and central computers are maintained in a secure room, to be accessed by authorized persons only.

END OF SECTION 1

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2 OCC Operations Plan

2.1.1 As part of the Operating Plan (Operations and Maintenance Functional Specification) the Concessionaire shall develop an OCC Operations Plan that shall enable the safe, secure and reliable operation of planned passenger services and management of unplanned events.

As part of the OCC Operating Plan, the Concessionaire shall coordinate with the Airports Authority of India, Airlines and their Agents in the development of interface Rules and Procedure required for Operation and Maintenance activities between OCC and IGI Airport Control.

2.1.2 OCC Functions

The key functions of the OCC to be considered are as follows:

- Monitor and regulate passenger train service in accordance with the time-table and institute recovery programs or manual intervention when required;
- Manage works train operation, as required; Manage planned and unplanned incidents;
- Manage Emergency and Security incidents and co-ordinate with the appropriate services
- Co-ordinate rolling stock entry and exit with revenue service and during non-revenue hours;
- Co-ordinate with station and other line staff in the safety interests of people in the system;
- Monitor Stations and tunnel portals for deleterious situations
- Co-ordinate fault and works for the Railway Systems;
- Manage track access and possessions;
- Provide train service information to passengers and public;
- Management of the Station and tunnel environmental and safety systems and monitoring of the associated engineering;
- Monitoring and Management of the HV electric power supply and traction system;
- Manage communications with passengers using Help Points;
- Monitor passenger movements for potential unsafe and illegal activities; and
- Monitor the maintenance activities during revenue service.

END OF SECTION 2

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SCHEDULE - E

APPLICABLE PERMITS

SCHEDULE E

APPLICABLE PERMITS

The Concessionaire shall obtain all the prior approval/permits required under the prevailing laws in India during the currency of the Concessionaire Agreement with the Employer. The following is a suggested list of applicable approvals/permits:

1. Central Pollution Board-for Noise, Water and Air pollution caused by any structure/equipment before setting up/establishing any plant/equipment.
2. Labour Permit-for employing unskilled/semi-skilled/skilled labour during day/night.
3. Municipal Corporation of Delhi and New Delhi Municipal Corporation for:-
   a. architectural/developmental approval of proposed permanent structures as per building-bye-laws/regulations, and
   b. dismantling/reconstruction/underpinning/strengthening of affected structures, disposal of solid waste/excess material or soil, setting up of temporary camps on Govt./private/leased land.
4. Delhi Urban Arts commission-Clearance for any urban structure affecting the landscape/environment.
5. Archeological Survey of India –for construction of any structure within the laid down radius of monuments.
6. Delhi Jal Board-for diversion of utilities including reinstatement/reconstruction to original specifications, water-supply connections from mains, disposal of liquid waste, sewerage connections.
7. Central Ground Water Board-for underground source of water-supply/tube wells
8. NDPL and BSES (Electricity Distribution Authority)-for electric supply/distribution related approvals.
9. Mahanagar Telephone Nigam (MTNL)-for telephone/IT connections.
10. Ministry of Environment and forests-for undertaking any work in designated forests and cutting of trees/branches/transplantation of any trees in the Works area.
11. Delhi Traffic Police/Transport Deptt.-for traffic diversions and running of vehicles on the specified routes/timings.
12. Delhi Fire services-prevention and control of fire in structures/facilities.
13. Central Custom/Excise Duty- for import/purchase of goods including exemption of laid down duties/tariffs, if applicable.
14. Govt. of National Capital Region-for Project Authority Certificate
15. Central Sales Tax/Delhi Value Added Tax-on goods brought to Delhi.
16. Commissioner of Railway Safety-for safety requirements under Indian Railways Act/Delhi Metro Act and Over-Dimensional Clearance (ODC) for move of over-sized equipment in rail wagons.
17. National Highway Authority/Central/State Public Departments for move of heavy vehicles/equipment on roads/bridges, maintenance/dismantling/construction of diversions along roads reconstruction of roads.
18. Defence Deptt. for access/permission to work in the restricted areas.
19. Ministry of External Affairs/Dept. of immigration-for necessary permission to expatriates working in India.
20. Ministry of Civil Aviation-for work in the area under their control.

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21. License for use of firearms or use/transportation of explosives/inflammable materials from the respective departments of State and Central Govt.

22. License for setting up of Kerb side pump or weigh bridge from Dept of Weights and measures.

23. Electrical Inspector for the Government of India(EIG).

24. Any other permits or clearances required from under the Applicable laws.

While DMRC shall provide necessary help and assistance in facilitating these, the concessionaire shall expeditiously carry out the necessary formalities and follow-up with the concerned departments/agencies well in time to avoid delay.

Following permits shall form part of conditions precedent for financial close :-

1. Labour permit for employing unskilled/semi-skilled/skilled labour during day/night.
2. Central Sales Tax/Delhi Value added Tax on goods brought to Delhi

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SCHEDULE - F

PERFORMANCE SECURITIES

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SCHEDULE F

PERFORMANCE SECURITY

(Refer Clause 5 of the Concession Agreement)

(To be stamped in accordance with the Stamp Act of the Country of Issuing Bank)

To: DELHI METRO RAIL CORPORATION, NBCC Place, Bhishma Pitamah Marg, Pragati Vihar,

New Delhi - 110003.

WHEREAS REALIANCE ENERGY LIMITED – CONSTRUCCIONES Y AUXILIAR DE FERROCARRILES, SA JOINT VENTURE (hereinafter called "the Concessionaire") has undertaken, in pursuance of Concession Contract AMEL-P1 dt. [insert date] to design, execute and complete and remedy any defects in the Physical Works of Concession Agreement AMEL-P1 (hereinafter called "the Concession"), namely:

1) CAT equipment, trackwork Power Supply, Signaling, Communications, Ventilation, Control and Safety Systems for the whole of the alignment between New Delhi Station and the terminal station at Dwarka Sector 21 via Indira Gandhi International Airport and,
2) A complete Maintenance Depot, together with the provision of an Operations Control Centre, and
3) Architectural finishes and the mechanical, HVAC, CCTV, electrical installations and all other systems and services to all Stations and ancilliary buildings,
4) Baggage Handling System at New Delhi, Shivaji Stadium stations and at Indira Gandhi International Airport, and
5) Provide the Rolling Stock, and
6) As otherwise shown in the Concession Drawings and as expressed or reasonably implied in the Concession Documents.

and to Operate and Maintain the Airport Metro Express Line, as expressed or reasonably implied in the Concession.

AND WHEREAS it has been stipulated by you in the said Concession that the Concessionaire shall furnish you with a Bank Guarantee by an Indian Nationalised bank for the sum specified herein as security for compliance with his obligations in accordance with the Concession.

AND WHEREAS we (Insert name and address of Bank) have agreed to give the Concessionaire such a Bank Guarantee:

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Delhi Metro Rail Corporation

NOW THEREFORE we hereby affirm that we are the Guarantor and responsible to you, on behalf of the Concessionaire up to a total Sum of Rs. 750 million (Rs.Seven Hundred and Fifty Million), such sum being payable in the types and proportion of currencies in which the Sum is payable and we hereby unconditionally, irrevocably and without demur undertake to immediately pay you, upon your first written demand and without cavil or argument any sum or sums within the limits of Rs. 750 million (Rs. Seven Hundred and Fifty Million) as aforesaid without your needing to prove or to show grounds or reasons for your demand for the sum specified therein.

We hereby waive the necessity of your demanding the said debt from the Concessionaire before presenting us with the demand.

We further agree that no change or addition to or other modification of the terms of the contract or of the Works to be performed thereunder or of any of the contract documents which may be made between you and the Concessionaire shall in any way release us from any liability under the guarantee and we hereby waive notice of any such change, addition or modification.

This guarantee shall be valid for 5 (five) years and shall be extended from time to time as per Concession Agreement upto 90 days beyond the Concession Period. The pendency of any dispute or arbitration or other proceedings shall not affect this guarantee in any manner.

SIGNATURE AND SEAL OF THE GUARANTOR

NAME OF BANK ----------

ADDRESS ----------

DATE ----------

Notes:

1. The stamp papers of appropriate value shall be purchased in the name of the Bank, which issue the 'Bank Guarantee'

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SCHEDULE - G

(NOT USED)

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Delhi Metro Rail Corporation Ltd.

SCHEDULE - H

PROJECT IMPLEMENTATION SCHEDULE

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SCHEDULE H
PROJECT IMPLEMENTATION SCHEDULE

Subject to the provisions of the Concession Agreement, various milestone/key dates for completion are given below. Non adhering to these dates shall result in penalty/damages to be paid by the Concessionaire to DMRC as per the Concession Agreement.

1. **Signing of Agreement** — **Within 60 days from LOA**
2. **Financial Close** — **Within 120 days of LOA**
3. **Key Dates and Milestone Dates**

a.	Start of Design & Interface With DMRC Contractors	30 day from LOA
b.	Completion of Design Interface With DMRC Contractors	6 months from LOA
c.	Completion of Design for Execution	9 months
d.	Delivery of 1st set of Train	October 31, 2009
e.	Start Testing of Rolling Stock	January 31, 2010
f.	Start of Integrated Testing and Commissioning	April 1, 2010

Note: The design work shall be a continuous process and designs shall be submitted and co-ordinated in phased manner so as to achieve the above key dates and for successful implementation of the Project.

4. **Commissioning of Project and COD** — **July 31, 2010**

5. **Access Dates** for Hand-over to **Concessionaire:**

To achieve the above key dates and milestones, the Sections shall be handed-over to the Concessionaire as per the Access Dates indicated below:

a. Depot Land : Dwarka depot -Partial — January 1, 2008; Permanent 1st March,2008
Palam siding and temporary construction site — 1st March,2008

b. Guideway Access (Chainage)

From (Km)	*To (Km)*	*Access date*
0.000	0.470	1st August 2009
0.470	2.000	1st October 2009
2.000	3.861	1st October 2009
3.861	6.208	15th December 2009
6.208	8.500	1st July 2009
8.500	13.566	1st August 2009
13.566	17.252	1st May 2009
17.252	18.605	1st June 2009
18.605	19.535	1st July 2009
19.535	21.941	1st November 2009
21.941	22.694	1st June 2009

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c. Station Access

Station	*Partial access*	*Complete access*
New Delhi	1st August 2009	1st November 2009
Shivaji Stadium	15th August 2009	1st November 2009
Dhuala Kuan	1st May 2009	1st August 2009
NH8	1st June 2009	1st August 2009
IGI Airport	1st May 2009	1st September 2009
Dwarka 21	1st June 2009	1st September 2009

Note: Partial access means simultaneous working with DMRC Civil Contractor by the Concessionaire.

d. ***Railway Sub-stations***

a. Near Kendriya Bus Terminal, Church Street — September 1, 2009

b. Within IGI Airport Complex — June 1, 2009

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SCHEDULE - I

LIST OF DRAWINGS

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SCHEDULE I

(Contract AMEL – P1) 1st Draft Conformed Spec

LIST OF SYSTEM DRAWINGS

Drawings of E & M facilities included in the schedule are provided to bidders to indicate the philosophy of the Specification functional objectives.

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i.	Cross-section of Viaduct for Contract AMEL-C2	ALC/DMRC/AMEL-P1/STR/009
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SCHEDULE - J

TESTS

SCHEDULE J

TESTS

1 TESTS

The tests shall be as specified in testing and commissioning plan.

1.1 Testing and Commissioning Plan

The Concessionaire shall develop a Testing and Commissioning Plan and test specifications for review by an Independent Assessor(s) and the Consultant.

The Concessionaire shall retain the services of an Independent Assessor(s) to supervise all Testing and Commissioning work. The scope of work for the Independent Assessor(s) shall be proposed by the Concessionaire and Approved by the DMRC

The Concessionaire shall develop a Testing and Commissioning Plan and test specifications for review by the DMRC. As a minimum, the Testing and Commissioning Plan shall include the following:

As a minimum, the Testing and Commissioning Plan shall include the following:

(1) Procured material, components and equipment QA tests

(2) Factory Acceptance Tests;

(3) Performance Tests;

(4) Bench tests;

(5) Installation tests;

(6) Sub-system test;

(7) System integration tests;

(8) Systems interface tests;

(9) Integrated Systems tests;

(10) Functional tests

(11) Structure Gauge test;

(12) System dynamic tests;

(13) Statutory Tests, as follows;

- Power and Telecommunications Consultative Committee;
- Inspection by the Electrical Inspector of the Government of India;
- Inspections by the Commissioner of Metro Railways Safety; and
- Fire Brigade;

(14) Test Running tests;

(15) Trial Running tests;

(16) Maintenance demonstration tests; and

(17) Reliability tests.

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1.2 Certification of Tests

Tests shall be carried out by the Concessionaire and witnessed and certified for acceptance by an Independent Assessor(s).

The DMRC reserves the right to carry out any additional tests and safety audits considered necessary by the Independent RAMS Consultant to verify the reliability and safe working of AMEL System equipment. The Concessionaire shall provide test equipment and staff to support the DMRC additional tests.

The Concessionaire shall maintain inspection records to demonstrate that each item of installed equipment has been inspected and found to be satisfactory.

Test records and test certificates are to be duly endorsed by the Concessionaires authorised representative. Test records and certificates shall be supplied for all tests, whether or not the Independent Assessor(s) has witnessed them.

The Concessionaire shall support any testing required by the Commissionaire of Metro Railway Safety necessary for the certification of fitness to operate passenger services.

1.3 Emergency Services Simulation

The Concessionaire shall conduct simulated emergency incidents in conjunction with the New Delhi emergency services, for police, fire, ambulance and the like. Where an emergency service identifies incompatibility in their procedures and equipment, the Concessionaire shall assist the service in correcting their procedures and equipment.

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SCHEDULE-K

FORMS OF COMPLETION AND PROVISIONAL CERTIFICATES

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Delhi Metro Rail Corporation Ltd.

SCHEDULE K

FORMS OF COMPLETION AND PROVISIONAL CERTIFICATES

I Form of Completion Certificate

To: Reliance Energy Ltd – Construcciones Y Auxilliar De Ferrocarriles S.A. Joint Venture (The Concessionaire)

And to: Delhi Metro Rail Corporation Limited

The Airport Line Consultant refers to the Delhi Airport Metro Express Rail Line Concession Agreement (the "Concession Agreement") between the Concessionaire and DMRC dated [insert date]. Capitalised terms used in this Certificate are as defined in the Concession Agreement unless otherwise stated.

In accordance with Sub-Article 17.4 of the Concession Agreement, pursuant to a notice dated [insert date] and received by the Consultant on [insert date], the Concessionaire has given notice that it is of the reasonable opinion that the Concessionaire's Works would be completed and of its intention to commence the Tests.

Pursuant to Sub-Article 17.5 of the Concession Agreement the Consultant hereby certifies with this Completion Certificate that the specified Tests as per the Concession Agreement have been determined to be successful and that the Airport Metro Express Line can be legally, safely and reliably placed in commercial operations as of the date stated hereunder (the "Commercial Operation Date").

Dated: [Insert date]
Signed:

Airport Line Consultant
Delhi Airport Rail Link

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Delhi Metro Rail Corporation Ltd.

II Form of Provisional Certificate

To: The Concessionaire

And to: Delhi Metro Rail Corporation Limited

The Consultant refers to the Delhi Airport Metro Express Line Concession Agreement (the "Concession Agreement") between the Concessionaire and DMRC dated [insert date]. Capitalised terms used in this Certificate are as defined in the Concession Agreement unless otherwise stated.

In accordance with Sub-Clause 17.4 of the Concession Agreement, pursuant to a notice dated [insert date] and received by the Consultant on [insert date], the Concessionaire has given notice that it is of the reasonable opinion that the Concessionaire's Works would be completed and of its intention to commence the Tests.

Pursuant to Sub-Clause 17.6 of the Concession Agreement the Consultant hereby certifies with this Provisional Certificate that the Tests have been determined to be successful, but that although the Airport Metro Express Line can be legally, safely and reliably placed in commercial operations as of the date stated hereunder (the "Commercial Operation Date") certain works or things forming part thereof are not yet complete.

Pursuant to clause 17.6 of the Concession Agreement the Consultant hereby identifies on the Punch List appended hereto the items which must be remedied, addressed or completed by the Concessionaire in accordance with Sub-Clause 17.6 of the Concession Agreement before the Completion Certificate can be issued

Dated: [Insert date]
Signed:
Consultant
Delhi Airport Rail Link

Appended: [insert list of Outstanding Items]

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SCHEDULE - L

OPERATIONS and MAINTENANCE REQUIREMENTS

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SCHEDULE L

OPERATIONS and MAINTENANCE REQUIREMENTS

Table of Contents

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1 Introduction

1.1 General

This Document provides the DMRC Requirements for the Operations and Maintenance of the Airport Metro Express Line (AMEL) during the Concessionaire Operating Period.

1.2 Abbreviations

Abbreviations relevant to this specification are contained in the Specifications and summarized in Schedule D Part I.

1.3 Codes, Laws and Standards

Compliance with Codes, Laws and Standards shall be as specified in Schedule D Chapter 1 General Technical Specification.

The application of the Standards, Codes and Laws of India that are relevant to this specification are mandatory. Typical Standards acceptable to the DMRC are listed in Schedule D, Part 1 Chapter 2.

1.4 Scope of the Specification

This Specification stipulates the performance requirements for the Operational and Maintenance requirements for the Railway System which shall be reflected in the design and supply. Fulfillment of requirements shall be demonstrated during daily Operation and Maintenance, from commencement of revenue service through to transfer of the AMEL railway system and City Airport Terminal (CAT's) facilities at the end of the Concession Period.

The purpose of this specification is to ensure that the Concessionaire shall construct and operate a quality Railway System that provides a safe, secure, clean, efficient, reliable, frequent and comfortable means of transport, which meets the DMRC specified requirements.

