

**CONFIDENTIAL**

**Contract C3855-22E**

**Provision of In-Train Remote CCTV System and Train Car Loading  
Indicator for M-Trains**

**PARTICULAR SPECIFICATION**

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## 1. INTRODUCTION

This clause provides a general introduction of this document, the project objectives and an overview of the In-Train Remote CCTV System and Train Car Loading Indicator for M-Trains.

### 1.1 Introduction

This Particular Specification (PS) describes the requirements for the project C3855-22E Provision of In-Train Remote CCTV System and Train Car Loading Indicator for M-Trains

### 1.2 Scope of Document

This document specifies the requirements for Contract C3855-22E Provision of In-Train Remote CCTV System and Train Car Loading Indicator for M-Trains, hereafter as the Delivered System, in TWL and ISL. It describes the scope of the works of In-Train Remote CCTV System and Train Car Loading Indicator for M-Trains. It also includes system performance, the processes adopted in its procurement, and the reliability and availability of the Delivered System.

### 1.3 Project Objective

The project is to enhance the Corporation's response in emergency situations by installing In-train CCTV System for the 79 M-trains running in TWL and ISL, hereafter as the **Delivered System**.

The functions of the Delivered System include:

- a) Allowing real-time monitoring of In-train CCTV footage at Operations Control Centre (OCC), stations and driver cabs;
- b) Providing local recording and download function for the CCTV footage; and
- c) Providing Train Car Loading Information using Video Analytic at TWL and ISL platforms

## 1.4 How to Interpret this Particular Specification

This Particular Specification is to be read in conjunction with the documents described below:

### 1.4.1 Related Documents

This Particular Specification (hereinafter referred to as the Particular Specification) shall be read in conjunction with the Conditions of Contract for the Engineering Works (Major) (hereinafter referred to as the Conditions of Contract), the General Specification for Electrical and Mechanical Engineering Works (hereinafter referred to as the General Specification), the Drawings and all other documents forming the Contract.

### 1.4.2 Precedence of Documents

To the extent that any provision of this Particular Specification is inconsistent with any provision of the Conditions of Contract, the provision of the Conditions of Contract shall prevail.

To the extent that any provision of the General Specification is inconsistent with any provision of the Conditions of Contract, the provision of the Conditions of Contract shall prevail.

To the extent that any provision of this Particular Specification is inconsistent with any provision of the General Specification, the provision of this Particular Specification shall prevail.

To the extent that any text contained in the Drawings is inconsistent with any text in this Particular Specification, the text in this Particular Specification shall prevail.

### 1.4.3 Reference to Clauses

Unless otherwise specified, any reference to a clause number or an appendix shall be a reference made to this Particular Specification.

## 2. ABBREVIATIONS

The following abbreviations are used in the Particular Specification:

AI	Artificial Intelligent
CCTV	Close-Circuit Television
COTS	Commercial Off-The-Shelf
CP	Competent Person
CPU	Central Processing Unit
DBU	Display Board Unit
DC	Direct Current
DLP	Defects Liability Period
EMC	Electromagnetic Compatibility
HMI	Human Machine Interface
HTTP	Hyper Text Transfer Protocol
ISL	Island Line
I/O	Input / Output
MCS	Main Control System
MQTT	Message Queuing Telemetry Transport
MTBF	Mean Time Between Failure
MTTR	Mean Time To Repair
NTH	Non Traffic Hour
O&M	Operations and Maintenance
OCC	Operations Control Center
OEM	Original Equipment Manufacturer
OS	Operating System
PIDS	Passenger Information Display System
PS	Particular Specification
QE	Qualified Examiner
RAM	Random Access Memory
RDT	Reliability Demonstration Test
REST	Representational State Transfer
ROM	Read-Only Memory
RSR	Railway Safety Rules
RW	Rewritable (for DVD)
SAT	System Acceptance Test
SCR	Station Control Room
SIM	Subscriber Identification Module
SQL	Structure Query Language
SSD	Solid State Disk
SSID	Server Set Identifier

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and Train Car Loading Indicator for M-Trains  
Particular Specification

TC	Traffic Controller
TCIDS	Train Crew Information Dissemination System
TCaps	Train Captains
TH	Traffic Hour
TWL	Tsuen Wan Line
T&C	Testing and Commissioning
USB	Universal Serial Bus
UPIP	Unified Passenger Information Platform
VA	Video Analytic
VPN	Virtual Private Network
WAN	Wide Area Network

### 3. SCOPE OF THE WORKS

#### 3.1 General

- 3.1.1 The scope of the Works for the Contract comprises the manufacture, shipping and delivery to site, installation, testing, commissioning, setting to work and repair of defects during the Defects Liability Period (DLP) of the Delivered System.
- 3.1.2 The following scope of supply and scope of the Works are not presented as an exhaustive or definitive scope. The Contractor shall provide all items listed in the scopes and provide for various services and works which may not be identified in the scopes, but which are required to achieve the functions and requirements of the Specification.
- 3.1.3 Functional and technical requirements of the Delivered System are detailed in Clause 4, Clause 5 and various parts of this PS. The Contractor shall ensure that all hardware and software provided shall meet these requirements.
- 3.1.4 Small details not usually shown or specified, but which are necessary for the installation and operation of the Delivered System, shall be the responsibility of the Contractor.
- 3.1.5 The Contractor shall coordinate and liaise with the Engineer and UPIP contractors which have interfaces with the Delivered System.
- 3.1.6 The Contractor shall refer to Clause 17 Programme in this PS. The Contractor shall complete the whole of the works and pass all relevant Tests on Completion by the completion date listed in Appendix Q of the PS.
- 3.1.7 The Contractor shall visit and inspect the site to ascertain that his installation proposal is practical and sound, quantities of materials are sufficient, and that his proposal covers the delivery of a complete and fully functional Delivered System to the satisfaction of the Engineer.

### 3.2 Scope of Supply

The scope of supply by the Contractor in broad terms shall include the provision of the following:

- 3.2.1 A total of 2528 Network Cameras for the 632 cars of the 79 M-trains for enabling video capture.
- 3.2.2 A total of 158 Mobile Android Tablets of minimum size of 8" for the two driver cabs of 79 M-trains to allow train captain to view the CCTV footage.
- 3.2.3 Up to 2686 SIM Cards with infinity data plan and Virtual Private Network (VPN) or Private Access Point Name (APN) shall be provided by the Network Service Provider for the tablets by phases covering FAT and SAT up to the end of the DLP or earlier (refer to Clause 4.4 for details). The required SIM Cards shall be made available up to M-train disposal schedule tentatively outlined in clause 17.1.
- 3.2.4 Up to 4 years infinity data plan for 2686 SIM Cards from the end of DLP. The required SIM Cards shall be provided up to the M-train disposal schedule tentatively outlined in clause 17.1 and in accordance with Clause 4.4.
- 3.2.5 Provision of a total of 790 protective fuses for fault protection on all trainborne equipment in passenger cars and driving cabs. The power consumption of trainborne equipment shall not exceed 300W per train unit and the Contractor shall submit the specifications and installation location of the fuse for the Engineer's Approval.
- 3.2.6 Software applications deployed in the minimum size of 8" Android Tablets for viewing of the CCTV real-time video or playback with software license up to the disposal schedule referred to in clause 17.1.
- 3.2.7 Device Management Platform for managing all the Tablets with licenses until the end of the DLP.
- 3.2.8 Minimum of 4 years Device Management Platform for managing the Tablets with licenses from the end of DLP.
- 3.2.9 Adequate cloud resources (including but are not limited to Virtual CPU, RAM, SSD storage, backup storage and dataflow) by Cloud Service Provider. The Contractor shall also provide infinity data plan and private APN provided by the Network Service Provider for the cloud platform of this project. The cloud resource shall allow to store CCTV footage of 28 days with at least 19 hours

daily train operation, in first-in-first-out basis, up to the end of DLP.

- 3.2.10 Minimum of 4 years cloud services from the end of the DLP of the Works. The application on the cloud platform shall be sufficient to support application/communication with Network Cameras, Mobile Tablets and Unified Passenger Information Platform (UPIP) from the end of DLP.
- 3.2.11 Model for Estimation of Train Car Loading Information
- Video Analytic (VA) using images from cameras shall be used to analyse the pixel change of the video images from the cameras to identify the presence of a person and to count the total number of people in the identified area, with the deployment of object deduplication algorithm;
  - Artificial Intelligence (AI) shall be used to develop a pre-trained mathematical models with learning data to identify the presence of a person when capturing of all the features of a person is not available from the camera, i.e. some of the body parts are being covered or overlapped by the adjacent people or objects, to count the total number of people in the identified area;
- 3.2.12 The computation outcome from the software model, i.e. the estimated real-time train availability to be displayed at Passenger Information Display System (PIDS) Display Board Unit (DBU) at the corresponding platform via UPIP.
- 3.2.13 Human Machine Interface (HMI) for the Employer's staff to monitor real time images of each Network Camera. The design of the HMI shall be user-friendly. Detailed design shall be submitted for the Engineer's approval.
- 3.2.14 Prototyping of the Network Camera with software applications on cloud servers and tablets of the Delivered System.
- 3.2.15 All associated software/firmware license up to train disposal schedule including OS, application, interface software, database software and anti-Virus software and other software necessary for the operation and maintenance of the Delivered System.
- 3.2.16 Three testing notebooks for software development and testing, and to be retained by the Employer after the DLP.
- 3.2.17 Appropriate development and/or testing tools to be included in the testing notebooks to facilitate software development and testing.

- 3.2.18 All source codes of the software (except Commercial Off-the-shelf (COTS) software) supplied for the Delivered System, all third parties Application Programming Interfaces (APIs) as well as all other necessary software and associated licenses for the Employer's in-house maintenance and future customization and modification.
- 3.2.19 All software development tools and compilers, source codes, CI List, flowcharts, hardware drivers, firmware, middleware together with valid licenses of the tools and software.
- 3.2.20 Backup images and recovery software for each equipment provided for this Contract.

### 3.3 Scope of Works

The Works to be provided by the Contractor shall include the following:

- 3.3.1 The preliminary schedule of Data Plan delivery shall be starting from the Equipment Delivery phase, while the submission of the final schedule shall be advised by the Engineer.
- 3.3.2 Design and install the Network Cameras with necessary housings, mounting brackets, cables and connectors to the existing panels of M-trains. The camera housing shall provide sufficient protection.
- 3.3.3 Install protective fuses in each car and driver Cab for the protection of Network Cameras and Tablets.
- 3.3.4 The Contractor is responsible to open hole for mounting in the existing panel of the train. The Contractor shall submit detailed mounting design to the Engineer for approval.
- 3.3.5 Field of view (FOV) for all cameras for the Engineer's approval with the actual mounting locations of camera relying on the result of the FOV.
- 3.3.6 Coordination with the Engineer or his representative to conduct site survey to determine the exact equipment locations.
- 3.3.7 Site survey, design, manufacture, shipping and delivery to site, installation, testing, commissioning, setting to work of the Works.
- 3.3.8 Preparation and submission of all plans, documents, drawings, programmes, manuals, method statements, records and reports.
- 3.3.9 Accuracy of the computation outcome of the developed model shall be verified by comparing the result from on-site people counting during traffic hours, including both morning peak and evening peak. Fine-tuning of the model shall be carried out to improve the accuracy in case the deviation of the computation outcome is more than 10% from the on-site people counting in the verification after cut-in and during DLP.
- 3.3.10 Attend design and project progress meetings and site coordination meetings with the Designated Contractor and interfacing parties.
- 3.3.11 Site visits, surveys and inspections if deemed necessary to obtain all information and data necessary for the implementation of the project.
- 3.3.12 Prototype testing, Software test, continuously fine-tuning and testing and commissioning (T&C).
- 3.3.13 O&M Manual, as-built drawings for Operators and Maintainers.

- 3.3.14 3 months Reliability Demonstration Test (RDT) commencing from the completion of the Whole of the Works.
- 3.3.15 12 months Defects Liability Period (DLP), including the collection of faulty devices from the stations and device management system administration, for the Works shall be provided by the Contractor.
- 3.3.16 A minimum of 8 training sessions for the Employer's staff to perform operation and maintenance duties on the Delivered System.

## 4. TECHNICAL REQUIREMENTS

### 4.1 General

- 4.1.1 All equipment supplied shall be discreet and line replaceable units connected through plugs and sockets to facilitate maintenance.
- 4.1.2 All equipment supplied shall be new.
- 4.1.3 Lifetime licences shall be provided by the Contractor for all software of the Delivered System and for all software required for the development of the Delivered System unless otherwise specified.
- 4.1.4 The Delivered System shall consist mainly of the following major hardware equipment and software for undertaking and handling of system functions and features, data logging, system administration.
  - a) 2528 nos. of Network Camera for M-trains
  - b) 1 set of Video Analytic application in-built in each camera
  - c) 1 set of 4G module in-built in each camera
  - d) 2686 nos. infinity Data SIM
  - e) 158 nos. Mobile Tablets for train captains
  - f) 1 set of HMI for In-train CCTV monitoring and downloading
  - g) 1 set of Cloud Server for interfacing with UPIP to provide Train Car Loading Information
- 4.1.5 All trainborne equipment shall fulfil following standards:
  - a) Fire standard : EN45545-2 (2020 edition)
  - b) Electronic equipment : IEC60571 (revision 3.0, Sep 2012)
  - c) EMC standard : EN50121-3-2 (2018 edition, with amendment in 2020)
  - d) Rolling Stock standard : EN50155 (2022 edition)
  - e) Vibration standard : EN61373 (2012 edition)
- 4.1.6 All equipment shall be designed for easy handling, operation, and maintenance. All the parts and components shall be implemented to operate in a simple way of “plug and play”, and “dismounting and mounting” processes without any need for complex work procedures.
- 4.1.7 All equipment shall auto-restart and initialize itself for normal operating state after power interruption. The Delivered System shall execute a healthiness check on its control. Upon the healthiness check, the Network Cameras and Tablets shall report the status of its controls in its event log and reflect the status on a LED indicator.

- 4.1.8 Mounting brackets and accessories of the electronic devices shall be designed to suit the physical constraints for the installation at the specified locations in the existing train compartment with due consideration of the human factor, design constraints, necessary operation and maintenance access requirements.
- 4.1.9 No damage to the existing car-body structure is allowed. The means of fixing shall follow the state-of-the-art railway proven design which can prevent any part of the installation from loosening, falling, rattling and shifting during train service. It shall comply with GM/RT2100 and BS12663 standards.
- 4.1.10 The complete installation of all equipment on the train in-saloon body and its equipment mountings shall be validated for compliance with the shock and vibration test requirement per BS EN 61373 “Railway application – Rolling Stock Equipment – Shock and Vibration Tests” Category 1a vehicle. The test report and results shall be submitted to the Engineer for Approval.

#### 4.2 Video Storage

- 4.2.1 The local storage shall support 7 days video footage. All video footage shall support remote downloading function. The video footage shall be overwriting by latest video footage when full. The viewed footage shall be kept in the cloud storage.
- 4.2.2 The cloud storage shall support 28 days viewed video footage. The video footage shall be overwriting by latest video footage when full.
- 4.2.3 The storage shall be encrypted based on password derivation. The video shall be encrypted by randomly generated keys with AES256 encryption algorithm.
- 4.2.4 The remote download function shall support encrypted download function to ensure the confidentiality of the video data transmission process.

#### 4.3 In-Train Remote CCTV System

The remote viewing and downloading function of In-Train Remote CCTV System shall include the functions listed below:

- a) To view real-time video of the In-train Remote CCTV system of 79 M-trains via Web-MMI portal or App on the Internet
- b) To remote download the recorded video of the In-train Remote CCTV system of 79 M-trains via Web-MMI portal or APP on the Internet

- c) To manage the Network Cameras and train car ID mapping
- d) To support Video Analytic edge processing function to provide real-time train availability information to UPIP for PIDS displaying

- 4.3.1 The time clock of the Network Camera shall be synchronized with the Hong Kong Observatory's Time Synchronization System (NTSS) with an accuracy of  $\pm 10$  ms.
- 4.3.2 All trainborne equipments supplied by the M-Train power system complies with EN50155. The supply voltage of the M-Train power system shall be 110V d.c. The trainborne equipment shall be operative between 77 and 137 Vdc. The power supply of trainborne equipment shall be derived from train auxiliary circuit at nominal 110Vdc and powered by the DC-DC Converter which is provided by controller.
- 4.3.3 All cables and connectors shall be permanently secured and fixed with supports/tie bar against vibration during the train movement.
- 4.3.4 The mounting and housing shall protect the Network Camera from external damage and vibration.
- 4.3.5 The Contractor shall carry out site survey for the actual arrangement of the existing train-borne equipment and make all necessary measurements.
- 4.3.6 Drilling on the critical structural members of train structures is prohibited. The Contractor shall conduct a detailed site verification and measurement to all installation locations to confirm the design and installation arrangement of the mounting or as instructed by the Engineer. Detailed technical characteristics, layout and arrangement of the Trainborne equipment including the mounting and attachment locations and their overall sizes shall be verified and updated for Approval.
- 4.3.7 The proposed solution for video analytic shall apply edge processing in the Network Camera side, while the proposed equipment be designed for easy installation and mounting on M-trains.
- 4.3.8 The Contractor shall conduct site survey, design, supply, manufacture, and install the mounting bracket and Trainborne cover plate for quick and simple installation. The installation method including any mounting, cutting in existing panel, etc shall be submitted to the Engineer for approval.
- 4.3.9 The minimum hardware requirement for the Network Camera is listed as below. The Contractor shall refer to the below hardware

configuration and propose the hardware equipment for the Engineer approval.

a) Camera	:	0.006 Lux@F2.0 (Color, 30IRE)
b) Field of View	:	Horizontal: 180° Vertical: 180° Diagonal: 180°
c) Video Compression	:	H.265+ / H.265 / H.264+ / H.264
d) Video Resolution	:	720p or above
e) Microphone	:	Build in
f) Storage	:	Micro SD card (256GB)
g) Mobile Network	:	4G LTE
h) Protection	:	IP67
i) Operation Condition	:	- 30°C to +55°C
j) Fire Standard	:	EN 45545-2
k) EMC Standard	:	EN50121-3-2
l) Rolling Stock Standard:	:	EN50155
m) Vibration Standard	:	EN61373
n) Others	:	Support edge image processing of Video Analytic

- 4.3.10 The Contractor shall supply and install all necessary accessories or cables for the In-Train Remote CCTV System, such as antenna, cables, connectors, DC-DC convertors, etc. The Contractor shall propose and submit the installation plan for the Engineer's approval. The proposed installation location shall refer to Appendix B.