The Concessionaire shall cooperate with the Airports Authority of India (AAI), airlines and their appointed agents in the implementation of the systems to be provided for the operation of CAT's and special railway equipment specified in the Contract.

The individual technical specifications contained in Schedule D Part III of the contract documents are based upon the operational requirements set out in this Operation and Maintenance Requirements.

1.5 Concessionaire's Responsibility

The Concessionaire shall design, construct, commission, operate and maintain the Railway System and CAT facilities in accordance with DMRC's requirements, for the period of the concession, as specified in the Agreement.

Concessionaire shall develop Operating and Maintenance Rules and Procedures for the AMEL which incorporate the mandatory requirements of The Delhi Metro Railway (Operation and Maintenance) Act, 2002 and amendments, and The Delhi Metro railway General Rules, 2002.

The Concessionaire shall be proactive in the mitigation of hostile acts within the AMEL premises. Facilities shall be provided to prevent the entry of hostile persons or dangerous materials to the Stations', Guideway or Depot.

The Concessionaire shall provide suitable staff as porters to assist passengers in conveying their luggage through stations and CAT's. At IGI Airport Station the porters shall operate within the station and airport terminal building.

The Concessionaire shall satisfy the requirements of the Commissioner of the Metro Railway Safety, appointed in accordance with The Delhi Metro Railway (Operation and Maintenance) Act, 2002 and Amendments also The Opening of Delhi Metro Railway for Public Carriage of Passengers Rules, 2002 and amendments

The Concessionaire shall be responsible for providing and maintaining all documentation necessary for operation and maintenance of the Railway System, for the duration of the Concession Period and hand-over of the Railway System.

The Concessionaire will be required to compile and present periodic reports to the DMRC, as Specified in Schedule W of the Agreement.

The Concessionaire shall co-operate with the Airports Authority of India, Airlines and their appointed agents and Local authorities for mitigation of illegal activities against passengers, secured baggage and AMEL infrastructure.

The Concessionaire shall be responsible for Operation of the Railway System during the concession period.

The Concessionaire shall be responsible for the Operation for airline passenger Check-in and issue of boarding cards, airline ticket enquiries and their issue service counters, and the Maintenance of all associated equipment at New Delhi, Shivaji Stadium and Dhuala Kuan Stations. The Concessionaire shall be responsible for the Operation of the airline passenger baggage Check-in and secure transportation to the injection point at IGI Airport air-side Baggage Hall, out of gauge baggage counters and excess baggage payment counters, and the Maintenance of all associated equipment at New Delhi, Shivaji Stadium (and Dhuala Kuan as required) and IGI Airport Station'.

All fatalities and major accidents that occur in conjunction with the Railway System shall be reported to the DMRC without delay.

Delays to AMEL passengers in excess of one service interval shall be reported to the DMRC without delay.

In accordance with EN 13816:2002, the Concessionaire shall enter and support a quality partnership with the DMRC. The DMRC shall be responsible for monitoring of quality of Railway System service.

1.6 DMRC's Responsibility

1.6.1 The DMRC will be responsible for facilitating the Approval of the following:

b) The Operational Safety Case and its revisions; and

b) Acceptance Tests and Demonstrations.

The DMRC shall monitor the performance and regulate the activities of the Concessionaire in accordance with the specified Operator Quality Criteria.

The DMRC shall coordinate with the Concessionaire on the corporate image to be adopted.

1.6.2 DMRC shall design, provide, Operate and Maintain Dwarka Section 21 Station facilities that are common to both the AMEL and Line 3, such as Station concourse architectural finishes, signage, air-conditioning and ventilation, lighting, security, cleaning, and the like. The Concessionaire shall coordinate the divisions O&M responsibilities with DMRC, during the initial design submission stage of the project.

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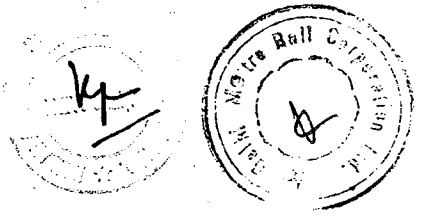
1.7 Operating Plan

The Concessionaire shall establish a Railway Operating Manuel, including the Operating Plan for the AMEL, which shall set out the core principles and controls that will permit the undertaking of safe, secure, reliable and frequent train (and other rail vehicle) services on the Railway System and shall at least consider the following items:

- Analysis of patronage forecasts and baggage capacity and development of timetables;
- Organization structure and staffing levels;
- Quality management;
- Management of incidents;
- Management of Operating Safety;
- Failure management and recovery strategy;
- Interface with emergency services;
- Alternative transport during degraded services;
- Interface with Airport Authority of India and airlines in the development of the CAT Operation Procedures;
- Interface with Airline Agents for the secure transfer of passenger baggage;
- Implementation of operations manual;
- Management of stations
- Operations Control Center operation; and
- Depot operation.
- Employment of suitably qualified and trained staff for the Operation and Maintenance of the AMEL Civil works, structures, finishes, Systems, CAT's and associated equipment. Where necessary, the Concessionaires shall obtain IGI Airport Security clearance of staff required to work within IGI Airport premises.
- Appointment of an Airline Agent or recruitment and training of staff for the Operation and Maintenance of the CAT's and associated equipment.

The Operating Plan shall be based on the proven practices of DMRC or an internationally recognized railway operator and shall be submitted to the DMRC for review during Initial Design Submission.

END OF SECTION



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2 Operations Objectives

2.1.1 General

The primary objective for the Railway System shall be to provide system capacity that is adequate to satisfy the approved patronage forecast for the design period of 30 years after commencement of revenue service.

The design of the Railway System shall support the Operation and Maintenance as follows:

1) Provide safe, reliable, comfortable, convenient, efficient rail services for able and mobility impaired passengers and their baggage;

2) Provide safe, convenient, user-friendly and efficient Operations of the CAT services.

3) Provide levels of Railway System safety and security that are equal to, or better than, current Railway industry standards;

4) Be designed to allow for operational contingencies to support continued safe operation during Railway System failures;

5) Provide benefits to the general public and to stakeholders affected by the Railway System;

6) Provide an environmentally compatible Railway System that considers: environmental issues to be part of decision processes; design for minimum energy consumption and environmental pollution; and protects the natural and urban environment;

7) Cooperate with the Central Industrial Security Force (CISF), or other Approved security agency, providing personal security examinations and x-ray of baggage entering the paid area of a station;

8) Allow for expansion of the Railway System capacity and network to meet projected future needs at planned modal transfer stations; and

9) Accommodate standard proven products and solutions of the transportation industry.

2.1.2 Hazard Consideration and Mitigation

Design, operation and maintenance of the Railway System shall give due consideration to hazards affecting:

(a) people boarding, alighting and being transported by the Railway System;

(b) personnel operating, maintaining or testing the Railway System fixed equipment and Rolling Stock, or supporting facilities and related properties;

(c) the general public and associated facilities in the vicinity of the Railway System; and

(d) adjacent properties.

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2.2 Operational Safety

2.2.1 Operational Safety Case

In order to demonstrate that the system will be managed safely, the Concessionaire shall produce and maintain an Operational Safety Case, in accordance with the Systems Assurance requirements detailed in the Contract documents.

Ownership of the Safety Case shall remain with the Concessionaire for the duration of concession period. .

2.2.2 The Operational Safety Case shall typically consist of but not be limited to the following:

a) Executive Summary;

b) Introduction;

c) Definition of System;

d) Quality Management Report;

e) Safety Management Report;

i) Introduction;

ii) Roles and Responsibilities;

iii) Safety Lifecycle;

iv) Safety Requirements;

v) Safety Standards;

vi) Safety Audit and Assessment;

vii) Supplier Management;

viii) Safety Controls;

ix) Configuration Management; and

x) Project Safety Training.

f) Technical Safety Report

i) Introduction;

ii) Assurance of correct functional operation;

iii) Effects of faults;

iv) Operation with External Influences;

v) Safety-related application conditions;

vi) Safety Qualification tests; and

vii) Other Outstanding Safety Issues.

g) Conclusion

As part of the Operational Safety Case development process, the Concessionaire shall ensure that plans and procedures as typically listed below will be in accordance with the Operational Safety Case requirements:

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a) System Management Plan;
b) System Management Plan;
c) System Operating Safety Plan;
d) Train Operating Plan;
e) Station and CAT Services Operating Plan;
f) Systems Assurance Plan;
g) Depot Operations Plan;
h) Emergency Preparedness and Fault Recovery Plan;
i) Rules and Procedures;
j) Relative IGI Airport Rules and Procedures; and
k) Health and Safety Regulations.

2.2.3 The Concessionaire's permission to operate the AMEL will be dependent upon approval of the Operational Safety Case by the Commissionaire of the Metro Rail Safety, report of the Independent Safety Assessor and the Competent Authority of DMRC.

2.2.4 The Concessionaire is recommended to refer to the Engineering Safety Management System ("Yellow Book") published by Railtrack on behalf of the UK rail industry, for case histories of a Safety Case

2.2.5 Security

The Concessionaire shall engage the Central Industrial Security Force (CISF) , a Government agency, or other Approved security agency to provide qualified staff and security equipment for the operation of DMRC security procedures for passengers and baggage entering Stations. The Concessionaire shall also maintain the Guideway and Depot as secure areas.

The Concessionaire shall provide security for passengers, staff and general public against criminal activities within the Railway System stations and trains.

In order to provide a safe and secure environment for passengers and staff, the Concessionaire shall provide features such as:

systems for passenger safety, e.g. for underground sections Platform Screens Doors (PSDs), fire detection, warning and protection systems;

sufficient staff are available and visible in key locations on the network, e.g. concourse, station entrances, platforms, trains;

security systems, such as CCTV, that are visible around the network and that such systems are seen to be used;

customer help points, public telephones, emergency stop buttons and emergency alarms which are highly visible and highly available; and

hazards are positively limited, in this context this requires the provision of physical barriers, warning notices and locking off of areas not intended for public access.

Airline passenger baggage checked into the Baggage Handling System, at each CAT and train. Baggage shall be checked-out of the Baggage tracking System at IGI Airport.

Passengers and baggage is to be security checked at each entrance to a station, with a minimum inconvenience and hindrance to passengers. The security inspection area at a Station entrance and the external approaches to the entrance shall be covered by CCTV cameras with associated monitors in the Station Security Office. This surveillance of passengers is to be repeated in the IGI Airport Customs Office.

The Concessionaire shall provide the security staff with required standard and they shall be supplied and trained with the latest safety equipment necessary to protect the AMEL property and its users.

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2.3 Operating Rules and Procedures

The Concessionaire shall develop a suite of Rules and Procedures, which will regulate the Operation and Maintenance of the Railway System with the highest regard to the safety of passengers, public and staff. Rules shall typically cover the following:

- Standards;
- conduct of personnel;
- service requirements;
- train operation and safety;
- train control and signaling system;
- *traction current system;*
- operational communication;
- tunnel and station systems;
- building services equipment;
- safety on or near the track;
- maintenance work;
- incidents and security; and
- emergency preparedness and arrangements.

Procedures shall typically cover the following.

- customer interface;
- staff responsibilities and certification;
- service planning;
- quality monitoring;
- driving modes and their hierarchy;
- station based duties;
- crowd management procedures;
- service start-up, shut-down and line clear procedures;
- train preparation for service and shut-down;
- track access procedures;
- staff booking on and booking off;
- Operations Control Center working;
- operation data and incident recording;
- security inspections of trains, stations, depot signaling disconnection's;
- failure of electric power supplies;
- total failure of communications equipment;
- installation of traction short circuit devices;
- failed train push or pull out procedures;
- station to station and single line working;
- co-ordination with emergency services;
- *supervision of contractor staff;*
- evacuation of stations and tunnels;
- route / service deviations and bus replacements; and
- configuration management.
- Tunnel limit control. Procedure for relaxation of one train per ventilation section.

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The Rules and Procedures to be developed shall be based on the proven practices of DMRC or another internationally recognized Railway System operator and shall be submitted to the DMRC for review during Detailed Design Submission.

2.4 Revenue Service Operation Requirements

2.4.1 Capacity Requirements

The Concessionaire shall provide sufficient passenger carrying capacity on trains during revenue service to meet the patronage demand.

Capacity shall be calculated for any time during the day, with all seats occupied and a standing density of not exceed 4 passengers per square meter of standing space. Standing space shall exclude foot-room between or in front of seats and circulation space for passengers with luggage.

2.4.2 Passenger Service Operating Hours

The DMRC requires passenger services shall be operated for not less than 20 hours daily.

The Concessionaire shall determine the revenue service hours to suit the passenger demand. During the no-revenue hours the passenger trains may be withdrawn to the Palam Depot and the revenue line made available for maintenance activities.

It is foreseen in the far future the IGI Airport demand for passenger rail services the operating period may require to be extended to 24 hours each day. At that time, single line working on sections of the track will be required, with maintenance activities taking place on the adjacent section.

The initial service capacity shall be determined from the Concessionaire's forecast for patronage demand, peak and off-peak periods. Patronage demand forecast results and proposed initial service shall be submitted to the DMRC for review during Initial Design Submission.

Patronage demand shall be reviewed periodically by the Concessionaire and the capacity provided shall be adjusted accordingly. Demand survey results and proposed service adjustments shall be submitted to the DMRC for review.

The Concessionaire shall identify the timing of any peak period patronage demands.

2.4.3 Operating Headways

The Concessionaire shall design and establish the Railway System for a minimum Operating Headways of 120 seconds and ensure that the Systems engineering is capable of continuously maintaining services at this interval.

The Concessionaire shall determine each station platform dwell time. Station dwell times shall be adjustable within a range, either automatically or manually from the OCC.

2.4.4 Degraded Operations

Following a failure which disturbs revenue train operation, normal timetable services shall be resumed within thirty minutes.

The Concessionaire shall provide routines for automated recovery of degraded operations. This shall include the ability to recover from failures of equipment, operator's error or interference by accidents.

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2.4.5 Emergency Procedures

The Concessionaire shall develop an Emergency Procedures Plan with the cooperation of all participating emergency services detailing specific actions required by all those who will respond during an emergency.

Procedures shall be demonstrated by simulated table-top and on-site exercises with full participation of the emergency services.

The Emergency Procedures Plan shall be submitted to the Implementing Authority for review during Detailed Design Submission.

2.4.6 Works Train Operations

The Concessionaire shall develop procedures for the safe operation of works trains during revenue and non-revenue hours. During revenue hours, only works trains fully equipped with Automatic Train Protection equipment shall operate in amongst passenger trains.

Procedures shall include but not be limited to the following:

works trains planning and authorized track occupation notice;

- documentation;
- staff qualification and duties;
- access to defined areas;
- protection of staff and trains working on revenue lines and in the depot; and
- safe working requirements.

Such procedures shall also be developed by the Concessionaire for operation of works trains during construction of the Railway System.

2.4.7 Station Operation

Stations shall:

- enable passengers to board trains and alight from trains;
- minimize passenger movements and enable safe egress in the event of evacuation;
- provide convenience and safety for passenger movements;
- enable passengers to obtain information on the Railway System services;
- enable passengers to purchase and validate tickets; and
- enable mobility impaired passengers to use the Railway System without assistance.

Each underground station shall be staffed with at least one operations person during revenue service hours that shall:

- assist passengers in the use of Railway System facilities;
- manage passenger movements;
- co-ordinate service start up and shut down of the station;
- maintain the station in a good order;
- control and monitor the station equipment;
- assist in the management of train movements during periods of degraded operations;
- co-ordinate safe track access for Railway System maintenance purposes;
- investigate incidents and co-ordinate mitigation;
- manage safe passenger egress in case of an evacuation;
- co-ordinate emergency incidents with the appropriate services;

- report to and act under supervision by the OCC.

Stations shall be managed from a Station Control Room (SCR) which shall be supervised from the OCC.

2.4.8 Operation of the Operations Control Center.

An OCC shall be provided to normally control and manage all relevant functions and subsystems of the revenue line operation. At the OCC, the Concessionaire shall provide, at least, the following functions:

- Control and monitor all revenue line operations;
- Manage and co-ordinate track access during revenue and non-revenue periods;
- Monitor the status of Railway System and CAT equipment;
- Co-ordinate faults and works operation;
- Manage Railway System security and co-ordinate with the Depot Security Office (DSO);
- Manage emergency incidents and co-ordinate with emergency services where required;
- Provide train service information to the public and passengers under normal and degraded working conditions;
- Support interfaces at modal transfers;
- Co-ordinate with the media;
- Co-ordinate with the Depot Control Centre (DCC);
- Manage the connection with the electricity supplier (DISCOM); and
- Provide recording of train movements, incidents, communication and measures taken.

The Concessionaire shall establish a systematic hierarchy of qualifications, responsibilities and access rights, and assign adequately trained and experienced personnel to operate the OCC facilities.

For the event that the OCC becomes unavailable, Local Control work stations located at each station shall be able to take over all functions of the OCC for the Railway System and provide a similar level of control to that of the OCC.

Staffing within the control centre shall at least support all above functions at all relevant times. Design and operation of the control centre shall take into account that they may require more personnel to be allocated to the control centre.

2.5 Dwarka Depot Operation

The Depot shall support Operation and Maintenance of the AMEL Railway System.

The Depot shall typically support the following functions:

- Delivery and retrieval of passenger trains;
- Stabling of passenger trains during non-revenue hours;
- Preparation of trains for service;
- External and internal routine cleaning;
- Inspection, routine maintenance and minor repair;
- Rolling stock accident damage repair and heavy overhaul;
- Railway systems equipment repair and refurbishment;
- Storage of spare parts / spare components and consumable maintenance materials;

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- Stabling and preparation of works trains, and recovery vehicles and equipment;
- Delivery and commissioning of new trains;
- Staff accommodation and duty management;
- Depot operations and maintenance management; and
- Security management of the premises.