#### 4.4 Cellular SIM Network

- 4.4.1 The Contractor shall supply and deliver a total of 2686 SIM Card with infinity data plan with VPN or private APN provided by the Service Provider up to the end of DLP or the train disposal schedule of the respective trains, whichever the earlier.
- 4.4.2 The Contractor shall propose infinity 4G/LTE plan to support the throughput of the usage, which is listed as below.
- a) Real time monitoring  
Calling 4 cameras for 10 minutes for monitoring 70 times in a month
  - b) Remote Downloading  
On demand
  - c) Heartbeat  
Sending heartbeat to the Cloud platform in a configurable

- time interval
- d) Train Car Loading Indicator  
Sending data from Video Analytic to the Cloud server every 10 seconds. The interval shall be configurable.

4.4.3 Before the end of DLP, the Contractor shall deliver and handover the contract in the name of the Employer, up to 4 years data plan services for the SIM Card commencing from the end of DLP of the Works until the train disposal schedule of the respective trains. For train disposed earlier than the end of the DLP, no contract is required to be handed over to the Employer. The data plan requirement shall be referred to Clause 4.4.2.

#### 4.5 Tablets

- 4.5.1 The proposed Tablets shall be minimum of 8-inch size and support Android Device Management Platform for remote control and management.
- 4.5.2 The Contractor shall provide license of Android Device Management Platform covering whole project period up to the end of DLP.
- 4.5.3 Before the end of the DLP, the Contractor shall provide and handover the contract in the name of the Employer, a minimum of 4 years Device Management Platform with licenses commencing from the end of DLP.
- 4.5.4 The tablets shall access the internet via station Wi-Fi and supplement with a cellular SIM network.
- 4.5.5 The Contractor shall design, supply and install the mounting for housing the tablet in the driver cab.
- 4.5.6 The minimum hardware configuration of the Tablets shall be as listed below. The Contractor shall refer to the below hardware configuration and propose the hardware equipment for the Engineer approval.
  - a) Processor : Octa-core 1.7Ghz
  - b) Memory : 4GB Ram
  - c) Operating System : Android
  - d) Screen Size : 8" Diagonal
  - e) Screen Resolution : 1920 x 1200
  - f) ROM Size : 64GB
  - g) Wi-Fi : Yes (802.11 a/b/g/n/ac/ax)
  - h) 4G/LTE Compatible : Yes or higher
  - i) Bluetooth : v5.0
  - j) Standard : MIL-STD-810H compliant
  - k) Water/dust Resistance : IP68
  - l) Stylus Pen : Yes
  - m) Additional Memory : Yes
  - n) Weight : < 500g

#### 4.6 Testing Notebooks

- 4.6.1 The Contractor shall provide three testing notebooks for testing purposes.
- 4.6.2 The minimum hardware configuration of the testing notebooks shall be as listed below. The Contractor shall refer to the below minimum hardware configuration and propose the hardware equipment for the Engineer's approval.
- |    |                       |   |                       |
|----|-----------------------|---|-----------------------|
| a) | Memory                | : | 8GB Ram               |
| b) | Processor             | : | 8-core CPU            |
| c) | Operation System      | : | Windows or Mac        |
| d) | Screen Size           | : | 13" Diagonal          |
| e) | Screen Resolution     | : | 1920 x 1200           |
| f) | Storage               | : | 512GB SSD             |
| g) | Wi-Fi                 | : | Yes                   |
| h) | Anti-virus protection | : | Symantec End Point 14 |
| i) | Weight                | : | < 1300g               |
- 4.6.3 Three testing notebooks, completed with all necessary software including OS (64-bit), anti-virus program, Microsoft Office (Pro), and interface software, for performing system maintenance and fault diagnosis purposes.

#### 4.7 Cloud platform

- 4.7.1 The Contractor shall provide cloud services from System Development and Implementation Phase until the end of the DLP.
- 4.7.2 Before the end of DLP, the Contractor shall also provide and handover a minimum of 4 years' service contract in the name of the Employer, from the service provider for cloud services commencing from the end of the DLP of the Works.
- 4.7.3 The Contractor shall provide a cloud platform (the platform) hosted by a Service Provider, a leader in 2021 Magic Quadrant for Cloud Infrastructure and Platform Service.



- 4.7.4 The platform shall be developed in modular design and can migrate from a service provider without re-development.
- 4.7.5 The platform's activity logs shall keep for at least 30 days and support self-housekeeping.

- 4.7.6 The Contractor shall allocate adequate cloud resources (include but not limited to Virtual CPU, RAM, SSD storage, backup storage and dataflow) with unlimited data plan and VPN or private APN provided by the Service Provider for the cloud platform.
- 4.7.7 Unless otherwise specified, the processor loading, memory utilisation and disk storage device utilisation of cloud-based server shall not exceed the figures specified below:

Resources	Utilisation Not Exceeding (Mean)	Utilisation Not Exceeding (Peak)
Processor core(s) allocated	50%	70%
Primary memory allocated	50%	50%
Disk Storage allocated	50%	50%

The Contractor shall demonstrate during T&C that these requirements are achieved.

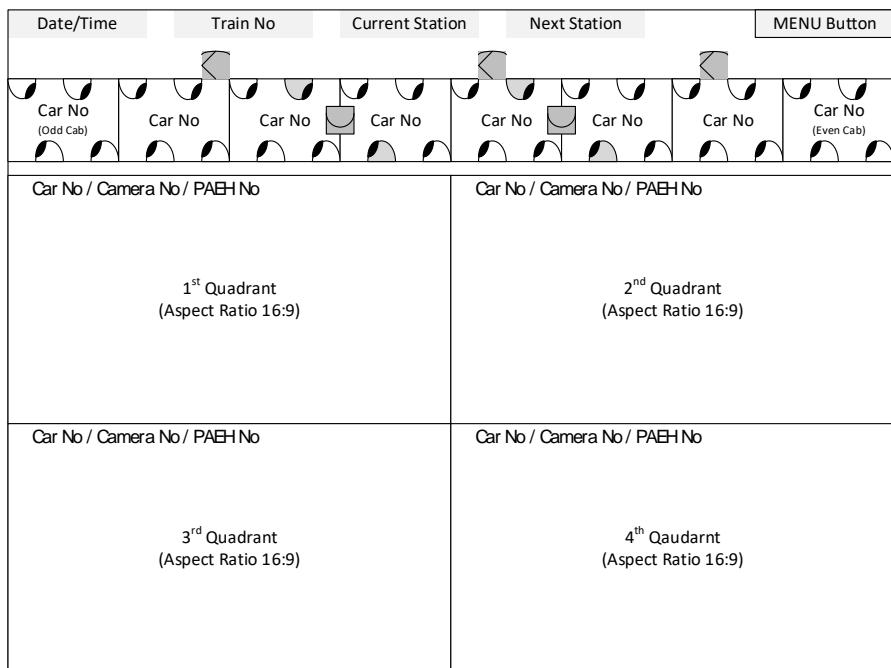
#### 4.8 Tablet software application

- 4.8.1 The tablet software application shall support profile management for access control and user personalisation.
- 4.8.2 The application shall support but not be limited to the listed related smart applications:
- a) View real-time video of the Network Cameras
  - b) View and capture the playback of the Network Cameras
  - c) Enable watermark on the video footage. The watermark shall be able to show Viewer ID, Car ID, Camera ID and timestamp.
  - d) Up to 4 cameras can be view at one time
  - e) Time out, which is configurable, for the real time monitoring

#### 4.9 Human Machine Interface (HMI) for Train Cap

4.9.1 The real time viewing of CCTV footages of a train shall also be available in the Tablet in train cap with the car number, camera number, train run number and location information. No delay, image retention and discontinuity shall be noticeable.

4.9.2 The exhibit of the MMI proposed as follows:



Car No Car number is overlaid on the CCTV image

Icon of pantograph

- Location is subject to train type
- Leftmost pantograph on 1<sup>st</sup> quadrant, middle on the 2<sup>nd</sup>, rightmost on the 3<sup>rd</sup>

Icon of train-divided detection

- Location is subject to train type

Icon of camera pairs for images of train-divided

- 1<sup>st</sup> pair shown on 1<sup>st</sup> and 2<sup>nd</sup> quadrant
- 2<sup>nd</sup> pair shown on 3<sup>rd</sup> and 4<sup>th</sup> quadrant

Icon of menu button

- For system configuration setup
- Green background to show system healthiness
- Red background to show system failure

Split Screen – combine the viewing areas of 1<sup>st</sup> and 3<sup>rd</sup> quadrants; and 2<sup>nd</sup> and 4<sup>th</sup> quadrants

Single Screen – combine the viewing areas of all the 4 quadrants

#### 4.10 Human Machine Interface (HMI) for OCC

4.10.1 The HMI shall be hosted in cloud platform.

4.10.2 The HMI shall support profile management for access control and user personalisation.

- 4.10.3 The HMI shall support configuration and monitoring health status of the Network Cameras.
- 4.10.4 The HMI shall support but not be limited to the listed related smart applications:
  - a) View real-time video of the Network Cameras
  - b) View and capture the playback of the Network Cameras
  - c) Enable watermark on the video footage
  - d) Up to 4 cameras can be view at one time
  - e) Time out, which is configurable, for the real time monitoring

#### 4.11 Mechanical Requirements

- 4.11.1 The Remote CCTV System shall be adequately designed to ensure its security to prevent loosening, rattling and shifting during train service.
- 4.11.2 Ergonomics and aesthetics shall be taken into account in the mounting and layout design of the Network Cameras and Tablets.
- 4.11.3 The mounting brackets and accessories of the electronic devices shall allow easy installation and removal that meets the maintainability requirements. Mounting details shall be submitted to the Engineer for Approval.
- 4.11.4 Simulation of validation for static and fatigue load cases of all equipment shall be conducted.
- 4.11.5 FEA simulations and calculations shall be used for validating the mechanical design of different complete assemblies in the CCTV system against the following loading requirements:
  - 4.11.6 Base-case loads for complete assemblies
  - 4.11.7 Fatigue loads for complete assemblies
- 4.11.8 The Static Load Tests shall be carried out safely on the prototype and be witnessed by the Engineer and the Employer's representatives. Each Static Load Test shall sustain a minimum of 30 seconds of applied load unless otherwise specified. Permanent deformation or damage to the specimens shall not be permitted. The test shall include Base-case loads for complete assemblies.
- 4.11.9 The Contractor shall demonstrate that the complete assembly satisfy the load requirements compliance with EN 12663.

Base-case proof loads	Fatigue Loads
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<p>The assemblies with mounting shall be able to withstand the following loadings with a safety factor of at least 1.2 (where downwards is the positive direction) and without permanent deformation:</p> <p>(1) Static Longitudinal Load of 5 g  (2) Static Vertical Load of -1 g and +3 g  (3) Static Lateral Load of 1 g</p> <p>Cases (1) and (3) shall be considered in either direction.</p> <p>Cases (1), (2) and (3) shall be considered to occur simultaneously in any combination.</p>	<p>For complete assemblies with mounting shall be able to withstand the following loads for 10 million cycles:</p> <p>(1) Longitudinal Load of <math>\pm 0.2</math> g  (2) Vertical Load of <math>\pm 0.15</math> g  (3) Lateral Load of <math>\pm 0.15</math> g</p> <p>Such loads shall be considered to be acting separately from each other, in conjunction with a 1 g vertical downwards load, and the damage from each case shall be summed.</p>
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- 4.11.10 The overall dimension, weight and mounting method of the In-Saloon CCTV system before prototyping shall be provided and submitted to the Engineers for Approval.
- 4.11.11 The material of the mounting brackets and accessories shall satisfy the Fire Performance Requirement of EN45545 HL3 or equivalent on smoke, toxicity & flammability
- 4.11.12 The equipment and associated mountings shall withstand the above loading conditions without permanent deformation or any form of damage, buckling or deterioration.
- 4.11.13 The Contractor shall submit finite element calculation for approval to demonstrate the above requirements have been achieved.
- 4.11.14 The equipment shall not be affected by the heat generated by other train borne equipment. The Contractor shall submit the installation layout to the Engineer for Approval.
- 4.11.15 An addition new sample of opening with plastic laminate assemble shall be made and conduct the test of IP 67 rating of BS EN 60529 or equivalent standard.
- 4.11.16 Welding at car body and underframe structure shall be prohibited unless otherwise approved.

4.11.17 The mounting interfaces shall make use the existing carbody structures without alternative or any adverse effect on the structural integrity. (Details to be submitted for Approval)

4.11.18 All mountings and jointing bolts / nuts / screws shall be stainless steel; Contractor shall provide the lists for Approval.

#### 4.12 Information Security Requirements

4.12.1 The Contractor shall initiate, implement and maintain an information security management system reference to ISO/IEC 27002:2005 Code of Practice for Information Security Management during the Contract period.

4.12.2 The Contractor shall assess the information security risk of the system depends on its vulnerability and review its posture regularly at different stages of the Contract. The Contractor may make reference to ISO/IEC 27005:2008 Information security risk management.

4.12.3 The Contractor shall implement effective information dissemination mechanism to deliver updated security information, including the security policies, procedures, incident reporting and new potential information security threats.

4.12.4 The Contractor shall implement adequate security control on portable/removable devices, sensitive data/information, login name and password, external consultants, sub-contractors and temporary staff.

4.12.5 The Contractor shall ensure appropriate change control and patch management mechanism for the proper and regular update of network configuration, security patches and software applications.

#### 4.13 Information Security Plan

4.13.1 The Contractor shall submit to the Engineer for Approval an Information Security Plan comprising the following:

- information security plan control;
- security organization and responsibilities of team members;
- asset classification and control: to keep the inventory of the important items including information/data and network software and equipment;
- personnel security;

- physical and environmental security: to safeguard any unauthorised access and modifications to the system by any unauthorised parties;
- communications management including backup, restart & recovery and incident reporting procedures;
- access control;
- systems development and maintenance;
- business continuity management for critical systems to ensure a plan on recovery is in place; and
- compliance: to ensure all provisions have proper licences or agreements.

4.13.2 The Contractor shall update the Information Security Plan to suit the changes on the progression of project throughout the Contract period and shall be submitted to the Engineer for Approval.

4.13.3 The Contractor shall implement the Information Security Plan and continuously maintain an effective information security management system in accordance with the Information Security Plan.

4.13.4 The Contractor shall submit details of the qualifications and experiences of the proposed security organisation for the Approval of the Engineer.

4.13.5 The Contractor shall monitor the security status and reported in the Monthly Progress Report any potential threats or attacks being identified.

#### 4.14 Information Security Control Practice

4.14.1 The Contractor shall ensure all parameters of the network equipment, including login name, passwords, IP address range and system configuration are properly configured and sufficient security control shall be implemented to prevent the disclosure of the details.

4.14.2 The Contractor shall develop procedures or means for immediate disabling of the system/network which had security incident occurred to limit the attack propagate to other system/network.

4.14.3 The Contractor shall assign different login name and password for system under test and after commissioning to reduce the risk of accidental log-on and other error. All tests shall be limited to the testing environment and with connection to the operating environment Approved by the Engineer.

- 4.14.4 The Contractor shall provide security management tools and procedures to ensure controls are consistently applied.
- Anti-virus and anti-spyware systems to stop any wide spread of virus, worms and malicious code attacks. “Symantec Endpoint Protection” anti-virus Software is being employed in the existing Corporate virus definition server;
  - Regular virus definitions update via the virus definition server from the virus definition server in the CDN to ensure protection against the latest virus attacks;
  - Regular system backup is executed and stored in secured location; and
  - Unnecessary/unused embedded services and connection devices/ points shall be disabled/disconnected.
- 4.14.5 The Contractor shall report to the Engineer immediately in case of any security violations or outbreaks are detected in accordance with the approved incident reporting and recovery procedures.
- 4.14.6 All systems processing and/or storing project information shall have a method or procedure in place to create and review system logs for unauthorised access. Logs shall be stored within the system or on a centralised logging server, and shall be maintained for a minimum of 3 years.
- 4.14.7 The Contractor shall implement and document procedures to regularly review records of information system activity, such as audit logs, access reports, and security incident tracking reports.