The Concessionaire shall submit a Depot Operating and Maintenance Plan for review by the DMRC during Initial Design Submission.

2.6 Palam Siding Operation

Palam siding shall accommodate off-line stabling for passenger rolling stock and online maintenance vehicle. The associated special track work on the revenue lines shall accommodate 'run –a –round' shunt movements of passenger trains.

The siding signaling shall be supervised by the OCC, with fall-back to the Local Control Panel at one adjacent station.

2.7 CAT Operational Coordination Procedures

The Concessionaire shall establish procedures for dealing with all operational interfaces operators at IGI Airport with the Airport Authority of India, participating Airlines and their Agents, under normal working and failure conditions, in compliance with the relevant Airport Operating Procedures. Procedures shall include but not be limited to the following issues:

(a) Operating rules for interfaces with AMEL passengers and baggage, i. e. AMEL passengers with hand-carried baggage, passengers checked-in at the CAT's and baggage transported by train.

(b) Control of passengers and baggage in the event of abnormal working of the Railway System,

(c) Management of passengers and baggage during unplanned and planned closure of the Railway System, including recovery of affected Operations;

(d) Communications and co-ordination between the OCC, Stations and CAT's and Airlines and their Agents, under both normal and abnormal traffic conditions,

(e) Passenger evacuation from the IGI Airport Station to a place of safety,

(f) Emergency and planned bus replacement procedures and provision of necessary facilities.

2.8 Branding and Imaging

All Concessionaire's personnel with contact to passengers and public shall be well trained in customer relations and properly dressed. Drivers and other personnel with visual contact to passengers and the public shall wear uniforms. Other Railway System personnel shall be identifiable by uniforms or equivalent, to an extent that passengers and the public will not feel insecure.

The Concessionaire shall establish a corporate image for the Airport Metro Express Link, its personnel and branding, in line with the policies agreed with the DMRC during the design development.

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2.9 Interface to Customers and Public

The Concessionaire shall develop a pro-active approach to service quality and interfaces with customers and the public. The Concessionaire shall establish a quality management program addressing at least the following issues:

- availability;
- accessibility;
- information;
- time;
- customer care;
- comfort;
- security; and
- environmental friendliness.

2.10 Documentation

The Concessionaire shall keep records of Operation and Maintenance activities and statistics. Record keeping and data format shall be determined in conjunction with the DMRC. Data shall be submitted to the DMRC on request, for auditing.

2.11 Monthly Reports

The Concessionaire shall submit a monthly report in accordance with the Contract to the DMRC, which shall include but not be limited to the following:

- outstanding issues;
- constraints;
- contractual matters;
- quality performance;
- patronage statistics and analysis (including ridership and trends, transportation planning surveys);
- public information surveys;
- failure statistics and analysis;
- forward planning;
- accidents and major service disruptions;
- engineering safety;
- security issues;
- public relations;
- customer complaints tracking;
- matters of concern;
- matters arising; and
- any other business.
- operation statistics and analysis;

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2.12 Patronage Information Reporting

The Concessionaire shall periodically report patronage information in accordance with the Contract requirements. Construction and Commissioning Phase

The Construction and Commissioning Phase as described here shall be including all test and trial running and pre-revenue operation. It is anticipated that several stages during this phase will need to be addressed individually.

2.13 Operating Procedures

The Concessionaire shall demonstrate how he intends to manage Operational Safety throughout the Construction and Commissioning Phase. Typically, the Concessionaire shall ensure that their staff, contractor staff and emergency services personnel will be adequately trained and instructed, and the public will be informed of potentially hazardous situations and their avoidance.

The Concessionaire shall identify milestones for planned construction train operation, test running and trial running within the management plan construction schedule, as detailed in the Contract.

The Concessionaire shall develop procedures for train operation, safe track access and energisation of the Overhead Line Equipment prior to revenue service, which shall be reflected in the Rules and Procedures and shall be in conformity with the Operational Safety Case.

The Concessionaire shall also demonstrate how to manage to raise public awareness of the system prior to full commissioning.

2.14 Emergency Planning

As required by the Operational Safety Case, the Concessionaire shall plan for the management of emergency incidents with the relevant emergency services and shall involve both table-top and simulated live exercises.

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3 Service Quality Criteria

In accordance with EN 13816:2002, a set of high level quality performance criteria shall be used by the DMRC to prescribe the level of passenger comfort and convenience that the Concessionaire is expected to deliver and maintain.

Under conditions of degraded operation which are outside of his control, the Concessionaire may be exempted from compliance with affected Service Quality Criteria.

The Concessionaire shall include proposals for satisfying and monitoring the quality criteria, as specified in this section, in the Operations and Maintenance Manual, to be submitted during Initial Design Submission.

3.1. Quality Criteria: Time

3.1.1 Objective

This measure determines the reliability of train services delivered with respect to the published operating timetable (EN 13816 Criteria 4.2.1/2: Time: Adherence to Schedule: Punctuality/Regularity). It shall recognize the actual amount of train trips effectively delivered in accordance with the timetable and the level of delays, both measured at the terminal stations.

3.1.2 Quality Targets

From the opening date of the Railway System to the first anniversary of its opening in any revenue operating day a result of 99 % of the Service Reliability Indicator (SRI) shall be accomplished and throughout the Concession Period 99.8 %.

Measurement Method

Direct Performance Measurement

A "service cancellation" shall be recorded when the commencement of a train trip is delayed in excess of the scheduled service interval.

F1: The number of scheduled train trip departures each revenue day;

F2: The number of actual train trip departures each revenue day;

The SRI shall be calculated as SRI = F2/F1 %

3.2 Quality Criteria: Comfort

3.2.1 Objective

The comfort and convenience of passengers is reflected in the seat availability and crowding levels (EN 13816, Criteria 6.2.1: Comfort: Seating and Personal Space: In Vehicle) of railway services provided.

3.2.2 Quality Targets

The crowding threshold criteria shall be all seats occupied and not more than 4 passengers per square metre of the design standing area. Standing area shall not include seat leg-room and circulation space for passengers with baggage to board and alight the train.

The Service Comfort Criteria (SCC) shall not be exceeded by 90 % of scheduled train trips performed each revenue period.

3.2.3 Measurement Method

Direct Performance Measurement

Patronage reports extracted from the Automatic Fare Collection System and scheduled service capacities shall be computed for the SCC.

F1: The average numbers of passengers for each hour of a revenue day;

F2: The passenger capacity provided during each hour of a revenue day;

The SCC shall be calculated as SRI = F1/F2. %

3.3 Measure: Passenger Convenience

3.3.1 Objective

These indicators are designed to measure the quality of Railway System facilities that affect passenger conveniences (Standard EN 13816),

Item 1 and 2- *Criteria* 2.3.1 Accessibility: AFC Ticketing and CAT Check-in Availability: Acquisition of Network;
Items 3 and 4 – Criteria 6.1.1 Comfort: Usability of Passenger Facilities: at b/a Points;
Item 5 – Criteria 6.4.1 Comfort: Ambient Conditions: Atmosphere;
Item 6 – Criteria 6.4.4 Comfort: Ambient Conditions: Brightness;
Item 7 – Criteria 6.5.3 Comfort: Complementary Facilities: Communication;
Item 8 – Criteria 7.1.5 Security: Freedom from Crime: Identified Help Points;
Item 9 – Criteria 3.2/3 Information: Travel Information Normal/Abnormal Conditions; and
Item 10 – Criteria 7.1.4 Security: Freedom from Crime: Staff and Police Presence.

3.3.2 Quality Target

The performance of the subjects listed in Table 3.3.3, shall be measured individually and summarized against an Aggregated Quality Target Indicator (AQTI). From the commencement of revenue service of the Railway System to the first anniversary of its opening, during any revenue service day the performances shall operate with an aggregated and weighted result of 97 % of Quality Target Indicators (QTI) and 98 % thereafter for the whole CAT and Railway System.

For each subject, Quality Target Indicators (QTI) shall not be lower than listed below.

Measurement Method

Item	Method	Subject	Wt	QTI	
				1st yr of operation	After 1st yr of operations
1	DPM	AMEL Ticketing System Availability	0.125	0.99	0.995
2	DPM	CAT Check-in Systems Availability	0.15	0.99	0.995
3	DPM	Elevator Availability	0.1	0.97	0.98
4	DPM	Escalator Availability	0.1	0.98	0.99
5	DPM	Air-conditioning and ventilation System Availability	0.1	0.98	0.99

6	DPM	Station and Tunnel Lighting Availability	0.1	0.99	0.995
7	MSS	Provision of fixed and mobile telephone systems Availability	0.075	0.95	0.96
8	MSS	Help Points Availability	0.075	0.98	0.99
9	MSS	Flight and Train Passenger Systems Availability	0.075	0.97	0.98
10	MSS	CAT and AMEL System Security	0.1	0.97	0.98 [1)]

Table: 3.3.3. Passenger Convenience items and Weighting

[1)] Against national statistics of reported crime

Where: DPM = Direct Performance Measuring

CSS = Customer Satisfaction Survey

MSS = Mystery Shopping Survey

QTI = Quality Target Indicator

Wt = Weighting.

a) Formula for calculating Direct Performance Measures:

$$\frac{\sum RSOH - \sum DTS}{\sum RSOH} = QT$$

Where: RSOH = Revenue service operating hours of each subsystem.

DTS = Down time of each sub systems.

QTI = Quality Target Indicator

b) Formula for calculating Mystery Shopping Survey results:

$$\frac{\sum IS - \sum IU}{\sum IS} = QT$$

Where: IS = Number of items surveyed

IU = Number of items not meeting pre-determined standards

QTI = Quality Target Indicator

c) Formula for the calculation of the Aggregated Quality Target Indictor:

$AQTI = W_1 \times QTI_1 + W_2 \times QTI_2 + W_3 \times QTI_3 + W_4 \times QTI_4 + \ldots\ldots$

Where: AQTI = Aggregated Quality Target Indicator

QTI_i = Quality Target Indicator

W_i = Weighting.

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3.4 Measure: Customer Care

3.4.1 Objectives

These indicators are designed to measure the level of passenger and public satisfaction with the Railway System (EN 13816),

Item 1 - Criteria 5.3 Customer Care: Staff;
Item 2 – Criteria 5.2.3 Customer Care: Customer Interface: Redress;
Item 3 – Criteria 3.1 Information: General Information;
Item 4 – Criteria 5.1 Customer Care: Commitment;
Item 5 – Criteria 7.1 Security: Freedom from Crime;
Item 6 – Criteria 6.3.1 Comfort: Ride Comfort: Driving;
Item 7 – Criteria 6.4/5/6 Comfort: Ambient Conditions/Complementary Facilities/ Ergonomy;
Item 8 – Criteria 6.4.3 Comfort: Ambient Conditions: Station cleanliness.
Item 9 - Criteria 6.4.3 Comfort: Ambient Conditions: Train cleanliness.

3.4.2 Quality Targets

The performance of the subjects listed in Table 3.4.3, shall be measured individually and summarized against an Aggregated Quality Target Indicator (AQTI). From the commencement of revenue service of the Railway System to the first anniversary of its opening, during any revenue service day the performances shall operate with an aggregated and weighted result of 90 % of Quality Target Indicators (QTI) and 95 % thereafter for the whole Railway System.

For each subject, Quality Target Indicators (QTI) shall not be lower than listed below.

3.4.3 Measurement Method

Item	Method	Subject	Wt	QTI [1)]	
				1st year of Operation	After 1st year of Operation
1	CSS	Customer interface with concessionaire O&M staff	0.10	0.95	0.98
2	DPM	Responsiveness to complaints	0.10	0.85	0.90
3	CSS	Interface to the general public	0.10	0.85	0.90
4	CSS	Public pride on the system	0.10	0.85	0.90
5	CSS	Passenger sense of personal security	0.10	0.95	0.98
6	CSS	Ride quality	0.15	0.95	0.98
7	CSS	Ambience conditions at stations	0.10	0.90	0.95
8	CSS	CAT & Station cleanliness	0.10	0.95	0.98
9	CSS	Train interior and exterior cleanliness	0.15	0.95	0.98

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Table 3.4.3 Customer Care items and Weighting

[1] against agreed target levels of satisfaction

Where: DPM = Direct Performance Measuring

CSS = Customer Satisfaction Survey

QTI = Quality Target Indicator

Wt = Weighting.

Formula for the calculation of the Aggregated Quality Target Indictor:

$$AQTI = W_1 \times QTI_1 + W_2 \times QTI_2 + W_3 \times QTI_3 + W_4 \times QTI_4 + \ldots\ldots$$

Where: AQTI = Aggregated Quality Target Indicator

QTI_i = Quality Target Indicator

W_i = Weighting.

3.4.4 Collection, Analysis and Reporting

Data collection and reporting shall be conducted on a regular and timely basis to allow the identification of any trends in performance.

Computation of data and algorithms shall be submitted to the DMRC for review during Detailed Design Submission.

Direct Performance Measurement: Data collection and analysis shall be undertaken by the Concessionaire continuously and shall be recorded daily. It shall employ automatic and technical means to the greatest possible extent. The DMRC shall be entitled to obtain all basic data for own analysis and verification. The DMRC shall also reserve the right to audit the data and its evaluation.

Market research professionals employed by the Concessionaire shall perform customer Satisfaction Surveys and Mystery Shopping Surveys on the specified criteria. Surveys shall be conducted according to rigorous procedures that provide objective ratings against pre-determined standards. A consistent ranking system shall be established using calibrated checklists, in order to minimize risk of variation between assessors.

Reporting shall be maintained on a monthly basis, with a three-monthly rolling program employed for establishing the performance trend in relation to the penalty threshold. Uncharacteristic deviations from the trend shall be analyzed and the cause reported to the DMRC as and when they occur.

3.4.5 Corrective Action

The Concessionaire shall be pro-active in identifying deterioration in the trend of performances and establish their cause. The Concessionaire shall propose remedial action and schedule for correction of the cause of a deteriorating trend, and submit a corresponding remedial plan to be agreed with the DMRC.

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END OF SECTION

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4 Engineering Design Criteria

4.1 Proven Technologies

The Concessionaire shall employ systems and equipment that have a proven record in service for Reliability and Maintainability. The Concessionaire is encouraged to use off-the-shelve products and elements. Where systems and equipment are proposed which have less than five (5) years proven reliability in service, the Concessionaire shall demonstrate the Reliability by statistical methods.

4.2 System Capacity

4.2.1 Patronage Forecasts

The Concessionaire shall provide a patronage forecast for a 30 years design period from commencement of revenue service as specified in the Concession Contract, which shall be agreed with the DMRC as the Design Year Capacity. The agreed forecast shall be used as the basis for engineering the infrastructure capacities and installation of equipment. The Concessionaire shall ensure reasonable capacity expansion capability of the Systems equipment during this period.

The Concessionaire shall undertake passenger counts at regular intervals and shall adjust capacity provisions to ensure specified passenger comfort is maintained.

4.2.2 System Upgrading

The Railway System and CAT's shall be sized to accommodated the patronage capacities of the Design Year, however, the Concessionaire should give consideration to the initial installation if equipment sufficient to patronage demand of the first 15 years, giving due consideration to the useful life of that equipment.

As a result of India's rapid economic growth it is considered that the capacity of IG International and Domestic Airports will increase and the addition of a station to serve the Domestic terminal is planned to meet the foreseen additional AMEL patronage demand.

In order to provide additional capacity, the Concessionaire shall make provisions in his design of the Fixed E&M equipment to accommodate a greater through-put of passengers and their baggage, with the minimum of cost and disruption to normal Operations. Provisions for future automated BHS shall be considered in the System design arrangements.

4.3 Fleet Size

4.3.1 Fleet size shall be established to meet

- service capacity;
- service reliability; and
- Rolling Stock availability.

4.3.2 Service Speed

Operating speed for the Railway System revenue and non-revenue lines shall be limited to the following:

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- Nominal 120 km/h on revenue lines;
- Civil speed restrictions in accordance with the Approved Alignment Design Criteria and passenger comfort; and
- 25km/h in the Depot area.

The maximum round trip time under undisturbed operation conditions shall be determined by the Concessionaire and included as part of the Initial Design Submission. The Concessionaire shall ensure that this round trip time is met under all conditions of undisturbed operation.

4.4 Conventions

The Railway System shall be normally configured for left track running, to suit national conventions.

4.5 Public Interfaces

4.5.1 Station Architectural Considerations

All Railway System facilities shall be designed to produce a safe and secure environment for passengers under normal and disturbed operation conditions, provide adequate capacity and convenience to passengers, deter crime and vandalism, be easy to be maintained and environmentally friendly.

Safe evacuation routes from stations shall be designed in accordance with NFPA 130.

Station platforms to be provided for revenue service shall be long enough to accommodate the longest train anticipated for revenue service and an additional length for operational purposes. Baggage Handling System areas shall be secured against entry by the passenger and unauthorized AMEL staff. Station platforms shall at least be 160 m in length.

Advertising and artwork shall not compromise safety, security, capacity and convenience of the Railway System.

Stations and CAT public areas shall be designed to be accessible for people with disabilities in accordance with Government of India Act, "The Persons with Disabilities (Equal Opportunities, Protection of Rights & Full Participation) Act, 2006".

All stations shall have a minimum of two entrances with provision of stairs at all entrances, and escalators at a minimum of two entrances from street level to concourse level.

There shall be at least one elevator path from street level to platform level which shall serve each individual platform (if more than one), serving the needs of handicapped people.

Stations may include commercial facilities such as kiosks, vending machines, telephones and advertising. The location and purpose of such facilities shall be subject to consent by the DMRC.

Public toilets shall be provided in every underground station.

Special arrangements shall be made whereby people with disabilities shall be permitted access to staff toilets, as required.