#### 4.15 Information Security Audit

- 4.15.1 The Contractor shall submit at the request of the Engineer any documents related to the information security management system, including internal information security audit reports and sub-contractors' information security audit reports.
- 4.15.2 The Contractor shall be subjected to information security audits of the Contractor's information security management system as required by the Engineer. During the audit by the Engineer, the Contractor shall provide all necessary access, assistance and facilities to enable the Engineer to verify that the Information Security Plan is being properly and fully implemented. The Contractor shall assign suitably qualified staff to accompany the Engineer in the audits. The Engineer will provide reasonable notice to the Contractor on the audit scope and schedule.

4.15.3 Following an audit by the Engineer, the Contractor shall carry out corrective actions, improvement and any recommendation required by the Engineer. The Contractor shall provide evidences to the Engineer to demonstrate that all Approved actions have been satisfactorily completed by the agreed completion dates.

#### 4.16 Network Security

4.16.1 The Contractor shall be responsible for configurations of the Symantec Endpoint Protection Server to perform manual/automatic update of the virus definition file from the virus definition server in the CDN, and subsequently provide downstream update for the systems/equipment in the Network.

4.16.2 The Contractor shall monitor and evaluate the patch release from Microsoft. Upon approval by the Engineer, the Contractor shall test and deploy the patches of Microsoft Windows System or perform mitigations as appropriate to address the vulnerability of their systems.

4.16.3 All the hardware units running on Microsoft Windows or Linux platforms shall be installed with Symantec Endpoint Protection (SEP) client software version 14 for virus protection. The Contractor shall supply SEP14 usage/definition updating licenses which shall be valid until the end of the Defects Liability Period (DLP) for the whole of the Works.

4.16.4 The Contractor shall be responsible for the configuration of live update feature of the Symantec Endpoint Protection client software so as to allow the latest virus definition/signature files to be downloaded from the designated anti-virus definition update server. Detailed configuration shall be agreed with the Engineer.

##### 4.16.5 USB Ports Control

- a) All unused USB ports of computing devices (e.g. servers, workstations, etc.) shall be disabled or physically blocked by USB port blockers. The access to the keys of USB port blockers must be under access control with access records.
- b) Authorisation from the system owner has to be obtained before re-enabling or un-blocking a disabled/blocked USB port.

##### 4.16.6 Network Switch Hardening

The Contractor shall benchmark network switch hardening standards and best practices and perform network switch hardening for all the supplied network switches.

##### 4.16.7 Cloud Security

- 4.16.7.1 The Contractor shall be responsible for providing dedicated channels (e.g. leased line, Metro Ethernet etc.) with fixed IP for the connection of public cloud to internal network.
- 4.16.7.2 The Contractor shall be responsible for the subscription of the following cloud security services for protection of the supplied systems on the cloud:
- 4.16.8 Upon Approval by the Engineer, the Contractor shall be responsible for updating all the supplied equipment with latest security patches during the project implementation phase and the DLP. The Contractor shall conduct the regression test with test report before deploying security updates to the production environment.

## 5. SYSTEM INTERFACES

This Clause 5 specifies the Delivered System's interfaces with external systems supplied by others. The Contractor shall co-ordinate and liaise with the Engineer and interfacing parties for any interface works required for the design, installation and testing of the Delivered System.

### 5.1 General Requirements

- 5.1.1 The interfaces of the Delivered System with the UPIP system shall be designed by the Contractor according to the system design of the interfacing systems provided by the Employer.
- 5.1.2 The Contractor shall design the interface in the way that normal operation of any of the Employer's systems shall not be affected due to failure of the Delivered System, and vice versa.
- 5.1.3 The Contractor shall take the leading role, unless otherwise specified, in the coordination, design and testing of the Delivered System's interfaces with other systems of the Employer.
- 5.1.4 For each interface described in this Clause 5, the Contractor shall develop and submit the Detailed Interface Specification for the Engineer's Approval within the period indicated in Clause 18.
- 5.1.5 The Contractor shall arrange interface meetings where necessary with the interfacing parties and also various working teams of the Employer to agree on the details of the interfaces. Such meetings shall be conducted in the presence of the Engineer where necessary. Records of each meeting shall be prepared by the Contractor and sent to the Engineer within fourteen days of the date of the meeting.
- 5.1.6 Decision made jointly by the Contractor, the interfacing parties and the Engineer in the interface meetings shall be subject to written confirmation from the Engineer.
- 5.1.7 The Contractor shall conduct interface testing with all interfacing parties to demonstrate that the performance requirements as specified in the Particular Specification are met. The testing arrangements shall be coordinated by the Engineer. The Contractor shall join with the interfacing parties and the Employer's staff to investigate any problem found during the interface testing in different project phases. The Contractor shall perform further investigation, correction and modification works to rectify the faults for the parts identified to be responsible by the Contractor.

- 5.1.8 The Contractor shall design the Delivered System in such a way that the performance of the Delivered System shall not be susceptible to interferences from equipment interfaced with it.
- 5.1.9 The interfaces between the Delivered System and other interfacing systems shall include hardware and software interfaces. The Contractor shall ensure that all hardware and software provided under the Contract be compatible with the equipment/systems with which the Delivered System interfaces.
- 5.1.10 If the Delivered System affects normal operation of any other system of the Employer, support of service or safety of the operating railway, further operations of the Delivered System shall not be allowed until the Contractor has eliminated the interference to the affected systems to the Engineer's satisfaction.
- 5.1.11 For each interface, the Contractor shall submit for the Engineer's approval the Detailed Interface Specification and the Detailed Interface Test Plan, and perform the joint interface tests on the interfacing systems with the relevant Designated Contractors and interfacing parties. The Contractor shall also prepare any other documentation required for the interfaces.
- 5.1.12 The interface log of each communication software module shall be stored in the Delivered System for a minimum of 3 months. The interface log shall contain the following as a minimum:
- a) Transaction time;
  - b) Direction of communication; and
  - c) Raw data of the protocol in hexadecimal and ASCII codes.
- 5.1.13 Detailed Interface Specification
- a) The Detailed Interface Specification shall cover the design of the physical, electrical, mechanical, functional, protocol, software and all other interfaces between the Delivered System and the interface system.
  - b) The Detailed Interface Specification shall show clearly the demarcation of responsibilities between the Contractor and the interfacing party.
  - c) The Detailed Interface Specification shall cover the following items:
    1. Purpose
    2. Reference Documents
    3. Glossary
    4. Interface Specification
    - 4.1 Interface Diagrams
    - 4.2 Physical Interface
    - 4.2.1 Nature, Location and Quantity

*4.2.2 Electrical Description  
 4.2.3 Mechanical Description  
 4.3 Functional Interface  
 4.4 Protocols  
 4.5 Software and Data Interface  
 4.6 Naming Convention  
 4.7 Design Constraints  
 4.8 Electromagnetic Compatibility  
 5. Implementation and Installation  
 6. Quality Assurance  
 6.1 Interface Requirements References  
 6.2 Verification and Validation  
 Appendices and Drawings  
 App. 1 Detailed Data Interface Schedules  
 App. 2 Cables Termination Schedules / Drawings  
 App. 3 System Start-up parameters*

#### **5.1.14      Detailed Interface Test Plan**

- a) The Detailed Interface Test Plan shall identify various tests required to ascertain the proper interfacing and interaction as required and shall cover the purpose, methodology, sequence, testing instrument, inputs and expected outputs, responsibility of the Contractor and the interfacing party in each test.
- b) The Detailed Interface Test Plan shall show clearly the demarcation of responsibilities between the Contractor and the interfacing party.
- c) The Detailed Interface Test Plan shall cover the following items:

*1. Purpose  
 2. Reference Documents  
 3. Glossary  
 4. Test methodology  
 5. Interface Test Specifications  
 5.1 Test XXX-YYY-IT-01  
 5.1.1 Purpose of the test  
 5.1.2 Reference to PS and other functionality requirements  
 5.1.3 Test Configuration  
 5.1.4 Testing Equipment  
 5.1.5 Test procedures with inputs and expected output  
 (format only)  
 5.2 Test XXX-YYY-IT-02  
 5.2.1 Purpose of the test  
 5.2.2 Reference to PS and other functionality requirements  
 5.2.3 Test Configuration  
 5.2.4 Testing Equipment  
 5.2.5 Test procedures with inputs and expected output  
 (format only) (repeat for all tests)*

6. *Logical sequence and dependence of the Tests (can be illustrated using a fish-bone chart)*

7. *Quality Assurance*

7.1 *Interface Requirements References Appendices and Drawings*

5.1.15 The Contractor shall refer to Appendix D for the details of interface demarcations.

## 5.2 Interface with Unified Passenger Information Platform (UPIP)

5.2.1 The Delivered System shall interface with the UPIP for providing number of passenger count in each camera. The protocol shall include camera ID to match with the train and car ID.

5.2.2 The Contractor shall provide network link as protocol server for the UPIP to connect.

5.2.3 The Contractor shall be leading contractor to propose the interface protocol for interface contractor to retrieve number of passenger count in each camera.

5.2.4 A demarcation diagram of this interface is provided in Appendix D of this Particular Specification.

## 6. MATERIALS AND WORKMANSHIP

This clause specifies the level of workmanship and use of material to be complied by the Contractor.

### 6.1 General

- 6.1.1 All materials except otherwise specified shall be provided by the Contractor.
- 6.1.2 All materials and components to be used for installation on site shall comply with the requirements of this Section. These requirements shall be the minimum requirements for general purposes and they shall not relieve the Contractor from ensuring that all materials and components incorporated in the Works are suitable for their intended purposes and environments.
- 6.1.3 All materials including cables and installation materials used shall conform to the international standards specified in this specification and shall be approved by the Engineer.
- 6.1.4 The material of the In-Saloon CCTV system shall satisfy the Fire Performance Requirement of EN45545 HL3 or equivalent on smoke, toxicity & flammability, as detailed in Clause 6.2.8.

### 6.2 Cables

- 6.2.1 All cables shall have Low Smoke Zero Halogen (LSOH) sheaths meeting various standards as detailed below.
- 6.2.2 All the cable requirements listed herein shall be met without compromising the anti-vermin, pest resistant, mechanical and electrical properties of the cables both during and after the installation. Resistance of cables to insect or vermin shall not require the use of any chemical additives.
- 6.2.3 The manufacturer must satisfy the Engineer by the production of a test certificate from an accredited testing laboratory that the materials used and the cable itself is of the highest possible standards and complies with all relevant specifications.
- 6.2.4 All signal and control cables shall be twisted pair, overall screened with DC resistance less than 0.03 ohm/m. The cross-sectional area of the conductor shall be not less than 2.5 mm sq.
- 6.2.5 All signal and control cables shall have a minimum of 20% or 1 spare pair, whichever is greater, reserved for future expansion.
- 6.2.6 The selection of cables and connectors shall be appropriate to their function.

### 6.2.7 Construction Requirements

#### 6.2.7.1 Conductors

- a) The conductors shall be of stranded, high conductivity annealed copper wire complying with all the requirements of IEC60228 and BS6360.
- b) Cables for fixed installations shall have conductors with stranding to table II class 2 of IEC60228, and flexible cables shall have stranded conductors to table II class 5 of IEC60228.
- c) Conductors shall be smooth, uniform in quality, free from scale, spills, splits and any other defects. There shall be no joints in individual strands except those made in the base rod or wire before final drawing.

#### 6.2.7.2 Insulation

- a) The cable insulation shall consist of extruded low smoke halogen free material.
- b) The nominal thickness of the insulation shall be as specified in BS6724.
- c) The insulation shall not break down when spark tested in accordance with BS EN 62230.

#### 6.2.7.3 Core Identification

The insulated cores shall be clearly identified by colours, and the identification scheme shall be in accordance with IEC60189.

#### 6.2.7.4 Pairs

- a) The insulated cores shall be twisted together to form pairs.
- b) The attenuation of each pair shall be measured and shall not exceed 0.88dB/km at 800Hz at a temperature of 20°C.

#### 6.2.7.5 Bedding

The bedding shall consist of an extruded layer of low smoke zero halogen bedding compound. When tested in accordance with BS EN 50267-2-1 Part 1, the level of HCl shall not be greater than 0.5%.

#### 6.2.7.6 Screening

- a) Screening shall be achieved by the use of laminated tape, consisting of an aluminium foil bonded to a polyester film for the strength, applied to the cable with an overlap so that full 100% coverage of the conductors is afforded (Note: spray on types of construction are not acceptable).
- b) A drain wire or continuity conductor, laid under and in contact with the aluminium foil shall be provided and shall be in accordance with BS5308 clauses 7 and 10 as appropriate. The tinned annealed copper conductor, which may be solid or a stranded construction, in keeping with current manufacturing techniques, shall have a minimum cross-sectional area of 0.5mm.
- c) The maximum resistance of the drain wire or continuity conductor provided shall meet with the requirements of IEC 60228.

#### 6.2.7.7 Oversheath

- a) The oversheath of the cable shall be an extruded layer of anti-corrosion, reduced flame propagation, low smoke zero halogen compound complying with the fire performance requirements stated herein.
- b) The colour of the oversheath shall either be black or grey.

### 6.2.8 Fire Performance Requirements

#### 6.2.8.1 Flammability

- a) All plastic components of the cable including oversheath, bedding, insulation, filler, binder, etc. shall be low smoke halogen free compounds and shall have a minimum oxygen index of 35 when tested in accordance with BS EN ISO 4589-2.
- b) The temperature index of the low smoke halogen free plastic components of the cable including oversheath, bedding, insulation, filler, binder, etc. shall not be less than 280°C when tested in accordance with BS EN ISO 4589-3.

#### 6.2.8.2 Flame Propagation

- a) The cable shall be flame retardant and shall comply with the requirements of IEC 60332-1 for tests on a single cable under fire conditions.
- b) The cables shall comply with the requirements of IEC 60332-3-24 for tests on bunched cables under fire conditions.

#### 6.2.8.3 Corrosive and Acid Gas Emission

The level of HCl of the low smoke halogen free compound (fillers, bedding, oversheath, etc) and the insulation of the cable shall not be greater than 0.5% when tested in accordance with BS EN 50267-2-1/IEC 60754-1.

#### 6.2.8.4 Smoke Emission

The level of light transmittance shall meet the requirements of IEC 61034-2 clause 7.

#### 6.2.9 Mechanical Requirements

- Maximum pulling tension 35kgf
- Minimum bending radius 7.5 × OD
- Operational Conditions -20°C to 60°C

### 6.3 Connectors

Wherever possible standard multi-pin plug/socket shall be used to terminate multi-core cables for connecting to equipment. Locking mechanism shall be integrated in the connector to secure the connection.

- 6.3.1 All exposed and terminated contacts inside multi-pin connectors shall be enclosed by heat-shrink tubings.
- 6.3.2 Any unconnected socket shall be covered up and properly labelled to avoid exposure for short circuit and making wrong connection by mistake.
- 6.3.3 Unused cable cores of multi-core cables shall be neatly tied and wrapped up inside the connectors.
- 6.3.4 Connectors shall be configured to avoid wrong mating.
- 6.3.5 Connectors at cable ends carrying high level voltage or current sources shall use female contacts.
- 6.3.6 Use of soldering in cable connection shall be minimised and it shall be used only for terminating conductors. Cables and wires shall be terminated by more flexible means such as screw

terminals, crimping or wire wrapping which shall be subject to the approval of the Engineer.

- 6.3.7 All exposed and terminated contacts inside multi-pin connectors shall be enclosed by heat-shrink tubings.

#### 6.4 Equipment Enclosures

All delivered equipment shall be installed in enclosures as approved by the Engineer.

#### 6.5 Terminal Blocks

- 6.5.1 Terminal blocks shall comprise banks of rail-mounted or frame-mounted, screw-clamp, solder-lug or wire-wrap terminals as appropriate to the design and duty of the cables to be terminated, and subject to approval by the Engineer. Pinch-type screws, where the screw is in direct contact with the conductor, shall not be used.
- 6.5.2 Each terminal assembly shall have two connection points, one each for the incoming wire and the outgoing wire, connected together as appropriate with a fixed or plug-type link. Insulating materials, which shall be self-extinguishing and flame-resistant and of non-hygroscopic type, shall be moulded around the base of screws or studs and shall surround links connecting terminals or plug sockets etc., to avoid exposure of live metal at the rear of terminal blocks and to prevent rotation or displacement of terminals.
- 6.5.3 Terminations shall be grouped according to function and no more than two wires shall be connected to one terminal. Labels shall be provided on the fixed portion of the terminal blocks to identify the function of each group.

#### 6.6 Fastenings

- 6.6.1 Bolts, studs, nuts, washers and pins shall be manufactured in galvanised steel, stainless steel or high tensile copper alloy as appropriate to each application with particular reference to the prevention of corrosion.
- 6.6.2 All threads shall be machined to standard forms having metric dimensions. Rolled threads will be considered acceptable for sizes up to M10 provided they conform to a recognised standard.
- 6.6.3 Plain and spring washers shall be provided under all nuts and also bolt heads where appropriate.
- 6.6.4 Bolts and studs shall protrude by at least one thread pitch beyond the outside faces of nuts, but shall not, except where otherwise

specified, protrude more than four thread pitches beyond the outside faces of nuts.