4.5.2 Platform Screen Doors

Platform Screen Doors (PSD's) for the purpose of air conditioning energy conservation shall be provided.

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In accordance with NFPA 90A Standard, public areas shall be provided with air conditioning and ventilation, electric power supplies, emergency lighting levels and fire detection and suppression systems.

4.6 Safety and Security Provisions

4.6.1 Help Points Designated Waiting Areas

For the safety and security of passengers, each station platform shall have at least two help points. In addition, a help point shall be provided at each Designated Waiting Area. The arrangement shall at least contain:

1) a hands-free telephone
2) call buttons for information and assistance from the Station Control Room (SCR), OCC and police
3) CCTV coverage
4) corresponding information.

Help points on station platforms shall also include Emergency Stop Plungers (Signaling and Train Control System Performance Specification). Designated Waiting Areas at stations shall also include a high intensity lighting system.

4.6.2 CCTV Monitoring

All Railway System public areas shall be monitored by a colour CCTV system which shall be linked to the OCC, SCR's and CISF station office. At IGI Airport Station, CCTV coverage shall include the passenger corridors linking the station and Airport terminal Building.

Data recording and storage shall be provided with adequate safety against data loss and destruction.

4.7 Modal Transfers

The Concessionaire shall provide convenient transfers between the Railway System and other modes, which shall at least include other railways, buses and private transport. In this context, convenient shall mean:

1) travel information (static and real-time);
2) provision and management of scheduled connections where applicable;
3) access with ease and comfort; and
4) signage.

4.8 Ticketing and AFC

With the exception of IGI Airport Station, stations shall have a closed fare system with gates and automatic gates for ticket validation.

The sale of tickets shall be from Ticket Vending Machines (TVM) and Sales Office at stations. Computer Smart Card (CSC) Tickets shall be for the common use of both the DMRC lines and AMEL, with revenue sharing via DMRC/Concessionaire "Central Clearing House". CSC tickets shall include Stored Value and Monthly 60 trip tickets; Single Trip Tickets/tokens may not be similar to those of DMRC.

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Stations shall be staffed to assist passengers with the payment of fares. The Concessionaire shall provide the functionality for passengers with invalid tickets or no tickets at all to pay excess fares.

Passenger queuing at AFC machines shall not exceed 4 persons at any time. When determining the number of passenger interface equipment to be provided, the Concessionaire shall compute the patronage, human factors, equipment operating time, and equipment Availability.

The Concessionaire shall develop a ticketing and fare collection system outline design for review by the DMRC during Initial Design Submission.

4.9 Travel Information

4.9.1 Travel information shall be provided appropriate locations for passengers in both English and Hindi, the official languages of the India, before, during, and at the end of a journey within the Railway System.

Media to be considered shall include:

- internet;
- telephone;
- printed media;
- static and dynamic visual and audible information within the Railway System; and
- radio and television.

Items to be included in stations:

- timetable;
- signage;
- way finding;
- evacuation routes and instructions;
- fare and ticketing;
- time;
- train arrival / departure time and destination; and
- station surrounding roads, public buildings and areas and major hotels.

Items to be included in stations and trains:

- accessibility to handicapped passengers;
- route network;
- connecting transport modes and services; and
- other audible and visual passenger information.

Items to be included in trains:

- next station;
- destination;
- route maps; and
- door closure.

Information shall be kept current, correct, clear, unambiguous, and legible and shall not obstruct the free movement of persons.

4.9.2 Service information shall be given as dynamic (i.e. real-time) information (e.g. time to and destination of next services). Essential service information shall be duplicated in audible and

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visual messages. It shall be possible to update or overwrite such visual and audible information centrally from the OCC, or from Station Control Rooms.

4.10 Rolling Stock

Passenger trains shall be capable of being driven in Automatic Train Control Driving mode and Line of Sight (Fall-back) mode from Drive cabs at either end of the train.

A competent Train Operator shall be present in the lead cab during all passenger train operations and shall be responsible for all train movements.

Evacuation of passengers shall be from either end of a train drive cab bridge to the track level.

The baggage car shall be located in the Drive Car, immediately behind the cab at the southern end of each train. The baggage car shall be normally be secured from access by passengers and other unauthorized persons; during an emergency situation the evacuation route from the passenger saloon car through the baggage car to the emergency evacuation cab shall be opened as follows:

- By the driver releasing door lock with the train key, or
- By passengers accessing door lock release mechanisms from break-glass sealed enclosures located adjacent to the doors.

Passenger trains shall be bi-directional with doors on both sides, and shall allow passage through the saloon cars.

Passenger cars shall have not less than two doors per car. Door widths shall enable passengers with luggage to board and alight unimpeded. The concessionaire shall study the logistics of loading and unloading Baggage Containers from the train baggage car and determine the number of doors to be provided.

The interior shall be ergonomically designed to support passenger movement during boarding and alighting with luggage

Luggage racks shall be provided in a convenient location to doors, and sufficient to accommodate passengers traveling from the Airport to the AMEL Stations.

Seat covers shall consider temperature and humidity of the environment. Fittings and lighting shall enable safe and convenient travel to both seating and standing passengers.

All vehicles shall be fully air conditioned. It will be desirable that passenger doors will not remain open longer than necessary for boarding and alighting.

Exterior and interior designs of vehicles shall be modern in appearance, elegant and timeless, and shall be aesthetically compatible with the modern Railway System architecture. The exterior colour and front end design of the vehicles shall be determined by DMRC. The interior design shall be determined by the Concessionaire in conjunction with the DMRC. All vehicles shall allow for advertising inside.

Rolling stock shall be capable of meeting the passenger comfort and seat availability criteria outlined in the section on Quality Target Indicators.

All vehicles shall comply with the applicable accessibility laws and standard, "The Persons with Disabilities (Equal Opportunities, Protection of Rights & Full Participation) Act, 1995".

All vehicles shall be provided with emergency communication facilities between passengers and the driver, emergency door opening, and safety equipment.

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Traction current collection shall be from Overhead Line Equipment with pantographs.

All vehicles shall comply with NFPA 130 Standard for Guide way Transit Systems and Fire loading.

4.11 Operations Control Centre

The Operations Control Centre (OCC) shall concentrate and supervise at least the following systems:

train control and signaling;
SCADA and DISCOM interface data transmission system;
station management system SMS;
communication systems; and
CCTV systems.

It is envisaged that the equipment to support the above systems shall include:

mimic panel for the display for the real-time conditions of the Railway System;
projection facilities for CCTV images; and
multi-purpose workstations with uniform man-machine interfaces.

The Concessionaire shall consider maintaining AFC workstations and CPU in a secure environment at the OCC.

Architecture shall facilitate future expansion of control centre facilities. All facilities, electric and electronic equipment shall be safe and ergonomic to use.

Access to all OCC equipment and operating rooms shall be controlled and recorded.

Fire fighting equipment provided in accordance with the India Building Law, shall mitigate damage to sensitive equipment during an operation.

4.12 Signaling and Train Control

The revenue line Signaling and Train Control System shall be Continuous Automatic Train Control (CATC), comprising vital Automatic Train Protection (ATP), Automatic Train Operation (ATO) and Automatic Train Supervision and shall support bi-directional working on both tracks. Palam Depot Signaling shall be at least a Multi Aspect Signaling system. The revenue line and non-revenue link line to the Depot shall be supervised by an Automatic Train Supervision (ATS) system from the OCC. Transfer of trains between the CATC and Depot signaling areas shall employ safe hand-over procedures, involving least manual effort on the part of the Train Operator.

During certain failure situations of the revenue line Signaling and Train Control System, control of local signaling areas shall be provided by local control panels within station SCRs'

The main functions of the revenue line Signaling and Train Control System shall be:

a) ensure safe passage for trains along the routes, without conflicting movements, collisions or derailments;

b) enable the design headways and support necessary service margins for recovery from train operating perturbations;

c) automatic setting and signal routes and maintenance of service operation in accordance with timetables, including automatic recovery from perturbations;

d) to continuously provide OCC with train location and identification information; and

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e) to continuously provide system health information.

In the driving cab, the Train Operator shall be continuously provided with information for:

a) permitted route speed and actual train speed;
b) train berthing for passenger entry/egress;
c) drive mode availability; and
d) health status of train bourne train control equipment.

The Depot may be operated with a two aspect line side signal system, controlled from the Depot Control Centre (DCC). Train movements shall be limited to 25kph, except where facilities demand lower speeds.

A suitable section of the revenue line shall be designated for testing trains during non-revenue hours. The test track shall be equipped with similar signaling arrangements to that provided on the revenue line to enable comprehensive testing of trains. Train speed on the test track shall be similar to revenue line speed.

4.13 City Airport Terminals

4.13.1 Outbound airline passengers will have the option to check-in at the CAT facilities or take their luggage onto the train and check-in at IGI Airport.

4.13.2 Passengers are required to obtain a ticket, undertake a personal security check and have baggage x-rayed before entering the paid area of a station.

4.13.3 At stations, airline passengers are to be directed by the Airport Information Management System (AIMS) display to a common use or airline specific Check-in Counter. The check-in clerk interrogates the Common Use Terminal Equipment (CUTE) system for passenger details and allocation of seats and issue of a boarding pass. Accompanied baggage is checked-in and uniquely tagged with the passenger and airline identification.

4.13.4 The passenger may proceed to the station platform level and board a train for the IGI Airport Station. Flight information may be observed throughout the station and on trains on the Flight Information Display System (FIDS) monitors. At IGI Airport, passengers may proceed directly to the immigration hall and departure lounge.

4.13.5 Checked-in baggage is conveyed from the Check-in Desk by the Baggage Handling System (BHS) to the station baggage hall where it is stuffed into a Baggage Container (BC). Each bag and associated BC is registered with the AMEL Baggage Tracking System (BTS). BC's are lowered to the station platform and loaded into the secure baggage car of a passenger train and transported to IGI Airport Station. At IGI Airport Station, the Concessionaire shall de-train the Baggage Containers, hoist them to ground level for transportation to the IGI Airport Baggage Hall. The Concessionaire shall provide suitable road vehicles and transport the Baggage Containers to the designated reception in the Airport Baggage Hall. The Concessionaire shall return the empty Baggage Containers to IGI Station platform.

4.13.6 International Airline passengers returning to Delhi are required to clear Customs inspection at IGI Airport and take their luggage to IGI Airport Station. Passengers may purchase a ticket from a Ticket Vending Machine at IGI Station or at their destination station. On entering the Station passengers shall be required to undertake a personal security check by CISF. On boarding the train, luggage is placed in racks provided in the saloon cars.

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4.14 Dwarka Depot

The depot at Dwarka Sector 21 District shall accommodate stabling of all trains during non-revenue hours, and shall size for the maintenance of the Rolling Stock fleet required for the Design Year.

Rolling stock maintenance shall include all activities up to heavy overhauls and modifications, but may exclude refurbishments.

The Depot shall be controlled and managed by a Depot Control Centre (DCC) located within the Depot premises.

The depot perimeter shall be monitored by CCTV and intrusion detection fence supervised from the Depot Security Office (DSO) located at the main entrance to the facility. Vehicular and pedestrian access shall be controlled and recorded from the DSO.

All depot buildings shall be protected by fire detection and fire fighting facilities, and the Fire Alarm Control Panel is located in the DSO. The Depot facilities shall be accessible by emergency services vehicles and equipment.

Testing of vehicles under revenue line conditions and speeds shall be enabled in the Depot without compromising Depot operation and safety.

Staff based in the Depot shall be provided with amenities and, where appropriate, office accommodation.

4.15 During Normal working the Concessionaire shall operate the AMEL services from the AMEL Operations Central Control and Station Control Room (SCR) and the DMRC shall operate their Line 3 services from the OCC at Shastri Park Station and their SCR.

During a Station emergency situation, DMRC will take the lead in managing events from their Station Control Room and OCC, for the evacuation of passengers and coordinating with the Emergency services. To facilitate this Operation, certain of the AMEL and Line 3 engineering facilities, shall be overlapped between the respective SCR's and OCC's. The Concessionaire shall coordinate with DMRC to establish the System Operating Plan for the Station and the engineering necessary to implement the requirements.

END OF SECTION

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5 Maintenance Requirements

5.1 Responsibilities

The Concessionaire shall be responsible for the engineering and maintenance of all assets provided under the Contract.

The Concessionaire shall maintain / repair / replace all components and materials required for the continuous operation of the Railway and CAT System, including any upgrades or additions.

The Concessionaire shall provide all maintenance facilities for staff to carry out their duties efficiently.

The Concessionaire shall keep design documentation and maintenance records of the Railway System fully current with the as built situation. Where changes to safety critical equipment occur, the Concessionaire shall adjust the Operational Safety Case and shall advise to DMRC and licensing authority. The Concessionaire shall keep documentation of safety critical issues current and accessible to the DMRC without delay.

All maintenance shall be undertaken by qualified and, where required, licensed staff.

The Concessionaire shall co-operate with associated agencies in the maintenance and upgrading of interfacing facilities.

5.2 Maintenance Plan

The Concessionaire shall plan maintenance based on a proven strategy for maintenance of Railway Systems, typically reliability centered maintenance procedures.

All consumable items and components shall be replaced in accordance with the manufacturers' specifications. Replacement materials and components shall be of equivalent standard and quality.

The Concessionaire shall develop a Maintenance Plan that shall identify the resources necessary for the maintenance of the Railway and CAT System. The Maintenance Plan shall describe the maintenance work to be done, the times and frequencies at which it is to be carried out and the circumstances in which maintenance intervention will be necessary. Also, the Maintenance Plan shall schedule the protocols, standards and records to be retained in respect of each system, sub-system and component maintained by the Concessionaire.

The Maintenance Plan shall include, but not be limited to the following:

- development of the maintenance organization and engineering support in a structured manner;
- safety management;
- maintenance procedures;
- strategy for dealing with reactive maintenance activities including details of his recovery plans;
- duties and responsibilities;
- scheduling of preventative (planned) maintenance activities including details of possession times;
- human resources required, commensurate with skills development in India, and their training and licensing;
- quality assurance and testing;
- safety critical licensing;

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- spare parts and consumable stores to avoid shortages;
- health and safety of staff;
- data recording and trend analysis; and
- documentation and reporting.

The Maintenance Plan shall be submitted during Initial Design Submission and updates during Detailed Design Submission.

The Concessionaire shall arrange for his Maintenance Plan to be independently audited before the commencement of revenue service, and subsequently

at intervals not exceeding two years;

following any significant incident with fatalities or major injury;

following any significant organizational change; and/or

following the acquisition or retrofit or significant change of any major plant, equipment or procedure.

The audit shall determine that the Maintenance Plan conforms to the requirements of ISO 9001: 2000 - Quality Management Systems Requirements, with ISO 14004: 1996, and with such other requirements as may be determined by the DMRC.

5.3 Management of Safety

5.3.1 The Concessionaire shall develop a Safety Management System for the pro-active management of safety for people, rolling stock and infrastructure, throughout the Concession Period.

5.3.2 The Concessionaire shall propose a "Safety Policy" document for display at locations throughout the AMEL for his staff and contractors to observe and for passengers information.

5.3.3 The Concessionaire shall determine targets for Safety in quantitative and qualitative terms, similar or better than achieved by similar modern transit systems, for the maintenance and continuous enhancement of Safety and the plans and means for achieving those targets.

5.3.4 The Concessionaire shall establish routine "refresher" training programmes for persons working at the track-side and in the maintenance of safety and operationally critical equipment. Refresher training in simulated incident with Emergency Services staff shall be undertaken periodically.

5.3.5 The Concessionaire shall establish procedures, but not limited to the following;

i) Meeting the relevant operational and technical Standards and requirements laid down in the National Safety Acts/Rules and applicable laws.

ii) Hazardous failure situation and trends and their mitigation measures;

iii) Hazard analysis of changes in the operation rules and procedures, modifications to existing and new equipment;

iv) Control and distribution of safety related documentation and its modifications;

v) Reporting of accidents, incidents, near misses and other potentially dangerous occurrences, investigation and development of preventative measures.

vi) Periodic Safety Audits

5.3.6 The Independent Safety Assessor shall review the Concessionaires Safety Management System and recommend modifications to DMRC, where appropriate.

END OF SECTION

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6 Asset Stewardship

6.1 Asset Database

In accordance with the Concession Contract, as part of the Hand-over package, the Concessionaire shall develop and maintain an Asset Database for all assets provided under the Contract, equipment and documentation (including day to day Operation and Maintenance), required for the seamless transfer of the Operations and Maintenance of the Railway and CAT System to the DMRC at any time during the concession period.

The Concessionaire shall agree with the Implementing Authority before commencement of maintenance activities the value, residual life, depreciation methodology, and value at the end of the concession period of all assets listed in the database.

The Concessionaire shall prepare the format of the Asset Database and procedures for recording all assets for review by the Implementing Authority during Detailed Design Submission.

6.2 Reporting

The Concessionaire shall prepare and submit to the Implementing Authority a regular Asset Stewardship Report (ASR). The maximum reporting period shall not exceed six months.

The report shall contain but shall not be limited to the following:

a) any significant replacement or modification of assets during the reporting period;

b) any assets taken out of or put into use during the reporting period;

c) any significant asset replacements likely to be necessary during the next two reporting periods; and

d) any other significant change to the residual value of the assets.

The report shall include trend analysis, and shall at least distinguish between latent defects, wear and tear, and accident damage or other external impact.

6.3 Human Resource Management and Training

The Concessionaire shall be responsible for the recruitment, of Operations and Maintenance staff. All staff is required to establish fitness for their duties; medical examinations shall be undertaken, in accordance with DMRC procedure, by Approved medical practitioners. Station staff and Passenger Train Operators shall be required to satisfy DMRC psychological fitness test.

The Concessionaire shall be responsible for the development, training, examination and continued competency of staff in his employment, for the duration of the Concession Period. The Concessionaire shall also be responsible for the training of any third party employees in relevant rules and safety procedures where necessary.