- 6.6.5 Approved locking devices shall be provided for all fastenings.
- 6.6.6 The design of all components shall be such that, when completely assembled within the system, all bolt heads and nuts are readily accessible by means of ordinary open-ended or ring spanners during maintenance, inspection and repair.

#### 6.7 Wood

Wood materials shall not be used in this Contract, unless specifically approved by the Engineer.

#### 6.8 Labels and Markings

##### 6.8.1 Description

Descriptive labels shall be provided for all instruments, gauges, devices, fuses, cubicles and panels and the main apparatus contained therein. Such labels shall be fitted to the front and rear of all equipment cabinets. Labels shall be of engraved type, with durable markings. This requirement is not applicable to OEM items.

##### 6.8.2 Lettering

Labels for normal situations shall be of approved material, suitable to site conditions and securely fixed by means of rivets or bolts. Lettering and sizes of lettering shall be to the Approval of the Engineer.

##### 6.8.3 Wording

The designation on these labels shall be clear and shall, where practicable, incorporate the appropriate device number along with concise descriptive wording in English.

## 7. SAFETY MANAGEMENT

This clause specifies the safety requirements the Contractor shall comply with for the Delivered System in addition to the requirements specified in Clauses 5 and 15 of the General Specification (GS).

### 7.1 General

- 7.1.1 For the purpose of Safety Management Plan and GS Clause 15.2.1, the safety classification of this Contract is classified as Classification 3.
- 7.1.2 The Contractor shall conform to the "Contractor Fitness for Duty Management" requirements as stipulated at Appendix A under this PS.
- 7.1.3 The Contractor shall within the period specified in Clause 18 submit a Safety Management Plan in accordance with GS Clause 15.2 to the Engineer for consent.
- 7.1.4 A person shall be nominated by the Contractor to be its official safety authority. The Engineer will perform the role of safety authority for the Employer.
- 7.1.5 The Contractor shall only be allowed to carry out the Works within the station premises under attendance of the Competent Person(s) approved by the Engineer. For Works carried out on these locations, the Contractor shall provide attendance by a Competent Person (Non-Track) (CP(NT)) or Competent Person (Track) (CP(T)) according to the installation practices as specified in Clause 15.

### 7.2 System Safety Plan

The Contractor shall within the period specified in Clause 18 submit a System Safety Plan as defined by GS Clause 5.1.4, which shall include:

- a) the safety management organization.
- b) the safety management process to be adopted in the design, manufacturing, installation, testing, commissioning and operation of the Delivered System;
- c) the tasks and actions to be taken to ensure the safe operation of the Delivered System and the safety of the operating railways;
- d) the skills, knowledge or training of the Contractor's staff required to accomplish each named task and activity; and
- e) the explicit safety management responsibilities of all named parties.

### 7.3 Project Hazard Log

A Project Hazard Log shall be established by the Contractor, within the timescales as indicated in Clause 18, based on the results of the Hazard Analysis. The Contractor shall also maintain traceability on hazards identified by the Engineer in the Project Hazard Log.

### 7.4 Hazard Reporting

Anybody, throughout the duration of the Contract, uncovering a hazard to the integrity of the System, or hazard arising from execution of the Contract which could affect the safe operation of the Operating Railway, shall report to the respective safety authority immediately.

The Contractor shall ensure that all reported hazards are entered in the Project Hazard Log along with the appropriate action(s) taken.

## 7.5 Project Specific Safety Training (PSST)

- 7.5.1 The Contractor shall provide PSST to all site staff, including their sub-contractors.
- 7.5.2 A PSST Plan and Safety Training Need Analysis Report shall be submitted by the Contractor for the Engineer's approval within twenty-one (21) days of the date of the Letter of Acceptance. The Contractor shall conduct a Safety Training Need Analysis before submission of the Safety Training Need Analysis Report.
- 7.5.3 The Contractor shall provide PSST to all site staff, including sub-contractors, at least three (3) Days prior to commencing the related works. The trained staff shall be identified with a designated Identification Sticker Label on his/her safety helmet.
- 7.5.4 The Contractor shall conduct regular review or at other regular intervals at the discretion of the Engineer on the PSST Plan and Safety Training Need Analysis Report and submit the updated PSST Plan and Safety Training Need Analysis Report for the Approval of the Engineer.
- 7.5.5 The Contractor shall provide refresher training for all site staff, including sub-contractors, in accordance with the schedule stated in the PSST Plan and the interval between refresher training shall not be longer than one year.
- 7.5.6 The designated Identification Sticker Label shall be affixed to the trained staff's safety helmet throughout the period of the Contract.
- 7.5.7 The Contractor shall submit PSST records within fourteen (14) Days after completion of the PSST.
- 7.5.8 The PSST shall be conducted by the Contractor's Safety Officer or Safety Supervisor.
- 7.5.9 The Safety Training Need Analysis Report shall include the following:
- Background of Safety Training Need Analysis
  - Purpose of Safety Training Need Analysis
  - Safety Training Need Analysis method
  - Safety Training Need Analysis result
  - Analysis of Safety Training Need Analysis result and recommendation
- 7.5.10 The PSST Plan shall include the following:
- Schedule of safety training
  - Location of safety training
  - Training objective and provider

- d) The targeted trainees
- e) Pre-training testing and post-training testing for evaluation of safety training
- f) Refresher training arrangement (at least once every year)

7.5.11 The PSST records shall include the following:

- a) Training date and time
- b) Training location
- c) Length of training
- d) Subject of Training
- e) Contents of Training (including training materials)
- f) Trainers and their expertise
- g) Test results

7.5.12 The designated Identification Sticker Label (110mm (Length) x 40mm (Width)) shall be as shown below:

<b>Specific Safety Training</b>	
<b>Contract No (合約編號):</b>	
<b>Contractor (承判商):</b>	
<b>Employee Name (姓名):</b>	
<b>Completed Training Date (完成訓練日期):</b>	
<b>Expiry Date (到期日):</b>	
<b>Company Stamp (公司印章):</b>	
<input type="checkbox"/> <b>General</b> <input type="checkbox"/> <b>Height</b> <input type="checkbox"/> <b>Electrical</b> <input type="checkbox"/> <b>Lifting</b> <input type="checkbox"/> <b>Plant</b> <input type="checkbox"/> <b>Other:</b> _____	

## 8. TESTING AND COMMISSIONING

This Clause 8 specifies the testing process that shall be completed by the Contractor before the Delivered System or any subset of it may be put into service and accepted. The Engineer may call an unscheduled review meeting at any time during a test process if he believes it to be necessary.

### 8.1 General

8.1.1 The Contractor shall ensure that all activities performed in the course of the inspection and system testing within the Employer's premises shall not affect the operation, availability and performance of existing equipment/services.

8.1.2 The Contractor's test personnel shall be knowledgeable about the circuits and equipment of the Delivered System to the extent that they fully understand the implications and effects of all interface connections.

#### 8.1.3 Test Equipment Requirements

All test equipment, simulators, emulators, software, special tools and any consumable items deemed necessary for the tests shall be provided by the Contractor and be calibrated and in good conditions. The Contractor shall submit valid calibration certificates which shall be traceable to recognized national or international standards, for each piece of equipment, to the Engineer for Approval prior to commencement of any test.

#### 8.1.4 Sequence of Tests

The Contractor shall ensure that the testing activities are arranged in such a logical order that any succeeding tests shall not affect or introduce changes to activities performed earlier, thus requiring re-work of such an activity. If a test result is or may have been rebutted by a failure occurring at a later step of the same test or other succeeding tests, the Contractor shall, subject to the agreement with the Engineer and after the cause of the failure has been identified and the fault has been cleared, return to the test which produced the rebutted test result and start over again from that point.

### 8.1.5 Change of References

The Contractor shall prepare and submit for the reference of the Engineer prior to the test activities a comprehensive list of changes, discrepancies or amendments to the Specification which have been agreed, accepted or instructed by the Engineer throughout the development and design life cycle of the Delivered System. The list shall include the details of the change/discrepancy/amendment to the Specification and reference documentation/correspondence.

### 8.1.6 Test Records

The results of any testing shall be recorded in Approved test record sheets. The Engineer will determine whether a test item has passed or failed. In general, the test will be considered to have failed if either:

The result of the test is not in accordance with the expected result described in the test procedure, or

The result of the test is in accordance with the expected result described in the test procedure, but some other unexpected or unexplained event occurred which the Engineer considers to be a fault.

Within the timescales indicated in Clause 18, the Contractor shall submit three printed copies and one soft copy of test records for the Approval of the Engineer.

### 8.1.7 Faults and Failures

Troubleshooting and rectification shall be conducted by the Contractor for any faults identified during testing. The Contractor shall then arrange for the relevant tests to be repeated. If the remedial actions taken by the Contractor involve significant modifications in deviation from the original design, the Contractor shall conduct commissioning, System Integration Tests (SIT), and any other relevant tests as appropriate prior to repeating the test in which the fault is first identified.

The Engineer will have the right to suspend any test and abandon the test results in case:

- a) the errors and failures identified during the test become unacceptable;
- b) similar errors and failures, which are identified during previous tests, but have not been rectified within a reasonable time;
- c) the equipment is found to be significantly non-compliant with the requirements; or
- d) the Contractor fails to provide valid calibration certificate for all test equipment used.

#### 8.1.8 Contractor's Responsibility

The Contractor shall carry out the necessary testing to ensure that the safety, functionality, and performance of the Delivered System are compliant with the GS and this PS.

### 8.2 Test Plan

The Contractor shall submit the Test Plan for Approval within the time specified in Clause 18 of this PS. The Test Plan shall serve as a master plan for testing and commissioning and describe the overall strategy and processes. The Test Plan shall include the first and second level clauses given in the following sample Table of Contents. The sequence of clauses shall not be changed. Additional clauses may be added.

Table of Contents	
1.	Factory Acceptance Test Plan
1.1	FAT Logistics
1.2	Schedule of Tests
1.3	Type Test / First Article Inspection
1.4	FAT Regression Testing
1.5	Certification
2.	Installation Test Plan
2.1	Safety
2.2	Logistics
2.3	Schedule of Tests
2.4	Certification
3.	System Test Plan
3.1	Safety
3.2	Logistics
3.3	Schedule of Tests
3.4	Certification
4.	Testing and Commissioning Plan
5.	System Acceptance Test Plan
6.	Reliability Demonstration Test
7.	Regression Testing After Modification

Table of Contents for Test Plan

### 8.3 Test Results

Within the timescales indicated in Clause 18, the Contractor shall submit all test results to the Engineer for record.

### 8.4 Factory Acceptance Test (FAT)

Factory Acceptance Tests shall be conducted at the Contractor's premises or manufacturer's factory plants to prove, prior to shipment of any equipment that the Delivered System will comply with the specified safety, functional and performance requirements. Within the timescales indicated in Appendix F, the Contractor shall submit a FAT Plan as described below to the Engineer for Approval.

#### 8.4.1 FAT Plan

The FAT Plan shall include additional / third level clauses to describe in detail the test processes and procedures, records to be submitted, and procedures to be followed to correct any deficiencies that are recorded. In the event that a waiver is claimed by the Contractor against any specific tests, the Contractor shall provide applicable documents for inspection, including:

- a) Laboratory test reports, e.g. EMC and environmental test results;
- b) Copies of certificates, e.g. type approval and electrical safety;
- c) Design calculations in lieu of practical tests; and
- d) Test equipment calibration certificates and specification.
- e) Photocopies of applicable documents shall be provided.

## 8.4.2 FAT Logistics

### 8.4.2.1 Timing

The FAT shall be carried out over a contiguous period excluding weekends during local daytime office hours at the addresses given in the FAT Plan.

### 8.4.2.2 Transport

The Contractor shall provide transport between the factory site and temporary accommodation.

### 8.4.2.3 Emergency Contact Number

The Contractor shall provide a 24-hour emergency contact number for the duration of FAT.

## 8.4.3 Schedules of Tests

The schedule of tests shall list all tests to be carried out in their correct sequence, stating all pre-condition to the commencement of each test. The schedule shall also indicate which clauses of the Specification each test addresses.

The schedule shall include, but not be restricted to, the requirements described below:

- general mechanical inspections;
- general electrical tests;
- functional test of all functions described in Clause 5, including performance and timing as applicable;
- full capacity tests as a pressure test against full load conditions; and
- a list of all special software and hardware tools required to perform any tests.

## 8.4.4 Type Test / First Article Inspection

Type test and inspection of the first item to be installed of a particular design which is not commercial off-the-shelf product / equipment shall be conducted at FAT to prove, prior to volume production, that the Delivered System will comply with the specified reliability levels, safety performance, environmental tolerances and design criteria as part of the development process. The environmental tests (temperature and humidity) shall include

as a minimum 72 (seventy-two) hours temperature-cycled burn-in test for all assemblies that contain electronic components.

#### 8.4.5 FAT Regression Testing

If a test fails or is unsatisfactory, the Engineer and Contractor shall agree on the extent of re-test that is required. If no agreement is reached, the Engineer's decision shall be binding.

#### 8.4.6 Aborting the FAT

The Engineer may abort the FAT if in his opinion the extent of test failures makes it pointless to continue.

#### 8.4.7 Certification

The Engineer will sign-off the FAT on completion if he is generally satisfied that any failures are minor and that rectification and regression test plans are agreed. The FAT sign-off will be deemed void if the rectification and regression test plans are not carried out in the agreed time and to the satisfaction of the Engineer.

### 8.5 Installation Test Plan

The purpose of the Installation Test Plan (ITP) is to map the process of ensuring that the Delivered System is ready and safe for functional and performance testing and will not damage other equipment to which it will be connected. Installation testing covers wiring integrity, and tests on the electrical safety of installed devices and devices with which they will interface including those supplied by others, and may include preliminary assurance checks such as voltage and quiescent current measurements.

#### 8.5.1 Safety

The ITP shall identify hazards that may be encountered during installation testing and state how these will be managed. Particular attention shall be paid to electrical safety where equipment in the same locality may operate from different phases and may be at different stages of installation and commissioning.

#### 8.5.2 Logistics

The ITP shall describe the sequence and provisional timing for planned work in compliance with Clause 13 of the PS. It shall state where and when Competent Persons will be present, and which tasks require the presence of two Competent Persons for safety.

### 8.5.3 Schedule of Tests

The record forms of tests shall list all tests to be carried out in their correct sequence, stating all preconditions prior to the commencement of each test.

The record forms shall provide blank spaces to record the test results including the observations during the tests. The tests shall include integrity check of safety earth, cable insulation checks, checks on correct fuse values and types fitted, proper wire counts and one-to-one continuity checking results.

### 8.5.4 Certification

The Contractor shall not commence system site testing until installation testing has been certified complete and satisfactory by the Engineer. Certification may be on a site by site basis.

## 8.6 Site Test and Commissioning

8.6.1 The Contractor shall perform a range of site commissioning tests to demonstrate that all items have been correctly installed and adjusted on a location-by-location basis and that the Delivered System operates in every respect in accordance with the Specification. Details of these tests shall be submitted in accordance with the programme and be subject to the Approval of the Engineer. Site testing and commissioning shall be performed by the Contractor and witnessed by the Engineer.

8.6.2 The site testing and commissioning shall be conducted in such a way that the normal operation of the railway is not affected. Any site testing and commissioning which may affect the operation of the railway shall be conducted during non-traffic hours and shall be subjected to the Approval of the Engineer.

8.6.3 Within the timescales indicated in Clause 18, the Contractor shall submit a Testing and Commissioning Plan to the Engineer for Approval. The Plan shall be submitted on a Section by Section basis, and adopt a top down approach and describe the testing and commissioning strategies and processes.

8.6.4 The Testing and Commissioning Plan shall identify a comprehensive list of specifications, standards, procedures, pass/fail criteria, resources to be made available, drawings and records to be submitted to the Engineer for Approval. The plan shall also include a programme for identifying the dates for testing and commissioning submissions.

- 8.6.5 The T&C Plan shall include the commissioning of the installed equipment, spares supplied under the Contract and modification on any existing equipment.
- 8.6.6 The tests shall include the following test items:
- a) Testing of all functional and performance requirements for the Delivered System;
  - b) Testing of system resilience and redundant features;
  - c) Testing of all the supervisory and management functions of the Delivered System; and
  - d) Testing of all interfaces for the Delivered System.
- 8.6.7 Test procedures shall be carefully planned to ensure that the test can be completed in the time available. If the time available is restricted, this planning shall include contingency plans to be implemented if the test proceeds slower than anticipated or defects are identified which cannot be corrected.
- 8.6.8 Test procedures shall be approved by the Engineer prior to the start of any commissioning test. The presence of the Engineer shall be required before commissioning tests can be carried out. Upon completion of each site commissioning test, the Contractor shall submit three printed copies and one soft copy of the commissioning records to the Engineer for Approval.

## 8.7 System Test Plan

The purpose of the System Test Plan (STP) is to map the process of taking the Delivered System from completion of installation testing to readiness for putting into service to the commissioning process.

### 8.7.1 Safety

The STP shall identify hazards that may be encountered during system testing and state how these will be managed. The Contractor shall pay due attention to electrical safety and supervision by Competent Persons as required by Clauses 12 of this PS.