The Concessionaire shall only use appropriately qualified staff as trainers.

The Concessionaire shall establish a Training and Competency Management Plan which shall indicate the staff positions and associated levels of competency that must be achieved before assuming responsibility. It shall describe the training philosophy to be adopted and

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include a training programme. The Training and Competency Plan shall be submitted to the Implementing Authority for review during Detailed Design Submission.

The Training and Competency Management Plan shall be co-ordinated with the Project Master Schedule (Management Procedures, Volume 6) to ensure that sufficient staff will be available during construction and commissioning phases.

The Concessionaire shall maintain records of training provided and certification of competency. Staff certification records shall be included in the Operations Safety Case.

The Concessionaire shall provide all training facilities, material, manuals and other documentation. These shall include training classrooms, train-driving simulator(s), system and equipment simulators; computer based training systems and mock-ups.

The Concessionaire shall also provide familiarization training for appropriate emergency services personnel. The Concessionaire shall provide continued support to the emergency services in the further development of their training programmes.

6.4 Manuals

The Concessionaire shall provide comprehensive manuals for training the Concessionaires staff:

- in all aspects of operation of the Railway System;
- in the use, maintenance and workshop repair of the engineering equipment installed in the Railway System; and
- for the Management of the Railway System
- in all aspects of Operation and Maintenance of the CAT facilities;

Manuals shall be written in both English and Hindi and provided in electronic format. The content of the Manuals shall be compatible with the systems and equipment provided and routinely updated to reflect any changes that occur during the concession.

END OF SECTION

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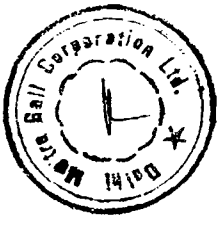
SCHEDULE - M

MONTHLY REVENUE STATEMENT

SCHEDULE –M

Monthly Revenue Statement

(Format to be agreed between Concessionaire and DMRC prior to COD)



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SCHEDULE – N, O, P

(NOT USED)

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SCHEDULE - Q

FORM OF ESCROW AGREEMENT

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SCHEDULE Q
(Ref Article 23)

Form of ESCROW AGREEMENT

(Subject to terms of the Financing Document(s) between the Concessionaire and Senior Lenders. However, DMRC's position in the cash flows shall not be changed.)

(This agreement does not fully reflect all the events in the Concession Agreement that require the Escrow Agent to take specific actions. It is also necessary to agree Escrow provisions after the Senior Lenders have no further rights on the Escrow account. These issues shall be addressed prior to signing of this Agreement.)

THIS AGREEMENT (the "Agreement") is made on the . . . . . day of . . . . . 200x by and among:

....., a Company incorporated in India whose registered office is at ..... , India (the "Company"); and

..... and having its registered office at ....., as Senior Lenders Representative (the "Lenders Representative"); and

..... and having its registered office at ..... (the "Escrow Agent"); and

Delhi Metro Rail Corporation Limited, a joint venture company of Govt. of India and Govt. of National Capital Territory of Delhi, and having its registered office at NBCC Place, Bhishma Pitamah Bagh, Pragati Vihar, New Delhi 110 003 ("DMRC").

WHEREAS:

The Company is undertaking a project for construction of the financing, design, procurement, installation, testing, and commissioning of all systems, and for the subsequent operation and maintenance of the completed Airport Metro Express Link (the "Project") through a concession on build, operate and transfer ("BOT") basis.

The Company has entered into a Concession Agreement dated as of ..... 200x with DMRC (the "Concession Agreement") wherein DMRC has granted Concession to Company for the work referred to above on BOT basis.

The Company has entered into Financing Documents with Senior Lenders wherein Senior Lenders (the "Senior Lenders") have agreed to lend and advance to the Company Rupee amounts aggregating ..... and foreign currency amounts aggregating US Dollars . . . . . in terms thereof;

One of the terms of the Concession Agreement and the Financing Documents is that the Company is required to establish an Escrow Account, inter alia on terms and conditions stated therein and satisfactory to Senior Lenders

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NOW IN CONSIDERATION FOR THE PREMISES IT IS AGREED BY THE PARTIES AS FOLLOWS:-

1. Definitions and Construction

1.1 **Definitions**: Each capitalised term used herein and not otherwise defined shall have the definition assigned to such term in the Concession Agreement or the Substitution Agreement as the case may be;

- "Account"' means the Escrow Account to be opened by the Company in accordance with this Agreement;
- "Authorised Investment" means any authorised investments which Lenders Agent may, from time to time permit the Company to make in accordance with this Agreement:
- "Business Day" means any day on which banks are open for business in . . . . . or in relation to any notice or communication to be made under this Agreement, a day on which banks are open for business in the place of receipt of such notice or communication;
- "Company Account" shall mean any bank account of the Company, other than the Escrow Account.
- "Enforcement Notice" means any enforcement procedure commenced by the Lenders Representative under any of the Security Documents;
- "Escrow Account" means an Escrow Account established in terms of and under this Agreement;
- "Event of Default" means an event of default as defined and detailed in the Financing Documents:
- "INR" means the lawful currency of India;
- "Payment Date" means in relation to any Permitted Payment, the date(s) specified for such payment;
- "Permitted Payment" means the Payments Agreed to in this Agreement excluding payment to the Company Accounts as more particularly given in Sub-Clause 3.3.1;
- "Required Balance" means on any Date in relation to the Sub-Account of the Escrow Account, an amount in INR/Dollars which if proportionately built over the months, would be sufficient to meet Permitted Payment on the Payment Date(s).
- "Security Documents" means all or any of the Documents executed, delivered or furnished to secure the Financial Assistance under the Financing Documents including but not limited to the Deed of Hypothecation, Mortgage Deed, Equitable Mortgage, Deed of Guarantee, Pledge Agreement, Undertakings, Negative Lien and other incidental or supplemental documents related thereto.
- "Sub-Accounts" means the Sub-Accounts of the Escrow Account, into which the monies due in relation to Permitted Payment would be credited every month and paid out if due and if not due in a month then appropriated proportionately in such month and retained in the Sub Account and paid out therefrom on the Payment date.
- "Year" means each twelve month period ending on March 31

1.2 **Interpretation**

In this Agreement;

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- Unless the context otherwise requires, the singular includes the plural and vice versa;
- Headings and the use of bold typeface shall be ignored in its construction:
- A reference to a Clause, or Schedule is, unless indicated to the contrary, a reference to a clause or schedule to this Agreement;
- References to this Agreement shall be construed as references also to any separate or independent stipulation or agreement contained in it; ,
- The words "other", "or otherwise" and "whatsoever" shall not be construed to be as any limitation upon the generality of any preceding words or matters specifically referred to;
- References to the word "includes" or "including" are to be construed without limitation;
- References to a person shall include such person's successors and permitted assignees or transferees;
- All references to agreements, documents or other instruments include (subject to all relevant approvals) a reference to that agreement, document or instrument as amended, supplemented, substituted, novated or assigned from tine to time.
- The words "herein", "hereto" and "hereunder" refer to this Agreement as a whole and not to the particular clause in which such word may be used;
- Words importing a particular gender include all genders:
- "person" includes any individual, partnership, firm, trust, body corporate, government, government body, authority, agency, unincorporated body of persons or association;
- any reference to a public organisation shall be deemed to include a reference to any successor to such public organisation or any organisation or entity which has taken over the functions or responsibilities of such public organisation:
- references to "Party" means a party to this .Agreement and references to "Parties" shall be construed accordingly; and
- references to any law shall include references to such law as it may, after the date of this Agreement, from time to time be amended, supplemented or re-enacted.

2 THE ACCOUNTS

2.1 Acceptance of Appointment of Escrow Agent

(a) The Escrow Agent hereby agrees to act as such and to accept all payments and other amounts to be delivered to or held by the Escrow Agent pursuant to the terms of this Escrow Agreement. Escrow Agent shall hold and safeguard the Escrow Account during the term of this Escrow Agreement and shall treat the amount in the Escrow Account as monies deposited by Company/DMRC with the Escrow Agent, as agent for the benefit of the Lenders' Agent, or its nominee, successors or assigns, in trust in accordance with the provisions of this Escrow Agreement. In performing its functions and duties under this Escrow Agreement, the Escrow Agent shall act as agent for the Lenders' Agent.

The Company also hereby declares that all right, title and interest in and to the Escrow Account, the Authorised Investments and Permitted Payments made from the Escrow Accounts shall be vested in the Escrow Agent and held in trust for the Senior Lenders acting through Lenders' Agent, DMRC and the Company in accordance with

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the terms of this Agreement and as their respective interests are provided for herein. Amounts deposited in the Escrow Account from time to time shall be held by the Escrow Agent in trust and received and applied as provided in and in accordance with the Agreement. No person other than the Lenders Representative, DMRC and the Company shall have any rights hereunder as the beneficiaries of or as third party beneficiaries under this Agreement.

(b) The rights of Company/DMRC in the monies held in Escrow Account are set forth in their entirety in this Escrow Agreement and Company/DMRC shall have no other rights against or to the monies in the Escrow Account.

2.2 Establishment of Escrow Account

At least thirty (30) days prior to seeking any disbursement (including issue of guarantees or all forms of Financial Assistance), the Company shall establish the Escrow Account with the Escrow Agent.

2.3 Maintenance of the Account

The Escrow Agent shall maintain the Escrow Account in accordance with the terms of this Agreement and its usual practices and applicable regulations and pay the maximum rate of interest payable to its customers on the balance in the said account from time to time.

2.4 Operating Procedures

The Escrow Agent and the Company shall agree (after consultation with the Lenders' Agent) on the detailed mandates, terms and conditions and operating procedures for the Escrow Account but in the event of any inconsistency between this Agreement and such mandates, term and conditions or procedures, this Agreement shall prevail.

3 Currency

3.1 The Escrow Account shall be established with the . . . . . Branch of the Escrow Agent. The Escrow Account shall be denominated in INR.

3.2 Deposits

3.2.1 The Company

A) agrees, confirms and undertakes that it shall deposit and/or credit the Escrow Account with:

(i) all its receivables;
(ii) all proceeds received pursuant to any insurance claims; and
(iii) all monies received from any other sources in relation to and in respect of the Project;

B) may make other deposits of the Company's other funds into the Escrow Accounts at any time. Provided however that the terms of this Agreement shall apply to such other funds deposited in the Escrow Account by the Company.

DMRC agrees, confirms and undertakes that it shall deposit and/or credit the Escrow Account with:

(i) all Fees collected by DMRC in exercise of its rights under Concession Agreement;
(ii) Revenue Shortfall Loan;
(iii) Grant and other monies paid or disbursed in accordance with the provisions of the Concession Agreement and/or the Substitution Agreement; and
Termination Payments as per provisions of the Concession Agreement and/or Financing Documents.

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3.2.2 The Escrow Agent shall ensure that all interest, if any, on the balances of the Escrow Accounts and interest on Authorised Investments made from the Escrow Accounts shall be credited to or deposited in the Escrow Account.

3.3 Withdrawals

3.3.1 The Escrow Agent shall withdraw amounts from the Escrow Accounts and appropriate in the following order every month as more particularly given in the Bank Proforma in Schedule 1 and deposit in the relevant Sub-Account for payments and if not due in a month then appropriate proportionately in such month and retain in the Sub-Account and pay out therefrom on the Payment Date(s):

a) All taxes due and payable by the Concessionaire;

b) All expenses in connection with and relevant to the Concessionaire's Works by way of payment to the EPC Contractor and such other persons as may be specified in the Financing Documents;

c) O&M Expenses subject to the ceiling, if any set forth in the Financial Documents

d) All License Fee, Concession Fee and Revenue Share due to DMRC from the Concessionaire under this Agreement;

e) Any payments and Damages due and payable by the Concessionaire to DMRC pursuant to this Agreement; and

f) The whole or part of the expense on repair work including Fees collection expenses incurred by DMRC on account of exercise of any of its rights under this Agreement provided DMRC certifies to the Escrow Bank that DMRC had incurred such expenses in accordance with the provisions of this Agreement;

g) Monthly proportionate provision of Debt Service Payments due in an Accounting Year and payment of Debt Service Payments in the month when due;

h) Debt service in respect of Subordinate Debt ;

i) Any reserve requirements required to be settled in terms of Financial Documents

j) Balance in accordance with the instructions of the Concessionaire.

The amounts specified in Clause 3.3.1 (a) to (j) constitute the Permitted Payments.

For each year, the applicable Bank Proforma would be separately provided by the Company to the Escrow Agent, with the permission of Lenders Representative and DMRC, not later than 60 days prior to the first day of each year.

3.3.2 Notwithstanding anything to the contrary contained in this Agreement upon Termination of the Concession Agreement or the expiry of Concession Period for whatever reason, all amounts standing to the credit of the Escrow Account shall be appropriated and dealt with in the following order:

(a) all Taxes due and payable by the Concessionaire:

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(b) any payments and Damages due and payable by the Concessionaire to DMRC pursuant to the Concession Agreement, including Termination claims, Concession Fee and Revenue Sharing payments;

(c) all accrued Debt Service Payment;

(d) all accrued O&M Expenses;

(e) any other payments required to be made under Concession Agreement; and

(f) balance, if any, on instructions of the Concessionaire.

3.4 Application of Insufficient Funds

As provided in Clause 3.3, the application of funds in the Escrow Account shall be in the serial order of priority set forth therein. If the funds available for payment to the Sub-Accounts are sufficient to pay a portion, but not all, of the amount required to be paid to any Sub-Account, the Escrow Agent shall apply such funds in the serial order of priority set forth in Clause 3.3, until exhaustion thereof.

4. Authorised Investments

4.1 Power to Invest

The Escrow Agent shall invest the amounts standing to the credit of any of the Sub-Accounts in Authorised Investments on the instructions of the Company as approved by the Lenders Representative, from time to time, in accordance with the provisions of the Agreement. The Escrow Agent shall not be bound to and shall not make investments under the Indian Trusts Act, 1882 without prior approval of the Lenders Representative.

4.2 Procedure for Investments

4.2.1 All Authorised Investments shall be made and/or realised by the Escrow Agent on the instructions of the Company as approved by the Lenders Representative from time to time in accordance with the provisions of this Agreement.

4.2.2 All documents of title or other documentary evidence of ownership with respect to Authorised Investments made out of any Escrow Account will be held in the custody of the Escrow Agent.

4.3 Realisations

Upon the realisation of any investment made under this Clause, the proceeds of realisation shall immediately be credited to the relevant Sub-Account by the Escrow Agent or immediately invested in another Authorised Investment in accordance with the Company's instructions as approved by the Lenders Representative.

4.4 Mandatory Realisations

In the event that the Company becomes aware that any Authorised Investment has ceased to be an Authorised Investment, the Company shall immediately instruct the Escrow Agent on a best efforts basis to realise such Authorised Investment on its maturity date or earlier if possible under intimation to the Lenders Representative or DMRC.

4.5 Accounts include Investments

Any reference in this Agreement to the balance standing to the credit of the Escrow Account shall be deemed to include a reference to the amount of the Authorised Investments in which all, or part of, such balance is for the time being invested.

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4.6 Interest on Investments

Any interest or other income received on account of Authorised Investments shall be to the credit of the Escrow Account.

4.7 Enforcement Notice

On receipt of an Enforcement Notice from the Lenders Representative, the Escrow Agent shall realise the Authorised Investments, whether such investments have matured or not on a best effort basis, and apply the proceeds as directed by the Lenders Representative.

5. Withdrawals following Event of Default

5.1 If the Lenders Representative notifies the Escrow Agent that an Event of Default is likely to occur or has occurred, and is continuing then, until such time as the Lenders Representative has notified the Escrow Agent that the Event of Default has been cured or waived under the Financing Documents the Escrow Agent shall only make withdrawals from the Escrow Accounts which constitute Permitted Payment and shall not make any payments from the Escrow Account to the Company Accounts.

6. Escrow Agent Provisions

6.1 The Escrow Agent and the Senior Lenders

The Company hereby appoints the Escrow Agent to act as trustee for the Lenders Representative, DMRC and the Company in connection herewith and authorises the Escrow Agent to exercise such rights, powers, authorities and discretion as are specifically delegated to the Escrow Agent by the terms hereof together with all such rights powers, authorities and discretion as are reasonably incidental hereto, and the Escrow Agent accepts such appointment pursuant to the terms hereof

6.2 Particular Duties of the Escrow Agent

The Escrow Agent:

(A) may, in the absence of bad faith or gross negligence on its part, rely as to any matters of fact which might reasonably be expected to be within the knowledge of the Company upon a certificate signed by or on behalf of the Company.

(B) may, in the absence of bad faith or gross negligence on its part, rely upon the authenticity of any communication or documents believed by it to be authentic;

(C) shall, within five *(5)* Business Days after receipt, deliver a copy to the Lenders Representative of any notice or document received by the Escrow Agent in its capacity as the Escrow Agent from the Company or any other person hereunder or in connection herewith; and

(D) shall, within five *(5)* Business Days after receipt, deliver a copy to the Company of any notice or document received by the Escrow Agent from the Lenders Representative in connection herewith.

6.3 Segregation of Funds

Monies and other property received by the Escrow Agent under this Agreement shall, until used or applied in accordance with this Agreement, be held by the Escrow Agent in trust for

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the purposes for which they were received, and shall be segregated from other funds and property of the Escrow Agent.

6.4 Termination

6.4.1 This Agreement shall remain in full force and effect so long as amounts remain outstanding from the Company in respect of the Financial Assistance received by it from the Senior Lenders or its obligations to DMRC, unless terminated earlier by the mutual consent of the Parties or otherwise in accordance with the provisions of this Clause.