### 8.7.2 Logistics

The STP shall describe the sequence and provisional timing for planned work in compliance with Clause 13 of the PS. It shall state where and when Competent Persons will be present, and which tasks require the presence of two Competent Persons for safety.

### 8.7.3 Schedule of Tests

The Schedule of Tests shall be based on the Schedule of Tests for the FAT, with additional tests to cover site specific configuration. System safety, functionality and performance as specified in the PS shall be covered. The Contractor shall refer to Appendix C for the schedule of tests.

For safety critical systems, safety performance when fault conditions identified in the FMECA analysis occur shall be demonstrated and all statutory tests shall be identified and included.

### 8.7.4 Stability Testing and Parallel Running

The STP shall include plans for a 7-day stability test during which time no system-wide failure shall occur and no Critical Functions, such as live PA announcement from the Central Microphone and Local Microphone, ad-hoc pre-defined message and schedule message from OCC, shall be lost. If failed, stability tests shall be repeated until they pass.

During the stability test, the existing PAS that is being replaced shall either be left running, or be available to take over if a critical or system-wide fault occurs in the Delivered System.

### 8.7.5 Certification

On satisfactory completion of the System Test, the Engineer will sign off the test report, and commissioning may then commence. Certification may be on a site by site basis.

## 8.8 Commissioning

Commissioning is the process of setting a fully tested Delivered System into service. It occurs at the end of testing phase, when the Engineer has certified the System Test process completed.

### 8.8.1 Testing and Commissioning Plan

The Testing and Commissioning Plan shall include:

- a) System Cut-in / Cutover plan;
- b) Contingency plans in case of a major problem with the Delivered System;
- c) Briefing and supporting operating staff on first day of operation;
- d) Removal of test equipment;
- e) The requirements of Clause 25 of the GS.

## 8.9 System Integration Test (SIT)

8.9.1 The Contractor shall submit a SIT Plan to the Engineer for Approval.

8.9.2 Following the completion of site commissioning or cutover of the Works, the Contractor shall perform a range of SIT to demonstrate that the Delivered System is functioning properly, including all interfaces with other systems, in every respect in accordance with the Specification.

8.9.3 The SIT shall comprise comprehensive testing of the assembled installation to ensure that it operates in accordance with the requirements of this Particular Specification.

8.9.4 Details of the SIT shall be submitted in accordance with the programme and be subject to the Approval of the Engineer. The SIT shall be performed by the Contractor and witnessed by the Engineer.

8.9.5 The testing shall be conducted in such a way that the normal operation of the railway is not affected. Any testing activity which may affect the operation of the railway shall be conducted during non-traffic hours and shall be subjected to the Approval of the Engineer as well as supervision of the Engineer.

- 8.9.6 Within the timescales indicated in Clause 18, the Contractor shall submit a System Integration Test Plan (SIT Plan) to the Engineer for Approval. The plan shall be submitted on a Section by Section basis, and adopt a top down approach and describe the test strategies and processes.
- 8.9.7 The SIT Plan shall identify a comprehensive list of specifications, standards, procedures, pass/fail criteria, resources to be made available, drawings and records to be submitted to the Engineer for Approval. The SIT Plan shall also include a programme for identifying the dates for SIT submissions.
- 8.9.8 The SIT shall include the following:
- a) testing of all functional and performance requirements for the Delivered System;
  - b) testing of all functional software units;
  - c) testing of the Delivered System's behavior under various failure conditions, e.g. changeover to redundant hardware; initiation of re-configuration function; and recovery of the equipment and system from failures;
  - d) inter-operability test; and
  - e) Testing of all interfaces for the Delivered System.
- 8.9.9 Test procedures shall be approved by the Engineer prior to the start of any SIT. The presence of the Engineer shall be required before SIT can be carried out.
- 8.9.10 Upon completion of each SIT, the Contractor shall submit three printed copies and one soft copy of the commissioning records to the Engineer for Approval.
- 8.9.11 The System Integration Tests as specified in the Particular Specification is one of the Tests on Completion as referred to in Clause 25.2 of the GS and Clause 62 of the Conditions of Contract. Any failure to meet the functional and performance requirements of the Delivered System shall be rectified by the Contractor at the Contractor's costs.

## 8.10 Regression Testing

- 8.10.1 The Contractor shall state the extent of testing to be carried out when modifications take place. Any design modifications shall be subject to the design approval and acceptance testing processes and shall therefore be fully documented prior to their implementation.

- 8.10.2 The relevant documents of the modified software shall be submitted for regression testing. Regression test shall be conducted for all modified software and shall only be put into services according to a programme that is agreed with the Engineer. Software modifications shall be documented with the same rigor as the original design, and configuration management shall be maintained.
- 8.10.3 Regression tests shall be conducted on site before and after cut-over.

#### 8.11 System Acceptance Test Plan

The System Acceptance Test Plan shall indicate how the requirements of Clause 25.2.1 of the GS will be met. Tests on Completion comprise system tests, commissioning tests and submission of copies of applicable test certificates. Approval of the Reliability Plan and Test Plan are prerequisites of system acceptance. The Contractor shall submit SAT Record after each SAT completed.

#### 8.12 Overall Reliability, Availability and Maintainability Assessment

Upon commencement of the Defects Liability Period of the Works, the level of performance on the reliability, availability and maintainability achieved by the Delivered System shall be monitored and assessed in the 3-month in-service Reliability Demonstration Test (RDT) by the Contractor and the results shall be included in the Reliability Demonstration Report.

Upon the completion of the Defects Liability Period of the Works, the overall level of performance on the reliability, availability and maintainability achieved by the Delivered System shall be evaluated by the Contractor. In the event that the level of performance achieved cannot meet the reliability, availability and maintainability targets as specified in Clause 9, the Defects Liability Period of the Works shall be extended until the overall assessment for the period including the extended period is satisfactory. The Contractor shall carry out the rectification as specified in Clause 9 during the extended period at his own cost.

## **9. SYSTEM ASSURANCE REQUIREMENTS**

This clause specifies the system assurance requirements in terms of reliability, availability and maintainability (RAM) for the system.

### **9.1 Reliability Requirements**

- 9.1.1 The Contractor shall ensure reliability assurance aspects are built into all of the design, manufacturing, testing and installation processes as necessary to satisfy the contractual reliability requirements.
- 9.1.2 The Contractor shall ensure that the equipment supplied under the Contract has a Mean Time Between Failure (MTBF) figure of not less than the following figures:

Equipment	MTBF (hours)
Network Cameras	>50,000
Power Supply Units	>60,000
Mobile Tablets	>50,000
UTP Cables	>100,000
Power and Feeder Cables	>100,000

- 9.1.3 The MTBF is the average operating time accumulated by the total population of identical items between relevant failures.
- 9.1.4 Relevant failures are failures related to:
  - a) Equipment design;
  - b) Equipment manufacture;
  - c) Software design; and
  - d) Contractor-furnished operating, maintenance or repair procedures that cause equipment failure.
- 9.1.5 Irrelevant failures are failures related to mis-operations of the system and failure of existing equipment not supplied by the Contractor.
- 9.1.6 Within the timescales indicated in Clause 18, the Contractor shall develop a Reliability Plan and submit this to the Engineer for Approval.

### **9.2 Availability Requirements and Analysis**

- 9.2.1 The availability of the Delivered System shall be not less than 99.5%.

Availability shall be assessed by the following measure:

$$\text{Availability} = 1 - \frac{DT_{CM}}{TT}$$

where,

TT      The total operation time in hours summed over all units of the Delivered CCTV System in the assessment period.

DT<sub>CM</sub>    The total down time in hours due to Corrective Maintenance of the Delivered CCTV System summed over all sessions carried out in the assessment period.

9.2.2     The Delivered System is considered to have failed when any of its equipment is not fully functional (not including the failure not caused by the Contractor's equipment). Failure conditions shall include:

- a) Failure of local recording of any Network Cameras.
- b) Failure to provide number of passenger count of any Network Cameras to UPIP server
- c) Failure to provide live streaming for the Tablet for driver cabs and OCC
- d) Any software fault resulting in the failure in providing the required system functions or performance as specified in this Particular Specification

9.2.3     When determining the system availability on basic functions, failures due to components which are not part of the Delivered System shall be regarded as irrelevant and be excluded from the calculation.

### 9.3 Maintainability

#### 9.3.1 Mean Time To Restore

- a) The time shall be counted when the Contractor's maintenance engineers can access the equipment. The Contractor shall demonstrate the conformance of the restore time of the system during the RAM demonstration period and if the test failed, the Contractor shall submit the rectification proposal for the Approval of the Engineer.

9.3.2 The maintenance of system software (data tables and/or functional software) shall not require the system to be non-operation for more than two hours. Those activities shall be conducted during NTH.

9.3.3 The equipment shall be of functional modules design to facilitate installation, fault diagnosis, equipment maintenance, hardware/software upgrade and possible future modification.

9.3.4 The equipment shall be designed to allow hot swapping of system components include assemblies, modules and hardware boxes.

9.3.5 The Contractor shall provide a complete list of preventive maintenance procedures for the system.

9.3.6 The compliance with a particular reliability, availability or maintainability requirement shall not in any way exempt the Contractor from complying with all the RAM requirements as specified in this Particular Specification.

9.3.7 The Contractor shall develop a Maintainability Plan, which shall include a comprehensive list of specifications, standards, guidelines, procedures and records to be submitted for approval of the Engineer.

#### 9.3.8 Mean Time To Restore System Functions

Before the end of DLP, the Mean Time To Restore the Delivered System to full operation by the Contractor's maintenance engineers following a failure referred to in clause 9.2.2 (exclusive of technicians' travelling time and once technicians have reached the equipment) shall be less than:

60 minutes by up to two technicians using no special tools.

### 9.4 Reliability Assessment

9.4.1 Upon commencement of the DLP subject to the agreement with the Engineer, the Contractor shall conduct a 3-months in-service Reliability Demonstration Test (RDT) to verify that the Delivered

System performs according to the reliability, availability and maintainability requirements as specified in Clause 9 of the PS.

- 9.4.2 The Contractor shall submit a RDT Plan for the approval of the Engineer in accordance with the timescale in Clause 18.
- 9.4.3 A final RDT Report shall be submitted for the approval by the Engineer. The RDT Report shall demonstrate that the reliability, availability and maintainability for the Delivered System as specified in Clause 9 are achieved during the RDT period.
- 9.4.4 If the RDT was failed according to Clause 9 of the PS, the RDT shall be continued at weekly intervals. Such process shall continue until the result satisfies the requirements of the Contract.
- 9.4.5 The RDT shall be conducted under normal operations without special test equipment or procedures.
- 9.4.6 The Contractor shall maintain records of all failures during the test period. Starting from commencement of the RDT period and on a monthly basis, each failure record shall be submitted in the Monthly RDT Report to the Engineer for endorsement.
- 9.4.7 The Employer's staff will operate the Delivered System according to the procedures described in the Approved O&M documents.
- 9.4.8 The Contractor shall at his own expense replace all the equipment failing to pass the Reliability Assessment, rectify all deficiencies and re-perform the Reliability Assessment as required by the Engineer. A monthly Reliability Assessment report shall be furnished to the Engineer for review.

## 10. SPARE PARTS

### 10.1 General

- 10.1.1 The Contractor shall submit for Approval of the Engineer a recommended list of spare parts sufficient for normal routine maintenance by the Employer after finalization of the design.
- 10.1.2 Minor items that are commonly available in Hong Kong need not be included.
- 10.1.3 A Spare Parts List containing the recommended spare parts and quantities shall be submitted to the Engineer for Approval within the time specified in Clause 18. Breakdown of capital, overhaul, consumable, repairable and contingency spares shall be fully considered and included as necessary. The recommended items and quantities in the Spare Parts List shall be sufficient for the first 3 Years of operation and maintenance following the expiry of the DLP of the Works.
- 10.1.4 The spares, if instructed by the Engineer not less than 6 months from the date for completion of the whole of the Works, shall be delivered at least 30 days prior to the completion of commissioning of Works.

### 10.2 Tests on Spares

- 10.2.1 The Contractor shall be responsible for the testing and commissioning of all spares supplied under the Contract. The test shall include functional and electrical testing to verify that all spares conform to standard and meet every aspect as specified in the Specification. Any defective item found during the course of tests shall be immediately replaced by the Contractor at the Contractor's expense.

## 11. TRAINING

### 11.1 General

This clause specifies the training to be provided by the Contractor to the operators and maintainers of the Employer.

### 11.2 Training Plan

- 11.2.1 Within the timescales indicated in Clause 18, the Contractor shall develop and submit a Training Plan for the Approval of the Engineer. The Training Plan shall be developed in accordance with GS Clause 27.1.2.
- 11.2.2 A minimum of 8 training sessions shall be provided by the Contractor to the Employer's staff of up to 20 persons from the maintenance and operation section to provide them with the skills and knowledge necessary to cope with the normal daily operation and corrective maintenance.
- 11.2.3 Training Manuals shall be provided 14 days after the Completion of T&C.
- 11.2.4 Operations and Maintenance (O&M) Manual shall be provided 4 weeks after the Completion of T&C.

## **12. PRODUCT SUPPORT**

### **12.1 Documentation**

- 12.1.1 The Contractor shall update and revise such drawings, as-built documentations, O&M manuals as well as prepare additional drawings and documentation as necessary for the Work, and submit for approval by the Engineer. The final sets of revisions of drawings and documentations shall be submitted two weeks after completion of T&C and four weeks after completion of work respectively.
- 12.1.2 The as-built documentation shall include drawings showing the location and connectivity of all equipment as well as any other details approved by the Engineer during the course of the Works. The drawings shall also show the name, type, location and routing of each cable as well as a full termination description shall be shown.
- 12.1.3 The Contractor shall be responsible for maintaining and updating the information contained in the manuals during the RDT and DLP to cover any alteration to the Delivered System which may be required during this time.
- 12.1.4 The Contractor shall deliver 3 sets softcopies and hardcopies of the approved O&M Manuals to the Employer four weeks after completion of work.

### **12.2 Software**

- 12.2.1 The Contractor shall submit for reference, recovery and record purpose soft copy of all modified software including configuration files, application programs and server programs, and etc.
- 12.2.2 The Contractor shall submit hard disk image backup of all modified computers for maintenance purpose.

### **12.3 Warranty**

- 12.3.1 The Contractor shall be responsible for a 3-month in-service Reliability Demonstration Test (RDT) during DLP which shall be conducted in accordance with the Approved RDT Plan. The availability of the Delivered System shall be not less than 99.5%.
- 12.3.2 The Employer's maintenance and operation staff will carry out first attempt corrective maintenance. For Failures which cannot be corrected during the first attempt, the Contractor shall provide 24 hours per day; 7 days per week support to carry out failure follow up, investigation of all failures including those related to the interfacing equipment after the first commissioning of the Delivered System to the end of the DLP.

- 12.3.3 The Contractor shall bear the cost of labour and transportation to dispatch competent and specially trained staff to attend any request for inspection and system restoring commencing from the first commissioning of the Delivered System to the end of the DLP. Contractor's call-out staff shall respond in the first instance by contacting the Employer's staff or the Engineer within 15 minutes from being notified. Response time shall be counted from the time the Contractor is informed of the fault to the time the Contractor's staff arriving at where the faulty equipment is located. Recovery time is the time between the fault reported and the time when the affected equipment is restored to perform all of its required function.
- 12.3.4 Should the Contractor fail to restore the Delivered System as set out herein, the Engineer may seek alternative service to remedy the fault. Any costs so incurred, shall be charged to the Contractor or deducted from money retained for the Contract.
- 12.3.5 The Contractor shall be responsible to clear away from the site all surplus materials, rubbish and temporary works and leave the whole of the site and installation clean to the satisfactory of the Engineer upon completion of the servicing, repair works. No materials or tools shall be stored at the Employer's premises without the Engineer's Approval.
- 12.3.6 The Contractor shall provide adequate amount of spare parts and manpower at all time in order to minimise the service impact due to repair of the Delivered System. If the time for defective parts repairing is more than 1 week, the Contractor shall be responsible for replacing/ exchanging all these parts from the spare parts retained by the Employer at the Contractor's own cost.
- 12.4 Use of the System by the Employer
- The Employer may put into service any part of the Delivered System immediately following the Contractor's satisfactory test and commissioning of that part with the issue of Handing-Over Certificate.
- The Contractor shall be responsible for all costs associated with the repair of the defects of that part of the Delivered System from the part being put into service until the completion of the DLP for the whole of the Works. The Defects Liability Period will commence only from the date as certified in the Certificate of Completion of the whole of the Works..

## 13. SITE ARRANGEMENTS

The Contractor shall adhere to site arrangements described in this clause for all installation, testing and commissioning (T&C) activities conducted under this Contract at the Employer's site. The Contractor shall note that the stations are operational areas. Site access for all works including survey, installation, T&C etc. shall be pre-arranged and approved by the Engineer. Advance notice of at least 1 week shall be required for any such activities.

### 13.1 Railway Operation

- 13.1.1 All works shall be conducted in such a manner that the normal operation of the railway is not affected and shall be carried out during the Non-Traffic Hours.
- 13.1.2 The Contractor shall refer to appropriate documents as directed by the Engineer concerning the daily traffic hours.
- 13.1.3 For all the works carried out, the Contractor shall ensure that the Operating Railway is returned to normal operation before the commencement of normal traffic hours.

### 13.2 Working Hours during Non-Traffic Hours

Non-traffic hours normally extend from 01:30 to 04:30 but will be subject to the latest amendments as published in the Traffic Notice or associated documents and be subject to the discretion of the Employer's duty officer. The Contractor shall get the Traffic Notice related information from the Engineer if necessary. The Contractor is responsible to propose 4 week rolling program to the Engineer which stated in Clause 17.

### 13.3 Works in Station Areas

For any works at Station Areas (excluding any work that requires the access to trackside areas), the Contractor shall commence working at 01:30 subject to the discretion of the Station Controller on duty. The works must be finished before 05:00 and the worksite shall be cleaned and made tidy to the satisfaction of the Engineer.

### 13.4 Works in Trains

For any works in Trains (excluding any work that requires the access to trackside areas), the Contractor shall commence working at 01:30 subject to the discretion of the Yard Master on duty. The works must be finished before 05:00 and the worksite shall be cleaned and made tidy to the satisfaction of the Engineer.

### 13.5 Works at Construction Site

Station Areas and Ancillary Buildings will be granted access to other

contractors occasionally. Access for installation shall only be granted by the Engineer if the Contractor demonstrates that the installation activity has adequate safety protection for the worker and shall not cause any damage to the structure or any loss to other parties.

### 13.6 System Cut-in/System Cut-over

System cut-in/system cut-over of the Delivered System shall be conducted during Non-traffic Hours. Prior to the scheduled system cut-in, the Contractor shall submit System Cut-in/Cut-over Plan and obtain approval from the Engineer.

### 13.7 Work During Traffic Hours

Access for work during traffic hours is prohibited in all public areas and operation areas. It will only be granted at equipment room if the Contractor demonstrates that the activity has no interaction with any equipment being worked on and that there is adequate protection of the power distribution system to the in-service equipment.

### 13.8 Work Supervision

All works shall be attended by a Competent Person (CP) employed by the Contractor at all times. The Competent Person can also be appointed to take up the role of the WPIC if fits to do so. Any work that may affect the operation of the railway shall be carried out only with the Approval and under the supervision of the Engineer.

#### 13.8.1 Contractor's Personnel

- 13.8.1.1 The supervisor of works shall be a Competent Person well familiar with all safety requirements, Railway Safety Rules in Appendix F to the GS, Method Statements, Safety Management Plan as well as any applicable statutory requirements.
- 13.8.1.2 The Contractor's site staff shall be knowledgeable in the circuits and equipment of the Delivered System to the extent that they fully understand the implications and effects of all connections including interface connections.
- 13.8.1.3 The Contractor's site staff shall be fully aware of the Employer's safety procedures and shall possess valid work passes issued by the Employer.
- 13.8.1.4 All the Contractor's site personnel shall be fully aware of the Employer's safety procedures and undertake all works in the Employer's premises in strict observance of Employer's rules and procedures.

### 13.9 Contractor's Competent Persons

13.9.1 All works shall be supervised by the Competent Persons. The Contractor shall nominate his site staff to attend the Competent Person Training Course conducted by the Employer prior to work commencement.

### 13.10 Contractor's Work Passes

13.10.1 All workers working in the Employer's premises shall possess:

- a valid work pass issued by the Employer; and
- a valid Construction Industry Safety Training Certificate (Green Card).

13.10.2 When working on fixed electrical equipment, the Contractor's person-in-charge shall possess a valid Registered Electrical Worker License, which identifies the scope for which the individual is licensed to work.

### 13.11 Temporary Works

13.11.1 Site works that require temporary installation arrangements shall only be permitted if the Contractor can demonstrate to the Engineer that there is no risk to the normal operations of the railway. All temporary works shall be clearly marked and clearly identifiable from the actual site equipment.

13.11.2 Temporary installation arrangements shall not infringe any site safety regulation. If in the opinion of the Engineer the temporary works are unsafe or may interfere with the operations of the railway, the Contractor shall remove any such temporary works immediately if instructed to do so by the Engineer.

### 13.12 Contractor's Storage

No storage space or office facilities will be made available to the Contractor and the Contractor shall arrange his own parking space as the Employer will not provide any parking space for the Contractor's vehicles at work sites.

### 13.13 P-Licensing System - Caring and Coaching System for new Contractor workers

#### 13.13.1 Aim

The P-Licensing system shall provide first line orientation and guidance to the new workers (or green workers with little experience) to clearly understand the safety requirements of the Employer, and to increase their safety awareness with a view to enhancing site safety, particularly the railway related safety.

### 13.13.2 Categories of New Workers

- 13.13.2.1 Probationer (P) refers to any worker who has less than 6 months' construction site experience.
- 13.13.2.2 Newcomer (N) refers to any worker who has attained at least 6 months' construction site experience worker who has attained at least 6 months' construction site experience and at least one month of which is obtained from operational related work sites of the Employer could be regarded as waiver to requirements of Newcomer. However, it would be up to Contractor to decide and judge whether a particular worker would require to undergo the familiarisation programme same as a "New Comer" notwithstanding that the particular worker concerned has acquired more than 1 month site experience with the operational railway of the Employer.

### 13.13.3 System Implementation

#### Probationer

- 13.13.3.1 The Probationer will be identified with a "P" sticker label affixed to his/ her safety helmet. If wearing of safety helmet is not mandatory for any contracts (e.g. cleaner Contract), the Probationer will be identified with a "P" sticker affixed on the working ID card or badge on his/her chest.
- 13.13.3.2 The Contractor shall conduct a min. 1.5-hour briefing to the Probationer on the general principles and practices of site safety and the safety matters which are relevant to the work sites of the contracts with the Employer (please refer to Clause 13.13.5 or details).
- 13.13.3.3 The Contractor shall appoint a skilled or semi-skilled worker, who has past working experience of the operation related contracts with the Employer, to act as a mentor/ coach.
- 13.13.3.4 The Contractor shall arrange a mentor to take care of remind the Probationer of the site safety requirements from time to time for a minimum period of 3 months.
- 13.13.3.5 The mentor will only be permitted to take care of a maximum of 4 Probationers/Newcomers at the same time.

- 13.13.3.6 The mentor shall, on full time basis, accompany the Probationer to work including the daily pre-work safety briefing and allocation of work.
- 13.13.3.7 A performance review shall be arranged to appraise the general safety performance of the Probationer after 3 months' coaching (Please refer to Clause 13.13.6 for details).
- 13.13.3.8 If the general safety performance is satisfactory as determined in the safety performance review, the Probationer will be allowed to work on his / her own without the "P" sticker label on the helmet. Otherwise, the Probationer shall continue with the mentoring/ coaching process until satisfactory performance is achieved.

*Newcomer*

- 13.13.3.9 The Newcomer will be identified with a "N" sticker on his / her safety helmet. If wearing of safety helmet is not mandatory, the Newcomer will be identified with a "N" sticker label affixed on the working ID card or badge on his/her chest.
- 13.13.3.10 The Contractor shall conduct a min. 1 hour briefing to the Newcomer on the safety matters which are relevant to working in the work sites of the contracts with the Employer (please refer to Clause 13.13.5 for details).
- 13.13.3.11 The Contractor shall appoint a skilled or semi-skilled worker, who has past working experience of the operation related contracts with the Employer , to act as a mentor/ coach.
- 13.13.3.12 The Contractor shall arrange a mentor to take care of/ remind the Newcomer of the site safety requirements from time to time for a minimum period of 1 month.
- 13.13.3.13 The mentor will only be permitted to take care of a maximum of 4 Probationers/Newcomers at the same time.
- 13.13.3.14 A performance review shall be arranged to appraise the general safety performance of the Newcomer after 1 months' coaching period (Please refer to Clause 13.13.6 for details).
- 13.13.3.15 With satisfactory safety performance, the Newcomer will be allowed to work on his / her own without the label of "N" affixed on the helmet. Otherwise, the

Newcomer shall continue with the mentoring process until satisfactory performance is achieved.

#### 13.13.4 Identification Sticker Label

13.13.4.1 The sticker labels will be provided by the Employer at a reasonable quantity.

13.13.4.2 The sticker labels will be affixed to the safety helmets throughout the mentoring period.



P" Sticker Label



"N" Sticker Label

#### 13.13.5 Training Materials

13.13.5.1 A Contractor Information Centre is currently available in the Employer's website <http://cic.mtr.com.hk> in which many safety related information are uploaded. Details of the P-Licensing System are also uploaded to this website. The Contractor shall prepare the training materials for providing safety briefing to workers based on related P-licensing training materials in the website.

13.13.5.2 The safety briefing shall be conducted by the Safety Officer or Safety Supervisor in such a way that the Contractor will address both the general industrial related site safety principles and practices, and the railway related safety matters for working at the Site. The safety briefing should include safety requirements for works under all working locations within the Site, the relevant lesson learnt case(s) extracted from the Construction Industry Council and the sample case(s)

provided by the Employer. Both the industrial and railway related safety topics shall carry proper weighting in the safety briefing.

#### 13.13.6 Safety Performance Review

- 13.13.6.1 The Safety Performance Review shall be undertaken by two assessors. One Safety Officer and one safety competent supervisory staff of the Contractor shall be nominated as the joint assessors for the Engineer's approval. The assessment result of the Safety Performance Review will be documented in the P-Licensing system as proper records by the Contractor.
- 13.13.6.2 In the event that there are frequent in/out movements of the Probationers or Newcomers under the P-Licensing system during the Contract Period, the related working experience of such workers shall be reviewed by the Contractor's assessors, with the final results of the review endorsed by the Engineer. In any case, no workers shall be considered fulfilling the mentoring requirements unless at least 80% of the mentoring period has been achieved under the P-Licensing system.
- 13.13.6.3 The assessors shall take into account of the different general safety degree/ level of risks and hazards in different locations of the Site in the performance review. For instance, the risks for the works at the running tracks may be higher than those at the station concourse.

#### 13.14 Site Attendance

- 13.14.1 For the Works carried out on railway premises, the Contractor shall arrange a qualified Competent Person (CP) to provide attendance for the Works in accordance with GS Clause 15.2.3.2. The extent of attendance and requirements for the Competent Person are set out in the "Railway Safety Rules and Safety Requirements and Information for Contractors" in Appendix F to the GS.
- 13.14.2 The Contractor shall arrange a qualified Fire Marshal to provide attendance for works which involve hot work. The requirements for the Fire Marshal (FM) are described in GS Clause 15.2.4.5.
- 13.14.3 Workers who do not have Railway Safety qualifications shall work under full-time close supervision by qualified Competent Person (CP). The Contractor shall ensure their workers shall obtain appropriate Railway Qualification(s) if they work in the Operating Railway for more than 3 consecutive days.

- 13.14.4 The Contractor shall bear at his own cost for his workers to attend the courses provided by the Employer as relevant to his Works. Further to GS Clause 15.2.4.3, the duration of the courses and job attachments, the validity of qualification and the charges for the respective courses are shown in the below table:

Type of Training Course	Duration of Course	Duration of Job Attachment	Validity of Qualification	Training Course Fee (per Person per Course)
Competent Person (Track)	CP(T)	2.5 days	4 nights	1 year HKD 1,300
Competent Person (Non-Track)	CP(NT)	1.5 days	2 nights	1 year HKD 800
Railway Safety Induction	RSI	1 day	N/A	1 year HKD 500
Fire Marshal	FM	0.5 day	N/A	2 years HKD 300

- 13.14.5 Refresher courses at the same rate shall be taken upon the expiry of the validity of the qualification.

- 13.14.6 Notwithstanding the provisions of GS Clause 15.2.4.3(e), the Contractor shall pay the training fee before submitting their nomination. No refund will be given by the Employer for not passing any of the examinations or for being absent from the training courses or the examination.

#### 13.14.7 Site Safety Cycle and Other Safety Requirements

The Contractor shall conform to the Site Safety Cycle and other safety requirements as Appendix L of this PS.

#### 13.14.8 Contractor Fitness for Duty Management

The Contractor shall conform to the "Contractor Fitness for Duty Management" requirements as stipulated at Appendix A under this PS.

**13.14.9 Implementation of Daily Rapid Antigen Test (RAT)**

The mandatory RAT requirement for entering MTR workplace shall not be required as a Corporate policy, except for working in or entering the locations specified in the following paragraph.

The Contractor's staff are required to carry out daily RAT as mandatory screening tools and obtain a negative test result before working in or entering all Operations Control Centres including Tsing Yi Operations Control Centre, High Speed Rail Operations Control Centre and Light Rail Operations Control Centre until further notice. The Contractor shall arrange RAT test kits for your staff.

## 14. SUBMISSION REQUIREMENT

This Clause 14 specifies the submission requirements that the Contractor shall follow during the execution of the Works described in this Contract.

### 14.1 General Submissions

The submissions shall be provided by the Contractor in accordance with GS Clause 8 and PS Clause 14. The Contractor shall indicate in each of these high-level submissions, the scope and nature of all sub-level documentation submissions or reports required by the high-level documentation.

### 14.2 Submittal list

In addition to the GS Clause 10.9, the Contractor shall provide a submittal list detailing all document submissions throughout the course of the Contract. The schedule shall be in a spreadsheet format identifying the work package (i.e. management, design, manufacturing, installation, test and commissioning, as-built drawings, operation and maintenance manuals) to which the document refers, a unique document reference number, specification reference, version number, document title, target submission date, design approval request (DAR) date, DAR reference, decision sheet date, decision sheet reference and the status. The submission status shall be updated each month and submitted with the Project Monthly Progress Report.

### 14.3 Document submission

All document submissions, including drawings, by the Contractor shall be in form of printed copies. The Contractor may, after agreement with the Engineer, submit documents in electronic format for the Engineer's information in advance. Hard copies, regarded as the only form of formal submissions, shall follow. Unless otherwise agreed with the Engineer, the Contractor shall submit 3 printed copies for each design submission.

## 14.4 Specific Submissions

### 14.4.1 Design Plan

In accordance with the timescales indicated in Clause 18, the Contractor shall submit a Design Plan to the Engineer for Approval. The Design Plan shall outline the procedures to be followed to achieve the requirements of Clause 10.9 of the GS. The Design Plan shall include a list of all the specifications for all parts of the Delivered System. It shall comprise a table of contents and a brief description of the scope for each specification to be produced. Dates for the submission of designs and specifications (as indicated below or equivalent applicable items) shall be in accordance with the Approved Contractor's Master Programme and as expanded in the Contractor's Detailed Programme. The Design Plan shall indicate the activities and deliverables associated with the following:

#### 14.4.1.1 System Level Design

For the complete Delivered System, drawings shall be produced showing the complete Delivered System including the equipment, their interconnections, major information flows, the location of equipment as well as supporting documentation detailing the major functions and how they are achieved by the Delivered System's design shown in the drawings.

Any items of equipment which will be specifically developed or modified for the Works shall be indicated. Any item of commercially available equipment shall also be indicated.

For the development of system software, all activities and deliverables are indicated in Appendix K up to and including completion of the overall system design activity (or equivalent in the Contractor's software development process).

#### 14.4.1.2 Functional Design

For any electronic item of equipment, specifications include functional and non-functional requirements and associated product interface control documents; product test specifications derived from the product specifications (and test completion report), product mechanical design drawings, etc. Details of software design and test as indicated elsewhere in this Particular Specification shall be included.

For the development of system software, all activities and deliverables are indicated in Appendix E up to and including completion of the software architectural design activity (or equivalent in the Contractor's software development process).

#### 14.4.1.3 Detailed Design

For all installation specific designs, the following (or equivalent) shall be included in the detailed design:

- a) For each electronic product, installation specific data files indicating in plain text the label and value of the data item; the particular site address or designation; any reference to interconnections expressed in a form that relates to the product interface control document; and any other site specific data as proposed by the Contractor for the Approval of the Engineer that may be particularly required by the Delivered System.
- b) For the development of system software, all activities and deliverables indicated in Appendix K up to and including completion of the software module coding activity (or equivalent in the Contractor's software development process).
- c) For electro-mechanical items or connections to existing RFID reader equipment and trackside equipment cabinets: wiring diagrams, contact analysis, termination analysis and any other information proposed by the Contractor for the Approval of the Engineer that may be particularly required by the Delivered System.
- d) For any type of product, rack layouts; cable core plans or data bit allocations; equipment room lay-outs; power supply requirements and cubicle drawings and any other information proposed by the Contractor for the Approval of the Engineer that may be particularly required by the Delivered System.
- e) Stage-work drawings for the installation comprising as appropriate; temporary data files; temporary wiring and any other information proposed by the Contractor for the Approval of the Engineer that may be particularly required by the Delivered System.
- f) All database configurations.

- g) For all physical locations, drawings showing the configuration of the equipment of the Delivered System with clear indication of interface points of the interfacing systems.

#### 14.4.2 Software Design Specification

14.4.2.1 The Contractor shall submit a Software Design Specification for review by the Engineer. The Software Design Specification shall describe the functions, structure and content of the software from its highest to its lowest level (module). Detailed data structures shall be included within the Software Design Specification.