6.4.2 The Company may, by not less than 45 days prior notice to the Escrow Agent, DMRC and the Lenders Representative, terminate this Agreement and appoint a new Escrow Agent, provided that the new Escrow Agent is acceptable to the Lenders Representative and arrangements are made satisfactory to the Lenders Representative for transfer of amounts deposited in the Escrow Account to a new Escrow Account established with the successor Escrow Agent.

6.5 Fees

The Company shall pay the Escrow Agent fees in an amount and at such times as may be agreed between the Escrow Agent and the Company.

7. Escrow Agreement Defaults

7.1 If the Company is in breach of any of its obligations under this Agreement and, following a notice of default from the Lenders' Representative, fails to remedy the same:

(A) in the case of a failure to deposit funds received by the Company in the Escrow Account, by depositing the same in the Escrow Account within five Business Days of receipt of such notice;

(B) In the case of a breach consisting of causing the Escrow Agent to transfer funds to any Company Account in breach of the terms of this Agreement, by depositing the relevant funds in the Escrow Account or any Sub-Account in which such transfer should have been made within five Business Days of receipt of such notice.

(C) in the case of a breach of the Company's obligations under Clause 4, by instructing the Escrow Agent to realise any investment made in breach of Clause 4 within five *(5)* Business Days of receipt of such notice; or

(D) in the case of any other breach, by remedying the same within five *(5)* Business Days to the satisfaction of the Lenders Representative.

7.2 The Company and the Escrow Agent agree and confirm that any default by the Company in the performance of its obligations under this Agreement resulting. in the opinion of the Lenders Representative, in a breach of this Agreement, shall qualify as an Event of Default under the Financing Documents/Security Documents.

8. Miscellaneous

8.1 Closure of Accounts

The Escrow Agent shall, at the request of the Company made on or after the payment by the Company of all outstanding amounts under the Financing Documents and Concession Agreement and upon confirmation of receipt from Senior Lenders and DMRC, close the Escrow Accounts and pay any amounts outstanding to the credit thereof to the Company. However, in the case of all outstanding amounts having been paid under the Financing Documents only, prior to closure of the Escrow Accounts, DMRC and the Company shall

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enter into a separate agreement to give effect to the provisions of Clause 25 of the Concession Agreement and such agreement shall be effective immediately after closure of Escrow Accounts. For clarification purpose, any amount standing to the credit of the Escrow Accounts at the time of closure of the Escrow Accounts shall be governed by the proposed new agreement.

8.2 Successors and Assignors

This Agreement shall be binding on and shall accrue to the benefit of the Parties and their respective successors and permitted assigns.

8.3 No Set Off

The Escrow Agent agrees not to claim or exercise any right of set off, banker's lien or other right or remedy with respect to amounts standing to the credit of the Escrow Accounts. For the avoidance of doubt, it is declared by the Escrow Agent that the monies and properties held by the Escrow Agent shall not be considered as part of the assets of the Escrow Agent and being trust property, shall in the case of bankruptcy or liquidation of the Escrow Agent be wholly excluded from the assets of the Escrow Agent in such bankruptcy or liquidation

8.4 Notices

8.4.1 All notices or other communication to be given or made under this Agreement shall be in writing, shall either be delivered personally or sent by courier, registered or certified mail or facsimile. The address for service of each Party and its facsimile number is set out under its name or, the signing pages hereto. All notices shall be effective upon actual receipt save that where a notice is received after 5.30 p.m. on a Business Day or on a day that is not a Business Day, such notice shall be deemed to be received on the first Business Day following the date of actual receipt. Without prejudice to the foregoing a Party giving or making a notice or communication by facsimile shall promptly deliver copy of such notice or communication personally, by courier or mail to the addressee of such notice or communication.

8.4.2 Any party may by notice change the addresses and/or addresses to which such notices and communications to it are to be delivered or mailed. Such change shall be effective when all the Parties have notice of it.

8.5 Waiver

Failure by any Party at any time to enforce any provision of this Agreement or to require performance by other Parties of any provision of this Agreement shall not be construed as a waiver of such provision and shall not affect the validity of this Agreement or any part of it or the right of the relevant Party to enforce any provision In accordance with its terms.

8.6 Severability

If any condition, Clause or provision of this Agreement not being of a fundamental nature, is held to be illegal or unenforceable, the validity or enforceability of the remainder of this Agreement shall not be affected thereby.

8.7 Amendments

No amendment to this Agreement shall be binding unless in writing and signed by the duly authorised representatives of the Parties.

8.8 Governing Law

This Agreement shall be governed by and construed in accordance with Indian law and, subject to Clause 8.9 below, the courts at New Delhi shall have jurisdiction over all matters arising out of or relating to this Agreement.

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8.9 Arbitration

Any dispute, difference or claim arising out of or in connection with this Agreement, which is not resolved amicably, shall be decided finally by reference to a Board of Arbitrators comprising of one nominee of each Party to the dispute. Such arbitration shall be held in accordance the UNCTIRAL rules of Arbitration and shall be subject to the provisions of the Arbitration Act. The Arbitrators shall issue a reasoned award and the venue of such arbitration shall be New Delhi. The Parties undertake to carry out any award of the arbitrators without delay. Awards relating to any dispute shall be final and binding on the Parties as from the date they are made and the Parties hereby waive the right to appeal or review such Award by any court of Tribunal of competent jurisdiction in so far as such waiver can be validly made. This Agreement and rights and obligations of the Parties shall remain in full force and effect pending the Award in any arbitration proceeding hereunder.

8.10 Regulatory Approvals

The Escrow Agent shall use its best efforts to procure and shall thereafter maintain and comply with all regulatory approvals required for it to establish and operate the Escrow Accounts. The Escrow Agent represents and warrants that it is not aware of any reason why such regulatory approvals will not be ordinarily granted to the Escrow Agent.

8.11 Notification of Balances

Seven Business Days prior to each Payment Date (and for this purpose the Escrow Agent shall be entitled to rely on an affirmation by the Company and/or the Lenders Representative as to the relevant Payment Dates), the Escrow Agent shall notify the Lenders Representative of the balance of the Escrow Account as at the close of business on the immediately preceding Business Day.

IN WITNESS whereof the Company has caused its Common Seal to be affixed hereto and to a triplicate hereof on the date first above written and the Escrow Agent, DMRC and the Lenders Representative have caused the said triplicate to be executed by the hand of an authorised official.

SIGNED AND DELIVERED BY
..... Escrow Agent

SIGNED AND DELIVERED BY
..... Lenders Representative

SIGNED AND DELIVERED BY
..... DMRC

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SCHEDULE - R

SUMMARY OF PENALTIES AND COSTS

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SCHEDULE R
Summary of Penalties and costs

1. Volume II Article 16.4 and 16.5, Delay in the Project completion, other than Force Majeure and reasons attributed to DMRC.

   i) Penalty: 0.5% of the Security Deposit per day from 1st August to 15th September 2010, and thereafter 1.0% of the Security Deposit per day from 16th September to 30th September 2010.

   ii) Consideration of Termination of the Agreement without any damage costs, in case COD is not achieved till 30th September 2010.

2. Volume II Article 17.6

2.1 Non-completion of Punch Lists

   i) Penalty: After 90 days from issue of the Provisional Certificate, Rs 200,000 per week for 60 days; thereafter

   ii) Consideration of Termination of the Agreement.

2.2 Volume III Schedule D-III Chapter 1 Systems Assurance Tests

   i) Stage 1 Reliability Demonstration Tests.

   Penalty: After 90 days from issue of the Provisional Certificate, Rs 200,000 per week for 60 days; then consideration of Termination of the Agreement.

   ii) Stage 2 Reliability Demonstration Test

   Penalty: On failure of 0.5% of the Security Deposit per day until satisfactory completion of any retesting.

   Stage 3 Reliability Demonstration Tests

   Penalty: On failure of 0.5% of the Security Deposit per day until satisfactory completion of any retesting.

   Stage 4 Reliability Demonstration Tests

   Penalty: On failure of 0.5% of the Security Deposit per day until satisfactory completion of any retesting.

3. Volume II Article 19.8. Safety and Accident

Hazardous and potentially hazardous events shall be classified by a Safety Review Board (SRB), as follows:

- Train-Related Accidents; which actually cause, or have the potential to cause, loss of life or injury to people or damage to property of others;
- Emergencies or Serious Accidents; which may not necessarily be as a result of train related accidents but which cause, or have the potential to cause, loss of life and/or injury to people and/or wide spread and prolonged distress.

The SRB shall comprise a quorum of representatives, as follows:

- The Independent Consultant (Chairman);
- The Independent Checking (Testing) Engineer
- The Independent Railway RAMS Assessor;

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- Independent Operations and Maintenance Consultant; and
- The Commissioner of Metro Safety for the Government of India; and

The terms of reference for the SRB shall be proposed by the Independent Consultants and reviewed by DMRC and the Concessionaire.

The SRB shall investigate each hazardous and potentially hazardous event and award penalty points to each event, dependent on the severity and circumstances of the event. Five penalty points within any continuous period of 365 days shall constitute a Material Breach of the Agreement.

4. Volume II Article 19.12/13.

4.1 Maintenance

i) Penalty: Failure to commence remedial work on unsatisfactory O&M items, within 30 days of receipt of notice, DMRC cost to remedy the O&M items and 25%of DMRC costs; or

ii) Penalty: In the event that DMRC doesn't undertake the remedial work, 0.5% of the average daily Fare per day until the default is rectified, or 0.1% of the cost estimated by the Consultant for the remedial work per day, which ever is the higher.

4.2 Volume III Schedule L, Service Quality Criteria

Penalty : For failure to commence remedial work on unsatisfactory Performance Indicators within 30 days of receipt of notice thereof, 0.5% of the average daily Fares paid during the preceding 15 days per day until the defaulting Performance Indicator is remedied, or 0.1% of the of the Consultant's cost estimate for the remedial work per day, which ever is the higher.

5. Article 22 .2 Financial Closure

Penalty: Failure to achieve Financial Closure within 120days, advance payment of Rp 100,000 per week for 60 days, then termination of the Agreement and forfeiture of Security Deposit.

6. Article 28 Material Breach of Agreement

6.1 Concessionaire in Breach

Penalty: All direct additional costs incurred by DMRC up to Termination of the Agreement

6.2 DMRC in Breach

Penalty: All direct additional costs incurred by the Concessionaire up to Termination of the Agreement

7. Article 29 Suspension and Termination

7.1 Termination by DMRC, the Concessionaire being at fault,

Penalty: 50% of the depreciated replacement value (DRV) of the Concessionaires assets.

7.2 Termination by the Concessionaire, DMRC being at fault,

Penalty: within 15 years of COD, 110% of DRV;
within 15 to 25 years from COD, 80% of DRV ; and
after 25 years from COD, 50% of DRV.

Delhi Rail Corporation Ltd.

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SCHEDULE S

SAFETY HEALTH AND ENVIRONMENT

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SCHEDULE S

SAFETY HEALTH AND ENVIRONMENT

The Concessionaire shall adopt DMRC Project Phase II policies and procedures, during the construction of the AMEL, as described in the "Safety Health and Environmental Manual" and Amendments, as follows:

Part 1. Safety and Health Policy and Procedures; dated September 2005

Part 2. Environmental and Health Policy and Procedures, dated September 2005

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SCHEDULE - T

REQUIREMENTS OF THE HANDOVER PACKAGE

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SCHEDULE - T

HANDOVER PACKAGE

Upon Termination, the Concessionaire shall comply with and conform to requirements set out in Article 30 and ensure that the Handover Package contains, at a minimum, the following information:

1. Premises – a list of the premises leased or operated by the Concessionaire, showing the status, address, telephone number, facsimile number, responsible manager and use of each;

2. Contracts – a list of all agreements, permits, licences or other documents which are material to the operation of the Concessionaire's business showing (as appropriate) the contact number, name, address, telephone and facsimile numbers of counterparties, contract price, value and subject matter;

3. Commercial Leases, sub-leases and other commercial arrangements – a summary of all Commercial Leases, sub-leases and commercial arrangements entered into by the Concessionaire in relation to the Interchange Facility identifying the counterparty, term of arrangement, rental, sublease area and summary of terms and conditions. Copies of all sub-leases and commercial arrangements should also be included;

4. Systems – a list of systems used (computer and otherwise) for the maintenance and operation of the Project, together with a description of the systems and master passwords where applicable;

5. Daily operations – a list of any other information key to the daily operation of the Concessionaire's business, including:
   a. the names, work and home telephone numbers of each person in possession of keys accessing the premises owned, leased or operated by the Concessionaire within the Precinct;
   b. lists of Plant and other assets owned, leased or otherwise operated by the Concessionaire material to the operation of the Concessionaire's Business; and
   c. master password

6. Organisational structure – a detailed diagrammatical representation of the organisational structure of the Concessionaire and its Affiliates;

7. Employees – details of each employee of the Concessionaire, including:
   a. names, work telephone numbers, roles and responsibilities;
   b. the date on which his or her of employment began;
   c. terms and conditions of employment;
   d. all payments, benefits or changes to terms and conditions of employment promised to any employee; and
   e. training record and certifications

8. Drawings – current and accurate "as built" drawings showing all modifications and augmentations. constructed or installed during the Contract Term, showing precise locations as installed, including three sets of all drawings and documentation, and one compete of set of drawings and documentation stored in labeled CD-Rom format;

9. Planning and building permit correspondence – copies of all correspondence with the relevant authorities, consultants, contractors, and subcontractors pertaining to access arrangements, applications for planning permits, applications for building permits, correspondence related to subsequent building works and alterations and additions to services, and any other building or operational issues related to the Project;

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10. Railway Systems, buildings plant and equipment - comprehensive set of commissioning and test data confirming that all Railway Systems and building services plant and equipment installed has been commissioned to meet the established design criteria; and

11. Manuals – copies of the most recent Operating Manual, Maintenance Manual and Quality Assurance Manual.

12. Asset listing giving life status and associated O&M Specification for each asset along with the maintenance schedule for the balance life.

13. Co-ordination procedures with emergency services.

14. Safety case log.

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SCHEDULE - U

SUBSTITUTION AGREEMENT

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SCHEDULE - U

Form of SUBSTITUTION AGREEMENT as per Article 29

THIS SUBSTITUTION AGREEMENT is made at New Delhi on this the _____ day of _____, 20__.

BETWEEN

1. DELHI METRO RAIL CORPORATION LIMITED (DMRC), a joint venture company of Govt. of India and Govt. of National Capital Territory of Delhi, and having its registered office at NBCC Place, Bhishma Pitamah Marg, Pragati Vihar, New Delhi 110 003 (hereinafter referred to as "DMRC" which expression shall unless repugnant to the context or meaning thereof include its administrators, successors and assigns),

2. RELIANCE ENERGY LIMITED AND CONSTRUCCIONES Y AUXILIAR DE FERROCARRILES S.A. JOINT VENTURE, a company incorporated under the provisions of the Companies Act, 1956 and having its Registered Office at _____, _____ (hereinafter referred to as the "Concessionaire", which expression shall unless repugnant to the context or meaning thereof include its successors and assigns),

AND

3. _____, having its registered office _____ at acting for itself and for and on behalf of the Senior Lenders listed in Schedule I hereto (hereinafter referred to as the "Senior Lenders").

(DMRC, the Concessionaire and the Senior Lenders are hereinafter collectively referred to as the "Parties" and individually are hereinafter referred to as "Party").

WHEREAS

A. By the Concession Agreement dated xxxxxxx entered into between DMRC and the Concessionaire, DMRC has granted to the Concessionaire the Concession for financing, design, procurement, completion and equipping of stations and the installation of all systems (including but not limited to Rolling Stock, Over Head Electrification, Track, Signaling and Telecommunication, Ventilation and Air Conditioning, Automatic Fare Collection, Baggage Check-in and Handling, Depot and other facilities required for a successful Airport Express link), Testing, Commissioning of the Airport Metro Express Link (hereinafter the "Project") on Build, Operate and Transfer (BOT) basis and for its subsequent Operation and Maintenance, all subject to and on the terms, conditions and covenants set forth in the said Concession Agreement or forming part thereof.

B. With a view to help facilitate obtaining of financing for the said Project by the Concessionaire so as to enable the Concessionaire to build, operate and maintain the same pursuant to and in accordance with the Concession Agreement, the Parties have agreed subject to the terms and conditions of the Concession Agreement and the Financing Documents that the Senior Lenders shall have the right to substitute the Concessionaire by a Selectee for the residual period of the Concession on the terms, conditions and covenants mentioned hereinbelow.

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C. As a condition to making any disbursement pursuant to the Financing Documents, the Senior Lenders have required and it is deemed necessary and expedient to record the terms, conditions and covenants of the above agreement between the Parties.

NOW THEREFORE THE PARTIES HERETO HEREBY AGREE AND THIS AGREEMENT WITNESSETH AS FOLLOWS:

ARTICLE 1 – DEFINITIONS

1.1 For the purpose of this Agreement, the following terns shall have the meaning hereinafter respectively assigned to them:

1.1.1 "Concession" means the bundle of rights, obligations and covenants of the Concessionaire under and as setforth in the Concession Agreement.

1.1.2 "Concession Agreement" means the Concession Agreement dated ..... entered into between DMRC and the Concessionaire granting the Concession to the Concessionaire in respect of the Project and includes without limitation any amendments thereto made in accordance with the provisions contained in this behalf therein.

1.1.3 "Event of Default" means occurrence of any of the following events:

(i) A Material Breach by the Concessionaire of the Concession Agreement, or the occurrence of a Concessionaire Event of Default as defined in the Concession Agreement.

(ii) A material default in payment by the Concessionaire to all or any of the Senior Lenders under the Financing Documents of any two installments, either of principal or interest or both, due and payable by it on account of Lenders Dues.