14.4.2.2 A variety of descriptive techniques shall be used within the Software Design Specification, as appropriate to the development methodology and techniques available. The descriptive techniques shall include the following:

- a) Data flow diagrams;
- b) Data dictionary/entity relationships;
- c) Object oriented notations; and
- d) State transitions.

#### 14.4.3 Detailed Design Specification

14.4.3.1 The Contractor shall submit a Detailed Design Specification for review by the Engineer. The Detailed Design Specification shall specify the installation locations and installation details of each device to be installed, the wiring and power supply arrangement, the network arrangement and the software configuration to be used.

14.4.3.2 The Contractor shall provide drawings and site survey photos in the Detailed Design Specification to clearly specify the detailed design of the Delivered System.

#### 14.4.4 Configuration Management Plan

To control change during the project life-cycle, the Contractor shall implement effective configuration management processes in accordance with ISO 10007. The Contractor shall comply with Clause 8.4 of the General Specification for the configuration management processes and the requirement of software configuration management given in Appendix E. A Configuration Management Plan shall be submitted by the Contractor within the timescales indicated in Clause 18.

#### 14.4.5 Software Quality Plan

The Contractor shall submit the Software Quality Plan and manage the development of the software in accordance with Appendix E.

### 14.5 Design Workshops

The Contractor shall conduct design workshops with the Engineer to clarify all the design issues that may arise in developing the Design Plan, Software Design Specification and Detailed Interface Specification. The design workshops shall be conducted on need basis.

### 14.6 Quality Plan

#### 14.6.1 Quality Plan Submission

The Contractor shall submit a Quality Plan in accordance with GS Clause 8.2 to the Engineer for comment within the timescale indicated in Clause 18. The Quality Plan shall adopt a top-down approach and describe the quality strategy and process to be adopted in the execution of the Contract.

#### 14.6.2 Quality Plan Requirements

The Quality Plan shall identify a comprehensive list of standards, procedures and records to be submitted to the Engineer for Approval. The Quality Plan shall also include a programme which shall identify the dates for submissions.

## 15. INSTALLATION AND INSPECTION

This Clause 15 specifies the inspections and tests required to prove that all deliverable materials, hardware and software provided for this Contract meet the requirements of the Contract.

### 15.1 General

15.1.1 The Contractor shall be responsible for all installation activities and shall perform adequate tests during installation to prove that the equipment and cables installed are ready for commissioning.

15.1.2 The Contractor shall conduct site survey to obtain accurate dimensions and layout of each location where the equipment are to be installed. The Contractor shall coordinate with relevant parties and Designated Contractors to agree the mounting details for the equipment.

15.1.3 The Contractor shall be responsible for the provision of any special tools at site that may be required for installation.

#### 15.1.4 Installation and Cutover Plans

The Contractor shall be responsible for all installation activities and shall perform adequate tests during installation to prove that the installed cables and equipment are ready for commissioning. The Contractor shall submit all test results for Approval of the Engineer within the timescales indicated in Clause 18.

#### 15.1.5 Installation Plan

In accordance with the timescales indicated in Clause 18, the Contractor shall submit an Installation Plan for the Approval of the Engineer. The Contractor shall discuss with the Engineer, all the Designated Contractors and all other interfacing parties and prepare the Installation Plan indicating how cables and equipment are to be staged, installed and connected and the activity schedule for each generic type of installation. The Installation Plan shall describe all activities leading up to the activities described in the System Cutover Plan.

#### 15.1.6 System Cut-in / Cutover Plan

In accordance with the timescales indicated in Clause 18, the Contractor shall submit a System Cutover Plan for the Approval of the Engineer. The Contractor shall discuss with the Engineer, all the Designated Contractors and all the interfacing parties and prepare the System Cutover Plan describing the detailed step-by-step cutover procedures including stage works, trial/pilot installation arrangements, fallback procedures and activity schedule for service cutover of each of the equipment of the Delivered System.

#### 15.2 Engineer's Safety Inspection and Audits

- 15.2.1 The Engineer will carry out a series of safety inspections and audits on the Contractor and his sub-contractors either independently or jointly with the Contractor's representative.

#### 15.3 Manpower Resources

- 15.3.1 In accordance with the timescales indicated in Clause 18, the Contractor shall submit a Contractor's Manpower Plan to the Engineer for Approval. The Contractor's Manpower Plan shall show the build-up and scaling down of resources both on site and at the Contractor's premises throughout the duration of the Contract sufficient to achieve the successful and timely completion of the Works. The Contractor's Manpower Plan shall include charts of the Contractor's project organization both at his home base and on site. The plan shall include indicative skill levels and experience for all members of the Contractor's team assigned to work for the Contract.

#### 15.4 Installation Practice

- 15.4.1 Installation undertaken by the Contractor on site shall be carried out in strict observance of the regulations contained in the Employer's Railway Safety Rules (RSR), electrical wiring standard and other safety documents. The Contractor shall prepare and submit an installation programme to the Engineer for site co-ordination before installation commences.

- 15.4.2 The Contractor shall provide competent staff, which shall have been qualified as Competent Persons by the Employer, for the supervision of all installation activities to ensure that all works are carried out conforming to the Employer's safety standards and RSR. All works shall be carried out according to the instructions of the Competent Person regarding site arrangement and safety issues.

- 15.4.3 The Employer shall organize training courses for Competent Persons and the Contractor shall appoint adequate numbers of engineers/supervisors to attend the training courses. Upon completion of the training course and passing the examination, the attendees shall be qualified as Competent Persons.
- 15.4.4 The Contractor shall pay fees to the Employer for attending the Competent Person training courses according to the schedule as indicated in GS Clause 15.2.4.3 d).
- 15.4.5 Prior to the cabling and equipment installation, the Contractor shall determine and obtain the Engineer's approval of the exact location and route on site. The Contractor shall produce two sets of drawings with mark-up arrangement, position and details of equipment location and cable routes and submit to the Engineer for approval. If the drawings are rejected by the Engineer (not approved), the Contractor shall reproduce the drawings at the Contractor's own cost and re-submit for the Engineer's approval.
- 15.4.6 All cables shall be neatly run and fitted in cable containments as appropriate. The arrangement, position and details of cable routes shall be shown on working drawings to be prepared by the Contractor and subject to approval by the Engineer.
- 15.4.7 All components shall be installed at the positions as approved by the Engineer and shall be securely fixed/supported.
- 15.4.8 Labels shall be supplied and fixed by the Contractor to all installed cables. Each cable section shall be labelled at both ends and at strategic locations, such as in the vicinity of wall/floor openings. Size and types of labels used and numbering scheme shall be submitted to the Engineer for approval.
- 15.4.9 The Contractor shall take every precaution to protect the existing equipment, civil structure and finishes from damage, and shall make good any damage caused by the Contractor's act or omission at the Contractor's own cost to the Engineer's satisfaction. The Contractor shall ensure that normal operation of the existing equipment shall not be interrupted during execution of the Works.
- 15.4.10 The Contractor shall be responsible for the cleanliness and tidiness of the work site after each period of work. Tools and materials shall not be left at site. At the end of each working period and before handing over, all work sites shall be thoroughly cleaned and restored to their original condition.
- 15.4.11 Works which will not affect the operation of the railway or cause disturbance to the public may be carried out during the traffic hours subject to the Engineer's approval. Otherwise, works shall

be restricted to non-traffic hours (approximately from 0100 to 0530 hours) subject to prior arrangement with the Engineer.

- 15.4.12 Electrical installation as a whole shall comply with and be tested in accordance with the latest edition of “Code of Practice” for the Electricity (Wiring) Regulations” as issued by EMSD. The electrical installation shall be carried out by a Registered Electrical Contractor/Worker under the enforcement of the Electricity Ordinance in Hong Kong.
- 15.4.13 The Contractor shall be responsible for the disposal of discarded materials after installation. The Contractor shall apply the Billing Account for Disposal of Construction Waste under Waste Disposal (Charges for Disposal of Construction Waste) Ordinance (Cap.354N) within 21 days of the Letter of Acceptance. The disposal procedure shall comply with the Code of Practice published by the Environmental Protection Department, the Government of the HKSAR.

## 15.5 Stress Analysis of Mounting Design

- 15.5.1 The Contractor shall submit stress analysis which shall be endorsed by Registered Structure Engineer employed by the Contractor on the proposed mounting design of each piece of equipment of the Delivered System for the Approval of the Engineer before the installation works. The analysis shall include stress calculations which verify the mechanical strength and the corresponding design margin of the proposed mounting against the environmental stress including shock and vibration conditions to be experienced in the trackside areas.

## 15.6 Construction Safety

### 15.6.1 Safety Management Plan

Within the timescales indicated in Clause 18, the Contractor shall submit a Safety Management Plan for Approval by the Engineer.

### 15.6.2 Works Safety Classification

The Works of the Contract are of Safety Classification 3.

## 16. INFORMATION SECURITY REQUIREMENTS

This Clause 15 specifies the requirements for information security requirement to be followed by the Contractor during the execution of the Contract.

### 16.1 General

- 16.1.1 The Contractor shall initiate, implement and maintain an information security management system reference to ISO/IEC 27002:2013 Code of Practice for Information Security Controls during the period of the Contract.
- 16.1.2 The Contractor shall assess the information security risk of the Delivered System depending on its vulnerability and review its posture regularly at different stages of the Contract. The Contractor may make reference to ISO/IEC 27005:2013 Information security controls.
- 16.1.3 The Contractor shall implement effective information dissemination mechanism to deliver updated security information, including the security policies, procedures, incident reporting and new potential information security threats.
- 16.1.4 The Contractor shall implement adequate security control on portable/removable devices, sensitive data/information, login name and password, external consultants, sub-contractors and temporary staff.
- 16.1.5 The Contractor shall ensure appropriate change control and patch management mechanism for the proper and regular update of network configuration, security patches and software applications.

### 16.2 Information Security Plan

- 16.2.1 The Contractor shall submit to the Engineer for Approval an Information Security Plan comprising the following:
  - a) information security plan control;
  - b) security organization and responsibilities of team members;
  - c) asset classification and control: to keep the inventory of the important items including information/data and network software and equipment;
  - d) personnel security;
  - e) physical and environmental security: to safeguard any unauthorized access and modifications to the Delivered System by any unauthorized parties;

- f) communications management including backup, restart and recovery and incident reporting procedures;
- g) access control;
- h) systems development and maintenance;
- i) business continuity management for critical systems to ensure that a plan on recovery is in place; and
- j) compliance: to ensure all provisions have proper licenses or agreements.

16.2.2 The Contractor shall update the Information Security Plan to suit the changes on the progression of the Works throughout the period of the Contract and submit the update Information Security Plan to the Engineer for Approval.

16.2.3 The Contractor shall implement the Information Security Plan and continuously maintain an effective information security management system in accordance with the Information Security Plan.

16.2.4 The Contractor shall submit details of the qualifications and experiences of the proposed security organisation for the Approval of the Engineer.

16.2.5 The Contractor shall monitor the security status and reported in the Monthly Progress Report any potential threats or attacks being identified.

### 16.3 Information Security Control Practice

16.3.1 The Contractor shall ensure that all parameters of the network equipment, including login name, passwords, IP address range and system configuration are properly configured and sufficient security control shall be implemented to prevent the disclosure of the details.

16.3.2 The Contractor shall develop procedures or means for immediate disabling of the Delivered System /network which had security incident occurred to limit the attack propagate to other system/network.

16.3.3 The Contractor shall assign different login name and password for system under test and after commissioning to reduce the risk of accidental log-on and other error. All tests shall be limited to the testing environment and with connection to the operating environment Approved by the Engineer.

- 16.3.4 The Contractor shall design and implement the user authentication in a way that all operator login passwords shall be prompted for regularly changes at 6 months intervals to reduce the risk of system hacking and intrusion.
- 16.3.5 The session timeout duration after successful user login shall be set long enough to avoid any interruption to the operation of system operators. The duration shall also be user-configurable.
- 16.3.6 The Contractor shall provide the following security management tools and procedures to ensure that controls are consistently applied.
- Anti-virus and anti-spyware systems to stop any wide spread of virus, worms and malicious code attacks. “Symantec Endpoint Protection” anti-virus software is being employed in the Employer’s existing virus definition server;
  - Firewalls and intrusion detection/protection system to detect the inbound and outbound network traffic, log any abnormal traffic and block those traffics;
  - Monitoring system to monitor security related activities and analyze the record on regular basis;
  - Regular system backup executed and stored in secured location; and
  - Unnecessary/unused embedded services and connection devices/ points to be disabled/disconnected.
- 16.3.7 The Contractor shall report to the Engineer immediately in case of any security violations or outbreaks are detected in accordance with the Approved incident reporting and recovery procedures.
- 16.3.8 All systems processing and/or storing project information shall have a method or procedure in place to create and review system logs for unauthorised access. Logs shall be stored within the Delivered System or on a centralised logging server, and shall be maintained for a minimum period of 3 years.
- 16.3.9 The Contractor shall implement and document procedures to regularly review records of information system activity, such as audit logs, access reports, and security incident tracking reports.

#### 16.4 Information Security Audit

- 16.4.1 The Contractor shall submit at the request of the Engineer any documents related to the information security management system,

including internal information security audit reports and sub-contractors' information security audit reports.

- 16.4.2 The Contractor shall be subjected to information security audits of the Contractor's information security management system as required by the Engineer. During the audit by the Engineer, the Contractor shall provide all necessary access, assistance and facilities to enable the Engineer to verify that the Information Security Plan is being properly and fully implemented. The Contractor shall assign suitably qualified staff to accompany the Engineer in the audits. The Engineer will provide reasonable notice to the Contractor on the audit scope and schedule.
- 16.4.3 Following an audit by the Engineer, the Contractor shall carry out corrective actions, improvement and any recommendation required by the Engineer. The Contractor shall provide evidences to the Engineer to demonstrate that all Approved actions have been satisfactorily completed by the agreed completion dates.

## 16.5 Cyber and Network Security

- 16.5.1 The Contractor shall apply all software patch updates to the Delivered System prior to the T&C stage.
- 16.5.2 After the start of T&C stage, no software patch shall be allowed to load on the Delivered System under test.
- 16.5.3 All subsequent software patches created after the T&C stage shall be first loaded into the software development and testing facilities for testing to ensure no negative impacts and problem-free to system operation before submission to the Engineer for approval of loading into the Delivered System.
- 16.5.4 For any equipment that are not installed with the corporate-wide Symantec Endpoint Protection anti-virus software, the Contractor shall provide alternative means of end-point protection subject to the prior approval by the Engineer.
- 16.5.5 The Contractor shall ensure full compliance with the requirements stated in Appendix AF Design Standard – Network Security for OD Data Network and Systems when performing the network and security design of the Delivered System.
- 16.5.6 The system control MMI shall be completely loaded and successfully run on Microsoft Internet Explorer 11.0 or higher in any OA PCs without any additional plug-ins or add-ons components (e.g. Active X control and flash player) installed.

- 16.5.7 The system control MMI shall be accessible by authorized users only. “Change Password” function shall be available for each user to change passwords.
- 16.5.8 The system control MMI shall be reachable by entering a domain name in a supported browser.
- 16.5.9 The Contractor shall establish account management by enforcing user account password history tracking, fixed the number of years for storage account password tracking, with password storage using irreversible encryption to prevent hacker’s intrusion.
- 16.5.10 The Delivered System shall be able to determine the number of unique new passwords a user can use before reusing any old password.
- 16.5.11 The Delivered System shall be able to determine the number of days the current password can be used before expiry. The value of the setting shall be configurable from 0 to 180.
- 16.5.12 The Delivered System shall be able to determine and configure the minimum number of days a password shall be kept to allow password history enforcement to prevent quickly changing passwords by the users.
- 16.5.13 The Delivered System shall allow password length configurable between 8 to 28 characters.
- 16.5.14 The Delivered System shall be able to determine the composition of the user passwords satisfying the complexity requirements which shall include mixed use of uppercase, lowercase English characters, number digits and non-alphabetic characters.
- 16.5.15 The Delivered System shall be using irreversible password encryption to prevent cyber-attacks by circumventing the password using reversible encryption to log on the network of the Delivered System.

## 16.6 Information Security Risk Assessment and Mitigation

- 16.6.1 The Contractor shall conduct information security risk assessment on the Delivered System to identify and quantify the information security risk threats and vulnerabilities for the Delivered System and determine their implications (e.g. financial, safety, business operational performance, legal or regulatory, and political or reputation) to the Employer.

16.6.2 Based on the result of the information security risk assessment, an Information Security Risk Mitigation Plan shall be established in the design stage of the Delivered System and be submitted to the Engineer for endorsement. All identified risks shall be ranked using the MTR Security Risk Evaluation Matrix as specified in Appendix P to indicate their risk level. All SeR1 and SeR2 items shall be resolved before the commissioning of the Delivered System.

## 17. PROGRAMME

### 17.1 Programme

The Contractor shall develop and submit for the Engineer's Approval the Master and Detailed Programmes detailing the various activities of the works based on the following key dates.