(iii) Any event of default under or breach of any of the terms of any of the Financing Documents or Project Agreements concerning the Project which in the sole opinion of the Lenders' Agent is material or major and which may seriously affect the ability of the Concessionaire to meet its payment obligations to the Senior Lenders under the Financing Documents or to design engineer, construct, complete, operate and maintain the Project pursuant to and in accordance with the Concession Agreement.

1.1.4 "Financial Assistance" means the loans, advances and other funding assistance including any syndicated/ participation facility provided by the Senior Lenders as set forth in Schedule II hereto for financing the whole or any part of the cost of the Concessionaire's Works,

1.1.5 "Financing Documents" means the documents executed to be executed by the Concessionaire or entered/to be entered into by the Concessionaire with the Senior Lenders and/or the Lenders' Agent in respect of the Financial Assistance and include loan agreements, guarantees, notes, debenture, bonds and other security agreements and other documents relating to the Financial Assistance and brief particulars whereof are set forth in Schedule II hereto in relation to each Senior Lender.

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1.1.6 "Lenders' Agent" means [xxx] and having its principal office at xxxxx and any replacement thereof appointed by all the Senior Lenders, inter alia, on the condition that as security for the Financial Assistance they shall have the right to seek transfer and assignment of the Concession Agreement including the Concession in accordance with the provisions of this Agreement.

1.1.7 "Lenders Certificate" shall have the meaning ascribed thereto in Clause 2.2(b).

1.1.8 "Lenders Dues" means the aggregate of all monies owned by the Concessionaire to the Senior Lenders under the Financing Documents on account of principal thereunder for funding the Concessionaire's works in respect of the Project, and all accrued interest, additional interest, liquidated damages, commitment fees, commission, prepayment premium, costs, charges and other monies including financing charges and fees owned by the Concessionaire to the Senior Lenders under the Financing Documents for the Project upto the transfer date, and which are payable under the Financing Documents.

1.1.9 "Notice of Default" shall have the meaning ascribed thereto in Clause 2.2(a).

1.1.10 "Proposal" shall have the meaning ascribed thereto in Clause 3.1(iii).

1.1.11 "Project Agreements" means this Agreement, the Concession Agreement, the Escrow Agreement, the Financing Documents, the EPC Contract and the O&M Contract, if any, and shall include amendments thereto made hereafter with the prior consent of DMRC.

1.1.12 "Senior Lenders" means the financial institutions, banks, funds and agents or trustees of debenture holders, including their successors and assignees, who have agreed to guarantee or provide finance to the Concessionaire under any of the Financing Documents for meeting costs of all or any part of the Project and who hold pari passu charge on the Concession granted by this Agreement and have a right of substitution of the Concessionaire pursuant to the Substitution Agreement.

1.1.13 "Selectee" means a new Concessionaire proposed by the Senior Lenders pursuant to this Agreement and approved by DMRC for substituting the Concessionaire for the residual period of the original Concession by amendment of the Concession Agreement.

1.1.14 "Substitution Notice" means the notice given by the Lenders' Agent pursuant to Clause 2.2 (c) of this Agreement.

1.2 The words and expressions beginning with or in capital letters used in this Agreement not defined in the Concession Agreement , shall have, unless repugnant to the context, the meaning respectively assigned to them in the Concession Agreement.

1.3 In this agreement unless the context otherwise requires:

a) any reference to a statutory provision shall include such provision as is from time to time modified or re-enacted or consolidated so far as such modification or reenactment or consolidation applies or is capable of applying to any transactions entered into hereunder;

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b) the words importing singular shall include plural and vice versa, and words denoting natural persons shall include partnerships, firms, companies, corporations, joint ventures, trusts, associations, organisations or other entities (whether or not having a separate legal entity);

c) the headings are for convenience of reference only and shall not be used in and shall not affect the construction or interpretation of this Agreement;

d) terms beginning with capital letters and defined in this Agreement shall have the meaning ascribed thereto herein;

e) the words "include" and "including" are to be construed without limitation;

f) any reference to a "day" shall mean reference to a calendar day:

g) any reference to "month" shall mean reference lo a calendar month:

h) the Schedules to this Agreement form an integral part of this Agreement and will be in full force and effect as though they were expressly set out in the body of this Agreement;

i) any reference at any time to any agreement, deed, instrument, license or document of any description shall be construed as reference to that agreement, deed, instrument, license or other document as amended, varied, supplemented, modified or suspended at the time of such reference provided that this clause shall not operate so as to increase liabilities or obligations of DMRC hereunder or pursuant hereto in any manner whatsoever;

j) references to Recitals, clauses, sub-clauses, paragraphs. or schedules in this Agreement shall, except where the context otherwise requires, be deemed to be references to Recitals, Articles, clauses, sub-clauses, paragraphs, Annexures, appendices of this Agreement.

k) any agreement, consent, approval, authorisation, proposal, notice, communication, information or report required under or pursuant to this Agreement from or by any Party or Senior Lender(s) shall be valid and effectual only if it is in writing under the hands of duly authorised representative of such Party or the Senior Lender(s), as the case may be, in this behalf and not otherwise; and

l) any reference to any period commencing "from" a specified day or date and "till" or "until" a specified day or date shall include both days or dates.

ARTICLE 2

SUBSTITUTION OF THE CONCESSIONAIRE BY A SELECTEE

2.1 DMRC hereby agrees to substitute the Concessionaire by a Selectee (selected by the Senior Lenders in accordance with the provisions of this Agreement and approved by DMRC) by amendment of the Concession Agreement or by execution of a fresh Concession Agreement in favour of the Selectee for the purpose of securing the payments of the Lenders Dues,

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provided that nothing contained herein shall entitle the Senior Lenders to operate the Concession themselves as a Concessionaire under and in accordance with Concession Agreement either individually or collectively.

2.2 (a) Upon receipt from DMRC of a copy of any Notice of Breach or Default under the Concession Agreement, or of and by itself the Lenders' Agent shall notify by a notice in writing to the Concessionaire (the "Notice of Default"), with a copy thereof simultaneously to DMRC, about the occurrence of a Concessionaire's Event of Default under the Concession Agreement and requiring the Concessionaire to remedy and cure such default within the Cure Period stipulated or, where no Notice of Breach or Default has been issued, within 30 (thirty) days from the date of delivery of such Notice of Default. The Notice of Default shall be accompanied by the Lenders' Certificate.

(b) A certificate under the hands of an authorised officer of the Lenders' Agent annexed to the Notice of Default certifying:

(i) the occurrence of a Concessionaire's Event of Default, and

(ii) the Lenders' Dues.

(the "Lenders' Certificate") shall be conclusive evidence of occurrence of such Concessionaire's Event of Default and of such Lenders' Dues. Such Lenders' Certificate shall be final, conclusive and binding upon the Concessionaire for the purposes of this Agreement and the Financing Documents.

(c) DMRC and the Concessionaire hereby agree that the Lenders' Agent may:

(i) within 30 (thirty) days of the date of delivery of the Notice of Default of the Concessionaire, or

(ii) within 7 (seven) days of the date of issue of the Termination Notice,

and without prejudice to any other right or remedy available to the Senior Lenders under the Financing Document, notify DMRC and the Concessionaire on behalf of all the Senior Lenders about the Senior Lenders decision to invite, negotiate and procure offers, either through private negotiations or public auction or process of tendering for the residual period of the Concession and the rights and obligations of the Concessionaire under the Concession Agreement, by a Selectee, subject to the approval of such Selectee by DMRC (the "Substitution Notice").

(d) Upon assumption by the Selectee of the liability and obligations of the Concessionaire under the Financing Documents and the Concession Agreement including obligation to pay any sums then due and payable to DMRC under the Concession Agreement, DMRC shall grant the Concession to the Selectee on the same terms and conditions for the residual period of the original Concession, by amendment of Concession Agreement and not by Termination thereof.

2. 3 The Lenders' Agent shall apply in the selection of the following criteria:

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(i) the Selectee shall be capable of properly discharging the duties, obligations and liabilities of the Concessionaire under the Concession Agreement;

(ii) the Selectee shall provide security to the satisfaction of Senior Lenders for repayment of the Lenders Dues;

(iii) the Selectee shall have the capability and shall unconditionally consent to assume the liability for the payment and discharge of dues of the Concessionaire to DMRC under and in accordance with the Concession Agreement and of Lender's Dues upon terms and conditions as agreed to with the Senior Lenders;

(iv) the Selectee shall have the networth, experience and technical equity parameters as setforth in the Concession Agreement or prescribed by DMRC thereunder in respect of the Concessionaire or as relaxed subsequently by DMRC;

(v) the Selectee shall have not been in breach of any agreement between the Selectee and DMRC; and

(vi) any other appropriate circumstance, whereby continuity in the performance of the Concessionaire's obligations under the Concession Agreement is maintained and the security in favour of Senior Lenders under the Financing Documents is preserved.

2.4 At any time prior to the acceptance of the Selectee by DMRC pursuant to this Agreement, DMRC may require the Lenders' Agent to satisfy DMRC as to the eligibility of the Selectee and the decision of the DMRC in this behalf (which shall be reasonable), shall be final, conclusive and binding on the Senior Lenders and the Selectee.

ARTICLE 3

MODALITY FOR SUBSTITUTION

3.1 The following modalities shall be applicable to any substitution of the Concessionaire by the Selectee pursuant to this Agreement:

(i) The Lenders' Agent may invite, negotiate or procure offers either through private negotiations or public auction or process of tender or otherwise for the substitution of the Concessionaire by the Selectee;

(ii) The Lenders' Agent shall on behalf of the Senior Lenders propose to DMRC pursuant to sub-clause (iii) below, the name of the Selectee for acceptance and shall apply as necessary to DMRC for:

a) grant to the Selectee (as substitute for the Concessionaire) the right to build, construct, complete, maintain, and operate the Project under and in accordance with and subject to and on the terms and conditions set forth in the Concession Agreement;

b) amendment of the Concession Agreement so as to grant to the Selectee on the same terms and conditions, the residual period of the Concession under original Concession Agreement; and

c) the execution of a new Substitution Agreement with the proposed Selectee for the residual period of Concession on the same terms and conditions as herein, and

(iii) The Lenders' Agent on behalf of the Senior Lenders shall be entitled, within a period of 60 (sixty) days from the date of delivery to DMRC of the Substitution Notice pursuant to Clause 2.2 (c) above, to select and propose to DMRC for its approval a Selectee (the "Proposal"). The Proposal of the Lenders' Agent pursuant to this sub-clause (iii) shall contain the particulars and information in respect of the Selectee, the Lenders' Dues and other data and information, all as prescribed in Schedule IV hereto. Without prejudice to the foregoing the Lenders' Agent agrees and undertakes to provide to DMRC such further and other information and such clarifications in respect of any data, particulars or information furnished pursuant hereto by the Lenders' Agent as DMRC may reasonably require. DMRC shall convey its approval or otherwise of such Proposal, including of Selectee, in its sole discretion within 15 (fifteen) days of (a) the date of receipt of the Proposal by DMRC, or (b) the date when last of further and other information and such clarifications in respect of any data, particulars or information comprised in the Proposal, as have been provided in the Lenders' Agent to DMRC, whichever is later. It is expressly agreed that the Proposal shall be accompanied by an unconditional undertaking of the Selectee that it shall upon approval by DMRC of the Proposal including the Selectee, observe, comply, perform and fulfill the terms, conditions and covenants of the Concession Agreement which according to its terms are required to be observed, complied with, performed and fulfilled by Concessionaire thereunder on the footing as if such Selectee were the concessionaire under the Concession Agreement and shall be liable for and shall assume, discharge and pay the Lenders Dues to the Senior Lenders under and in accordance with the Financing Documents. Upon approval of the Proposal including of the Selectee by DMRC, such Selectee shall become the Selectee hereunder.

(iv) DMRC shall, upon its satisfaction of the eligibility of the Selectee and in accordance with the provisions of this Agreement, and subject to the provisions of Sub-clause (v) below, proceed to substitute the Concessionaire or the Selectee by amendment of the Concession Agreement or such other writing as DMRC may reasonably require on the same terms and conditions for the residual period of the Concession in favour of the Selectee.

(v) The substitution as aforesaid shall be subject to the Selectee, obtaining requisite Indian Government approvals, clearances and permission necessary for operating the Concession under and in accordance with the Concession. Agreement.

(vi) The objection if any of DMRC to the substitution as aforesaid shall be reasoned and be made after hearing the Lenders' Agent, provided however, that in the event of a refusal as stated above, the Lenders' Agent may propose another Selectee. In the event that no objection is raised with respect to the Selectee by DMRC within the period set forth in sub-clause (iii) above, the Selectee shall be deemed to have been accepted by DMRC. DMRC shall, subject to the provisions of Sub-Clause (v) above, grant the Concession for the residual period within 15 days of its acceptance/deemed acceptance of the Selectee.

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(vii) The substitution as aforesaid, pursuant to the security interest in favour of the Senior Lenders, shall be deemed to be complete only upon the Selectee as Concessionaire accepting and complying with the terms and conditions stipulated in the Concession Agreement.

(viii) The decision of the Senior Lenders and DMRC in the selection of the Selectee shall be final and binding on the Concessionaire and shall be deemed to have been made with the concurrence of the Concessionaire and the Concessionaire hereby expressly waives all rights to object to or challenge such selection of the Selectee on any ground whatsoever. No third party shall have the right to question the decision of the Senior Lenders/Lenders' Agent and DMRC.

(ix) All actions of the Lenders' Agent hereunder shall be deemed to be on behalf of the Senior Lenders, and be binding upon them. The Lenders' Agent is authorised to receive payment of compensation, payment to cure default and any other payments, consideration for transfer in accordance with the Substitution Notice and the Financing Documents and give valid discharge on behalf of all Senior Lenders.

3.2 The terms and conditions for substitution of the Concessionaire by the Selectee shall be proposed by the Senior Lenders through the Lenders' Agent to DMRC, on or after the occurrence of an Event of Default but at least 2 months prior to the anticipated date of substitution as aforesaid for the residual period of the Concession.

3.3 The Concessionaire hereby irrevocably agrees and waives any right to challenge the Senior Lender's decision to apply to DMRC for substitution as aforesaid and neither the Concessionaire nor DMRC Shall be entitled to prevent the Lenders' Agent from proceeding to seek such a substitution of the Concessionaire by Selectee as hereinbefore provided. The Concessionaire agrees and confirms that the Concessionaire shall not have any right to seek re-valuation of the Concessionaire's assets and the Concession Agreement including the Concession, otherwise than as contracted in the Financing Documents while DMRC permits substitution as hereinbefore provided, pursuant to the Lenders' Agent's request. The Parties acknowledge that the rights of the Senior Lenders hereunder are irrevocable and shall not be contested in any proceedings before any court of authority and the Concessionaire shall have no right or remedy to prevent, obstruct, injunct or restrain DMRC and/or the Senior Lenders from effecting or causing the substitution as aforesaid.

3.4 Where no suitable Selectee can be found by the Lenders' Agent and DMRC shall decide to take over the concession then DMRC shall advise the Lenders' Agent of all steps it proposes to take under the Concession Agreement for determination of Termination Payments thereof.

3.5 (i) If DMRC decides to substitute the Concessionaire by any other person (DMRC Nominee), it shall take into account the Senior Lenders' Dues while considering offers from such persons and shall include a suitable condition as agreed to by the Lenders' Agent on behalf of the Senior Lenders for payment or take over of such dues by such DMRC Nominee to the extent agreed by the Lenders' Agent while substituting the Concessionaire by the DMRC Nominee. The DMRC Nominee shall similarly be bound to execute a supplementary/fresh substitution agreement on the same terms and conditions as provided herein.

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(ii) Notwithstanding anything contained in Clause 3.4 and this Clause 3.5, DMRC shall not be required to take over, upon Termination of the Concession Agreement including the Concession, the liabilities representing the Lender's Dues save and except to the extent of Termination Payments due and payable upon such Termination under the Concession Agreement. In such an event DMRC's obligation shall be limited to assumption of such liabilities and payments of dues as DMRC has agreed to bear under the Concession Agreement.

3.6 Nothing contained in these presents shall mean or be interpreted as provision of any guarantee or surety by DMRC and it is expressly agreed that DMRC has not provided any surety, guarantee or counter guarantee whether directly or indirectly for the recovery of amount of Financial Assistance advanced by the Senior Lenders to the Concessionaire.

3.7 The person substituting the Concessionaire shall be deemed to be the Concessionaire under Concession Agreement and shall enjoy all rights and be responsible for all obligations under Concession Agreement as if it were the Concessionaire. Further, in the event of such step-in or substitution, an additional Cure Period of 90 (ninety) days from the date of such substitution shall be provided by DMRC to enable the Concessionaire to cure any breach or default subsisting on the day of such step-in or substitution. Provided further that if the Senior Lenders step in to operate and manage the Concession for a period not exceeding 90 (ninety) days, their liabilities shall be restricted to the obligations relating to and arising during such 90 (ninety) days period.

ARTICLE 4

INTERIM PROTECTION OF SERVICE AND PRESERVATION OF SECURITY

4.1 In the event of the Senior Lenders notify DMRC and the Concessionaire of the Concessionaire's Event of Default (and the concessionaire has not cured the default for a period of 30 days) or in special circumstances affecting the security of the Senior Lenders, the Senior Lenders shall be entitled to institute protective legal proceedings for a receivership (:he "Receiver") to maintain, preserve and protect the assets (other than the Concession Agreement including the Concession) held as security by the Senior Lenders provided always that such receiver shall be DMRC if such assets are in the opinion of DMRC necessary and required for the operation and maintenance of the Project and the Parties hereby consent and agree to the same. The Lenders' Agent shall in such an event notify DMRC to assume receivership of the assets held as security and DMRC shall operate and maintain the same pending the substitution of the Concessionaire by the Selectee. In the event DMRC does not assume receivership and declines the request of the Lenders' Agent, the Lenders' Agent shall for itself and each of the Senior Lenders, be entitled to seek the appointment of a Court Receiver for the Concessionaire's assets held as security and DMRC shall operate and maintain the same pending substitution as aforesaid and/or the takeover of the Concession Agreement including the Concession and the Project in accordance with the Concession Agreement or this Agreement by DMRC. All the receivables shall be deposited by the Receiver in the Escrow Account and shall be dealt with in accordance with the Concession Agreement. The Receiver shall be responsible for protecting the assets in receivership and shall render a true and proper account of the receivership to the Senior Lenders in accordance with the terms of its appointment. The Receiver shall make best efforts to operate and maintain the Project in accordance with the obligations of the Concessionaire under the Concession Agreement.

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4.2 Any person other than DMRC may be appointed as Receiver only with the prior consent of DMRC. In a declaratory suit for appointment of a Receiver, notwithstanding that no recovery or mortgage suit or any suit or proceeding for enforcement of the Senior Lenders' security under the Financing Documents is instituted by the Lenders' Agent for itself or the Senior Lenders, any action for appointment of DMRC as Receiver or appointment of an Independent Court Receiver shall be without prejudice to the other rights and remedies of DMRC, and of the Senior Lenders under the Financing Documents.

ARTICLE 5

TERMINATION OF THE CONCESSION BY DMRC

5.1 If under the Concession Agreement an event occurs which shall entitle DMRC to Terminate the Concession Agreement, DMRC shall intimate this to the Senior Lenders prior to exercising of its decision to Terminate the Concession and advise the Senior Lenders to ensure the cure of the event which otherwise can result in Termination of the Concession and the Concession Agreement. Subject to the provisions of Clause 30.2 of the Concession Agreement, such a notice may entitle the Senior Lenders to cure any financial or other default of the Concessionaire within a period of two months from the date of the notice received from DMRC, failing which DMRC, without any further notice to either the Concessionaire or the Lenders' Agent/Senior Lenders, shall be entitled to Terminate the Concession Agreement.

5.2 Upon receipt of the Notice as referred to in Clause 5.1, intimating occurrence of an event which can entail Termination of the Concession Agreement including the Concession, the Senior Lenders shall be entitled to consider such notice as an Event of Default and may initiate steps to invite, negotiate and procure offers for the substitution of the Concessionaire by a Selectee in accordance with the procedure set forth in this Agreement.

ARTICLE 6

SENIOR LENDERS RIGHT TO RECEIVE TERMINATION PAYMENTS

6.1 DMRC and Concessionaire hereby agree, and confirm that without prejudice to any other right or remedy, DMRC shall be entitled to deposit the Termination Payments into Escrow Account and the Senior Lenders shall be entitled to receive the same without any further reference to or consent of the Concessionaire under and in accordance with the Concession Agreement towards the satisfaction of the Senior Lenders Dues out of and limited to the sum of Termination Payments worked out under and in accordance with the Concession Agreement. The Senior Lenders shall be entitled to appropriate any consideration received for the substitution as hereinabove provided from the Selectee towards the payment of their and DMRC's respective dues to the exclusion of the Concessionaire.

6.2 The Concessionaire hereby nominates, constitutes and appoints the Lenders' Agent as its constituted attorney for doing all acts, deeds and things as may be required to be done for the substitution of the Concessionaire by the Selectee pursuant hereto and for receiving consideration for discharge of the Lenders' Dues pursuant to Clause 6.1.

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6.3 The Concessionaire hereby expressly authorises payment of sums by DMRC on account of Termination Payments into Escrow Account and the Lenders' Agent to draw the same therefrom for and on behalf of the account of the Senior Lenders notwithstanding the pendency of any dispute or objection or claim that the Concessionaire may have against the Senior Lenders and/or DMRC. The deposit by DMRC into the Escrow Account and payment to the Senior Lenders directly or through the Lenders' Agent in accordance with this Agreement, made or caused to be made by DMRC shall constitute a valid discharge of its obligation of the payment thereof to the Concessionaire. All such payments shall stand charged to the Senior Lenders under the Financing Documents and shall be receivable by the Lenders' Agent from the Escrow Account on behalf of the Senior Lenders to the exclusion of any receiver or liquidator appointed.

ARTICLE 7

GENERAL

7.1 The Parties hereto expressly represent and warrant that they are duly empowered to sign and execute this Agreement and the Lenders' Agent is duly and fully authorized by each of the Senior Lenders to enter into this Agreement on their behalf.

7.2 Notices under this Agreement shall be sent to the Addresses first hereinabove mentioned. Any change in the address of any Party shall be duly notified by a Registered post acknowledgement due and delivered to the other Parties.

7.3 The expressions "DMRC", the "Concessionaire", the "Senior Lenders" and the "Lenders' Agent" herein used shall, unless there be anything repugnant to the subject context, include their respective successors, legal representatives, administrators and permitted assigns.

7.4 This Agreement shall not be affected by reorganisation of any Senior Lender, Lenders' Agent or DMRC and the successor-in-interest of such Senior Lender, Lenders' Agent or DMRC shall have the benefit of this Agreement.

7.5 No amendment, variation or modification to this Agreement shall be valid and effectual unless made in writing and executed by the duly authorised representatives of all the Parties hereto.

7.6 All stamp duties or other imposts and charges as are applicable on this Agreement or on amendment of the Concession Agreement or execution of fresh Concession Agreement for the purpose of substitution as aforesaid shall be borne by and be to the account of the Concessionaire. In the event of the Senior Lenders making such payment for the time being, it shall be deemed to be a part of the Lenders Dues.

7.7 The Parties hereby expressly agree that for the purpose of giving full and proper effect to this Agreement, the Concession Agreement and this Agreement shall be read together and construed harmoniously. The terms of this Agreement shall prevail in the event of any inconsistency with the Concession Agreement.

7.8 The consultation, recommendation or approval of the Lenders' Agent under this Agreement shall always be taken as consultation, recommendation or approval of every concerned Senior Lender and such Senior Lender shall be bound by the same and hereby waives its right to question or dispute the same.

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7.9 This Agreement shall be in addition to and shall not be in derogation of the terms of the Financing Documents.

7.10 It shall not be necessary for the Senior Lenders or the Lenders' Agent to enforce or exhaust any other remedy available to them before invoking the provisions of this Agreement.

7.11 This Agreement shall be governed by and construed in accordance with Indian law and, subject to Clause 7.12 below, the courts at New Delhi shall have jurisdiction over all matters arising out of or relating to this Agreement

7.12 Any dispute, difference or claim arising out of or in connection with or in relation to this Agreement which is not resolved amicably shall be decided finally by reference to arbitration to a Board of Arbitrators comprising of one nominee of each party to the dispute. Such arbitration shall be held in accordance with the UNCTIRAL rules of arbitration and shall be subject to the provisions of Arbitration Act. The Arbitrators shall issue a reasoned award and the venue of such arbitration shall be New Delhi, India. The Award shall be final and binding on the Parties. The Parties agree and undertake to carry out the award of the arbitrators (the "Award") without delay. This Agreement and rights and obligations of the Parties shall remain In full force and effect pending the Award in any arbitration proceeding hereunder

IN WITNESS WHEREOF THE PARTIES HERETO HAVE SET THEIR HANDS THEREUNTO ON THE DAY, MONTH AND YEAR HEREINABOVE MENTIONED.

SIGNED AND DELIVERED ON BEHALF OF RELIANCE ENERGY LIMITED AND CONSTRUCCIONES Y AUXILIAR DE FERROCARRILES S.A. JOINT VENTURE
BY :
Name :
Title :

SIGNED AND DELIVERED ON BEHALF OF
DELHI METRO RAIL CORPORATION LIMITED
BY :
Name :
Title :

SIGNED AND DELIVERED ON BEHALF OF
SENIOR LENDERS
BY:
Name :
Title :

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SCHEDULE-V

VESTING CERTIFICATE

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SCHEDULE – V

(See Article 30)

VESTING CERTIFICATE

1. DMRC represented by Managing Director, refers to the Concession Agreement dated xxxxxxxx (the "Agreement") entered into between DMRC and RELIANCE ENERGY LIMITED AND CONSTRUCCIONES Y AUXILIAR DE FERROCARRILES S.A. JOINT VENTURE represented by xxxxxx (the "Concessionaire") for Airport Metro Express Line System Project (AMEL-P1) of Delhi Mass Transport System on build, operate and transfer ("BOT") basis on Public Private Partnership (PPP) mode.

2. DMRC hereby acknowledges compliance and fulfilment of divestment of rights and interests set forth in Article 30 of the Agreement on the basis that upon issue of this Vesting Certificate, DMRC shall be deemed to have acquired, and all title and interest of the Concessionaire in or about the AMEL-P1 shall be deemed to have vested unto DMRC, free from any encumbrances, charges and liens whatsoever.

3. Notwithstanding, anything to the contrary contained hereinabove, it shall be a condition of this Vesting Certificate that nothing contained herein shall be construed or interpreted as waiving the obligation of the Concessionaire to rectify and remedy and defect or deficiency in any of the Divestment Requirement and/or relieving the Concessionaire in any manner of the same.

Signed this xxxxxxx day of xxxxxxxx, 2008 at [xxxx]

AGREED, ACCEPTED AND SIGNED	SIGNED, SEALED AND DELIVERED
For and on behalf of	For and on behalf of
CONCESSIONAIRE by:	DMRC by:
(Signature)	(Signature)
(Name)	(Name)
(Designation)	(Designation)
(Address)	(Address)

In the presence of:

1. 2.

Delhi Rail Corporation Ltd.

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SCHEDULE - W

RECORDS AND REPORTING

SCHEDULE W

RECORDS AND REPORTING

1 Introduction

The Record and Report requirement below have been provided in terms of the type of information required by DMRC. The Concessionaire, Independent RAMS Consultant and Independent Checking Engineer shall determine the scope, format and media of the reports to be provided.

2 Part 1

2.1 Reporting Requirements

2.1.1 Monthly Construction Report:

Within 7 days of each month ending of the Construction Period, the Concessionaire shall provide to the DMRC and Independent Consultants, one copy each of the report, which shall identify the following, as a minimum:

- Concessionaire key staff mobilization and site establishment;
- Concessionaire progress of Work during the past month and planned work for forthcoming month;
- Accident reports; serious accidents on site shall be reported to the DMRC within 2 hours of occurrence and an investigation report submitted within 24 hours;
- Actual and foreseen delays to the Project Schedule activities and recovery plan;
- Construction constraints;
- Hand-over of sections of the guideway and station structures from the Civil Works contractor;
- Hand-over of High Voltage Electric Power from the DMRC designated Contractor;
- Design Submittals, comments received from the DMRC and Consultants and the Concessionaire compliance, or otherwise;
- Coordination of interfaces with DMRC Designated Contractors, Civil Contractors and conclusions reached. Where conflicts exist the ruling issued by the Independent Consultants shall be reported;
- Equipment procured and delivery to site;
- Quality Assurance documentation of procured and manufactured equipment;
- Tests conducted and test results. Remedial work and schedule for completion shall be reported;
- If required, additional test required by the Independent Checking Engineer or Independent RAMS Consultant, and results;
- Application for Safety Certification and authority to operate passenger services on the AMEL
- Weather report;

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2.1.2 Video Recording of the Construction progress.

2.1.3 Monthly Escrow Account Report within 7 days of the end of each month which falls within the Operations Period, the Concessionaire shall provide to the DMRC and Independent Consultants a copy of the report containing the summary of the receipts in payment from the Escrow Account for the month ended.

2.1.4 The Concessionaire shall supply to DMRC, free of charge, the following prior to requesting the issue of the Completion Certificate.

- Detailed drawings and specifications of the Project Works, as-built covering all interfaces with the Civil Works and Systems engineering facilities which constitute the AMEL.
- Original copies of all Test and Commissioning records.
- List of all Assets of the AMEL.

2.1.5 Copies of Agreement made with Airlines and Airline Agents for Operation and Maintenance of the CAT's and associated equipment.

2.1.6 Operations Manual, including the following:

- Concessionaire Staff structure and appointments;
- Management of Safety and Safety Case amendments;
- Operations Plan;
- Maintenance Plan;
- Operation Rules and Procedures;
- Depot Operating Plan
- Rules and Procedures for interfacing with Airlines and Airline Agents at IGI Airport;
- Performance Indicators measurement and, if required, any remedial activities; and
- Fare Structure and amendments

2.1.7 The Concessionaire staff, their qualifications, training certificate and medical test record shall be submitted in a confidential report.

2.1.8 All other Reports in accordance with the provisions of the Concession Agreement.

2.1.9 Such other reports as may be reasonably required by the DMRC or Independent Consultants.

2.2 Operation Phase

2.2.1 Monthly Traffic Report: Within 7 days of end of each month of the Operating Period, the Concessionaire shall provide the DMRC and Independent Consultants, a copy of the report containing the following:

- Daily boarding and alighting at each station;
- Daily total of passenger journeys, per direction;

- Train capacity provided;
- Projected patronage for the following 3 month period and capacity adjustment required;
- Performance Indicators measurement and, if required, Concessionaire remedial activities;
- Number and classification of complaints received from passengers and public;
- All departures from the O&M Requirement as specified in Schedule L.

2.2.2 Monthly Revenue Account Report within 7 days of the end of each month which falls within the Operations Period, the Concessionaire shall provide to the DMRC and Independent Consultants, a copy of the report containing the summary of the revenue and payments from the Account for the month.

2.2.3 Monthly Operations Report:

Within 7 days of each month ending of the Operations Period, the Concessionaire shall provide to the DMRC one copy each of the report, which shall identify the following, as a minimum:

- Accident reports. Serious accidents shall be reported to the DMRC within 2 hours and an investigation report within 24 hours
- Failure reports and analysis. Remedial Maintenance activities and engineering planned to mitigate loss of performance.
- Wrong-side failures and averted unsafe incidents;
- RAM Demonstration tests and reports;
- Maintenance Reports of activities for preventative, corrective and predictive maintenance activities;
- Concessionaires Inspections and tests;
- Dispute which arise or foreseen and measures taken by the Concessionaire to mitigate disruption to the AMEL operations; and
- Revisions to the Asset listing.

2.2.4 An annual report on the performance of the AMEL engineering. Where a system is showing signs of premature aging, the Concessionaire shall indicate planned remedial actions.

Where patronage is forecast to increase the demand of capacity or hours of service, the Concessionaire shall indicate amendments to the Operations and Maintenance Plans and additions to the Rolling Stock Fleet.

2.2.3 The Concessionaire shall submit a copy of the audited accounts within 120 days of the close of each Accounting Year after the appointed date.

2.2.4 All other reports in accordance with the provisions of the Concession Agreement;

2.2.5 Such other reports as may be reasonably required by the DMRC and Independent Consultants.

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3 Part 2

3.1 Record requirements

1	Design	Retention period of the Concessionaire
1.1	Design Standards, Codes of Practice, calculations, assumptions, simulation reports, and the like, employed in the design of the Works	Till handover to DMRC at termination of Concession
1.2	Interface design criteria and coordinated solutions between Civil and Structures and Systems engineering; between E&M systems, between the AMEL and Emergency Services; IGI Airport, and the like, developed during the design of the Works	Till handover to DMRC at termination of Concession
1.3	Quality and Safety Management plans and application records	Till handover to DMRC at termination of Concession
1.4	Complete set of each Design submittal, DMRC comments and the Concessionaire replies	Till handover to DMRC at termination of Concession
2	**Construction**	
2.1	Video Recording submitted to DMRC	Until 2 years after the issue of the Completion Certificate
2.2	Complete set of construction records relating to procurement, installation, workmanship standards and remedial work, instructions issued and correspondence.	Till handover to DMRC at termination of Concession
2.3	Complete set of construction drawings	Till handover to DMRC at termination of Concession
2.4	Complete set of Test specifications and records	Till handover to DMRC at termination of Concession
2.6	All licences, agreements and permits, methods and systems incorporated in the Project	Till handover to DMRC at termination of Concession
2.7	Listing of all Assets incorporated in the AMEL	Till handover to DMRC at termination of Concession
2.8	Complete set of As-built drawings for the Systems Engineering	Till handover to DMRC at termination of Concession
3	**Operation and Maintenance**	
3.1	Records of the RAM Demonstrations and tests	Till handover to DMRC at termination of Concession
3.1	All records of accidents and incidents which affect the Operation and Maintenance of the AMEL	Till handover to DMRC at termination of Concession

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3.2	Records of the Concessionaire periodic Inspections and Tests	Till handover to DMRC at termination of Concession
3.3	Details of all equipment replaced before the design life expiry.	Till handover to DMRC at termination of Concession
3.4	Full set of Monthly Reports	Till handover to DMRC at termination of Concession
3.5	Daily patronage and 3 month rolling average patronage	Till handover to DMRC at termination of Concession
3.6	Consequent on actual and projected patronage, provide details of adjustments to the Operations Plan and Maintenance Plan and Rolling Stock fleet.	Till handover to DMRC at termination of Concession
3.7	Record of daily revenue at each station	Till handover to DMRC at termination of Concession
3.8	All financial and accounting records to be maintained in accordance with the relevant Laws	Till handover to DMRC at termination of Concession
3.9	Safety Case and amendments	Till handover to DMRC at termination of Concession
3.10	Other records as may reasonably expected by the DMRC.	Till handover to DMRC at termination of Concession

4 All other records in accordance with the provisions of the Concession Agreement

5 Additional Requirements

5.1 Should a conflict arise between the record requirements of Schedule W and a requirement stated in the Agreement, the latter shall take precedence.

5.2.1 The requirements set out in Schedule W indicate the minimum requirements for compliance.

5.2.2 Records shall be retained, as follows:

- All records of operational aspects of maintaining the records. Records shall be systematically filed for easy retrieval and periodically up-dated.
- Records which have been superseded shall be retained for historical, contractual and legal purposes.

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