<u>Milestone</u>	<u>Completion Date</u>
Contract Award	: Week 0 (Tentatively in July 2023)
System Design	: Week 4-8
Prototype	: Week 12
Equipment Delivery	: Week 24
Installation	: Week 24
Training	: Week 44
Testing and Fine-Tuning	: Week 44
System cut in/cut over	: Week 50
Completion of the whole of the Works	: 30 July 2024

The M-Trains are scheduled to be disposed in stages. The tentative schedule of remaining M-train that will be in service is listed below:

December 2024	:	79 Trains
December 2025	:	68 Trains
December 2026	:	44 Trains
December 2027	:	32 Trains
December 2028	:	20 Trains
June 2029	:	All M-Trains will be disposed

17.1.1 The date of commencement of the Works shall be the date of the Letter of Acceptance.

17.1.2 The Contractor's Master Programme shall clearly state the dates by which information to be provided by the Engineer is to be delivered.

### 17.2 Constraints on the Programme

The Contractor shall implement all site installation and commissioning activities whilst adhering to the programme constraints as described below:

#### 17.2.1 Documentation for Testing and Commissioning

A "working copy" of the Test and Commissioning Plan of the Works including procedures and the necessary drawings shall be available to the Engineer at least 10 days prior to the

commencement of any testing and commissioning activity of the Works.

#### 17.2.2 Design Submission

The Contractor shall obtain the Engineer's Approval of system design and installation design prior to any installation works. The Contractor shall include the time required for the Engineer to conduct design review on the submission as well as the time required for any necessary re-submission.

A stamp indicating the Approval status will be applied by the Engineer to each drawing submitted by the Contractor. The Contractor's person-in-charge at the work site shall be required to present such drawing together with all comments given by the Engineer. Failure to do so shall lead to suspension of installation works at the concerned work site at the Contractor's own cost.

## 18. SUBMISSIONS

The Contractor shall note that, except for those listed in the following table or specified otherwise, all submission requirements as described in the General Specification for E&M Works shall not apply.

Clause Reference	Submission	Submission Date	Type of Review
GS 12.2.2	List of Workman's Names	5 days before the commencement on site of any workman	Information
GS 10.1.1	Key Personnel	30 days from Commencement of the Works	Approval
GS 10.4.1	Contractor's Master Programme	30 days from Commencement of the Works	Approval
GS 10.4.2	Contractor's Detailed Programme	Within 30 days from Approval of Contractor's Master programme	Information
GS 10.4.3	Contractor's 4 Week Rolling Programme	Weekly	Information
PS 14.2	Submittal List	30 days from Commencement of the Works	Comment
PS 7.1.1	Safety Management Plan	30 days from Commencement of the Works	Approval
PS 14.6	Quality Plan	30 days from Commencement of the Works	Approval
GS 10.9.1.4	Names of Manufacturers of materials and equipment	30 days from Commencement of the Works	Approval
GS 9.3.3	Reliability Plan	30 days from Commencement of the Works	Approval
PS 7.3	Project Hazard Log	Within 60 days from the date for Commencement of the Works	Approval
PS14.4.1	System Design Plan	45 days before the commencement of the design and development for the Delivered System	Approval
PS 15.1.5	Installation Plan	28 days from Commencement of the Works	Approval
PS 8.4.1	FAT Plan	14 days before the Commencement of the first Factory Acceptance Test to be conducted	Approval
PS 8.4.1	FAT Report	7 days after FAT	Approval
PS3.3.11	Prototype Test Plan	30 days from Commencement of the Works	Approval
PS3.3.11	Prototype Test Report	90 days from Commencement of the Works	Approval
PS4.10	HMI design plan	30 days from Commencement of the Works	Approval
PS 9.4.2	RDT Plan	14 days before the commencement of the RDT for the Works	Approval
PS 9.4.3	RDT Report	7 days after RDT	Approval
PS 10.1.1	List of Spare, Special Tools & Test Equipment	7 days before the commencement of the site works	Approval

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PS 8.11	SAT Plan	14 days before the Commencement of the first Site Acceptance Test to be conducted	Approval
PS 8.11	SAT Record	14 days after each SAT	Approval
PS 11.2	Training Plan	8 weeks before commencement of training	Approval
PS 11.2.3	Training Manual	14 days before commencement of training	Approval
PS 12.1.1	As-constructed Drawings and data files	2 weeks after completion of T&C	Approval
PS 12.1.4	Operations and Maintenance Manual	4 weeks after completion of work	Approval

**19. LIST OF APPENDICES**

Appendix A	Contractor Fitness for Duty Management
Appendix B1	Proposed Installation Location
Appendix B2	CADD Drawing of the Mounting Panel
Appendix C	Conceptual System Diagram (For Reference Only)
Appendix D	Interface Demarcation with UPIP
Appendix E	Design Standard for Operations Software
Appendix F	Materials and Workmanship Standard for Rolling Stock Electrical Equipment
Appendix G	Engineering Drawing Standard
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Appendix I	Cable Installation Standard
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Appendix M	Maintainability and Testability Standard
Appendix N	Reliability and Availability Engineering Standard
Appendix O	Material and Workmanship Standard for Rolling Stock Mechanical Equipment
Appendix P	MTR Security Risk Evaluation Matrix
Appendix Q	Schedule of Completion Obligation

## **Appendix A - Contractor Fitness for Duty Management**

### **Definition of Fitness-for duty**

1. Fitness-for-duty means that an employee is in a physical, mental, and emotional state which enables him/her to perform the essential tasks of his or her work assignment in a manner which does NOT threaten the safety or health of oneself, co-workers, property, or the public at large.

### **Contractor Fitness for Duty Management Requirements**

2. The Contractor shall establish systems for ensuring all direct & in-direct workers performed physical duties not suffering from physical and/or mental conditions, or being taking medical treatment likely to cause:
  - sudden loss of consciousness;
  - impairment of awareness or concentration;
  - sudden incapability;
  - impairment of balance or coordination
  - significant limitation of mobility.
3. The Contractor shall set up test system at work site against use of drugs & alcohols.
4. The Contractor shall disseminate information provided by the Employer on any “Contractor Fitness for Duty Management” to workers and other persons that are likely to be affected.

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### **Appendix B1 – Proposed Installation Location**



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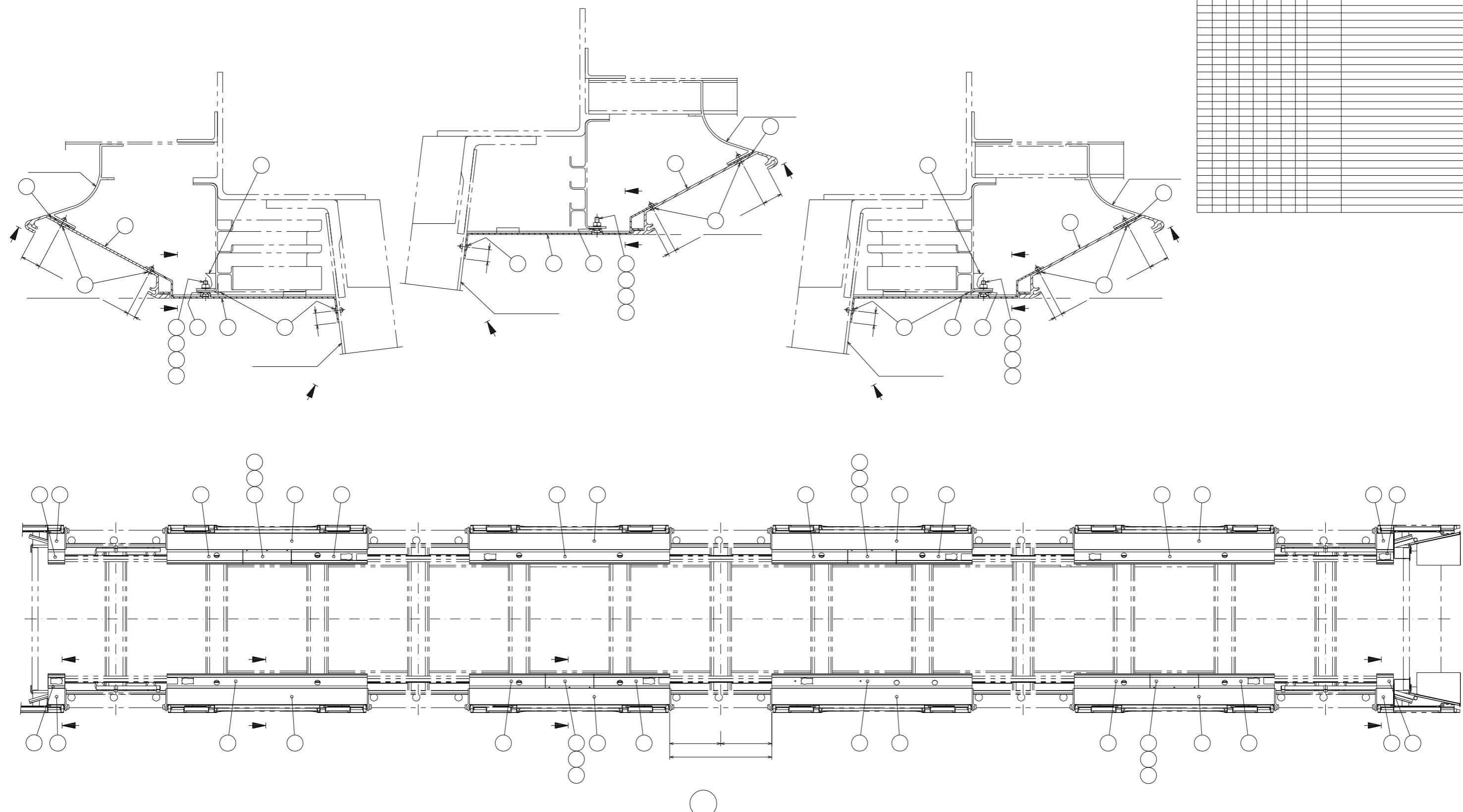
Contract C3855-22E

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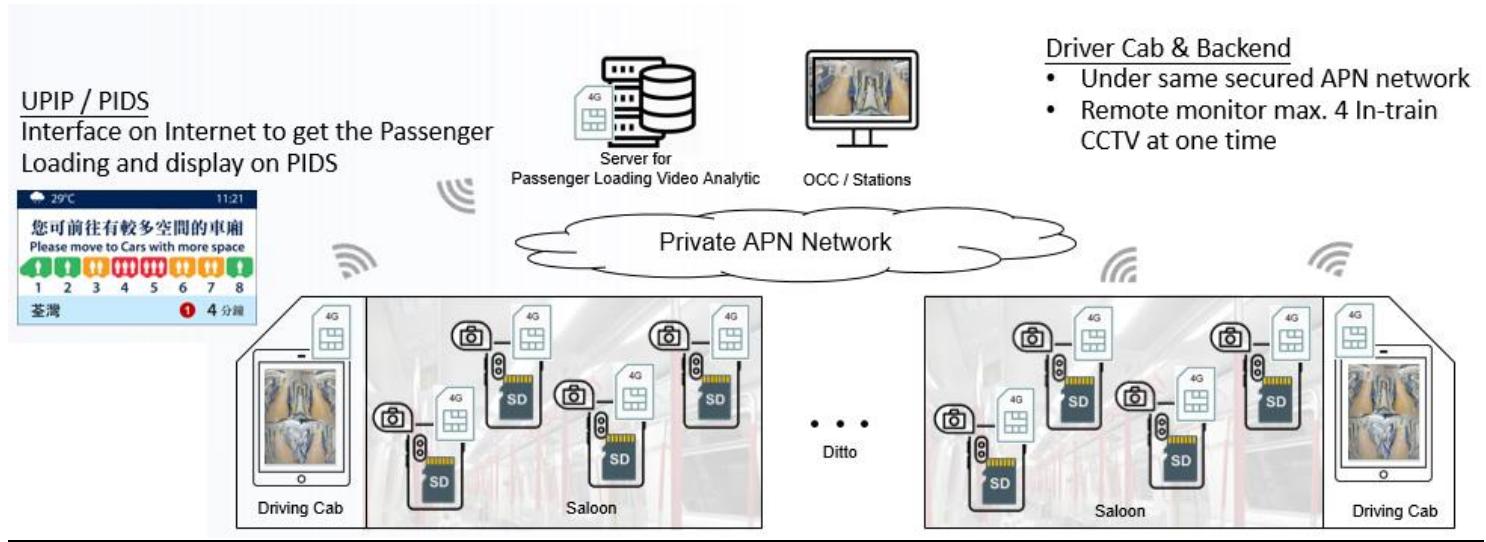
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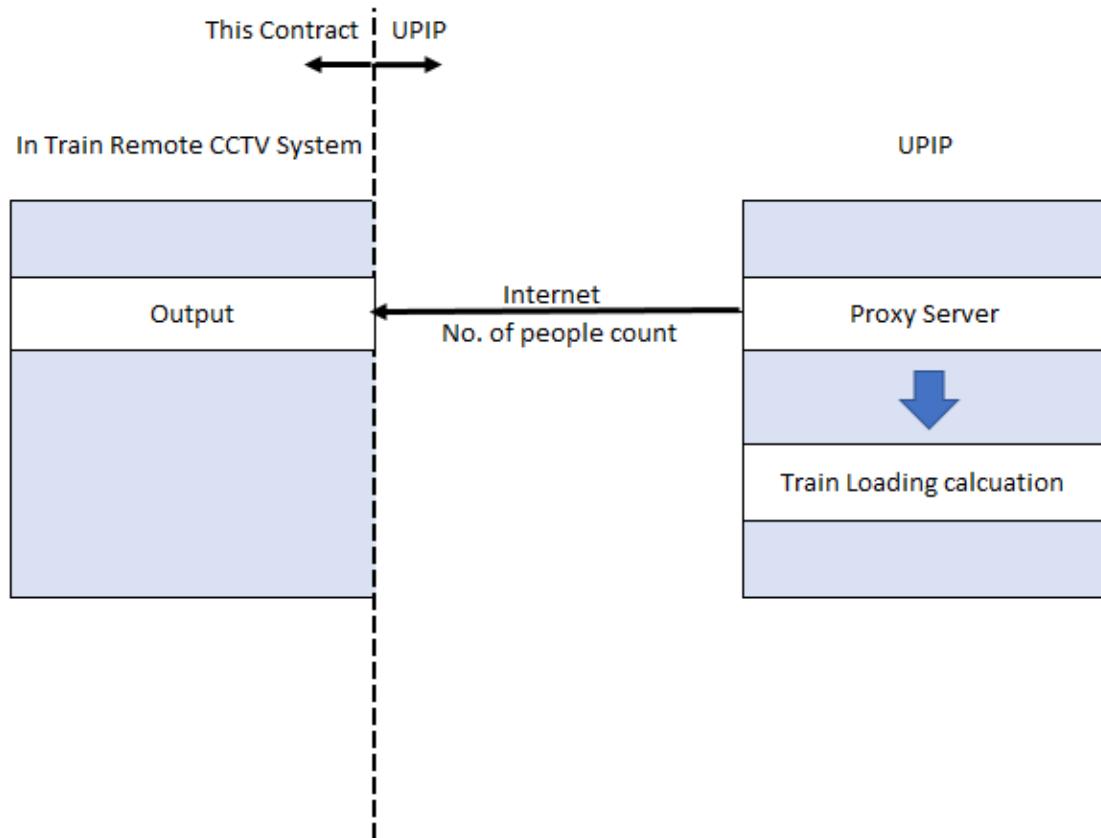
**Appendix B2 – CADD Drawing of the Mounting Panel**





### Appendix C – Conceptual System Diagram (For Reference Only)



**Appendix D Interface demarcation with UPIP**

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**Appendix E      Design Standard for Operations Software**

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Issue: 1 Design standard for Operations software for incorporation by OSMO in Particular Specification

Revision: 2

22 February 2018

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# **Design standard for Operations software for incorporation by OSMO in Particular Specification**

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**DEFINITIONS**

Confidence Level	A classification assigned to a software product to indicate the sensitivity of a possible fault within the software to its impact on people or service. The classification is related to safety, customer service, environmental obligations and revenue.
Development Level	<p>It is classified as Level A, B and C.</p> <p>The Development Level of a software package is defined as C if the software package is a commercial off-the-shelf software package with a demonstrable installation base, release history, and proper user documentation.</p> <p>The Development Level of a software package is defined as B if the software package is existing software with changes less than 20% of the functional or technical requirements. The existing software is one which has been used in a similar project at least 6 months prior to the commencement of this work, and which has not been changed since then.</p> <p>The Development Level of a software package is defined as A if neither B nor C is applicable.</p>
Metrics	A quantitative indication of a particular aspect or characteristic of the software. Metrics cover both the software development process and the output from the process, including the software and documentation.

## **1. SOFTWARE PROCESS MANAGEMENT**

This document specifies the software process management requirements for all the software elements supplied under this Contract.

### **1.1 General requirements**

#### **1.1.1. Software strategy**

The Contractor shall adopt a pro-active strategy for the monitoring and control of the Contractor's activities when there is a software element in the supply. The approach adopted is designed to ensure that the complexity of software is controlled and that the software development process remains highly visible throughout the Contract. The approach also ensures that the relevant good engineering practice is applied to software and that it is possible to demonstrate conformance with the Contract requirements.

#### **1.1.2. Development methodology**

These general software process management Clauses are applicable to all software supply irrespective of the technology base and the development methodology used, they also apply to those systems which only utilize proprietary based products. Although the software Clauses are based on a conventional software development reference model the Contractor shall utilize the development model(s) most suited to the application and the system technology.

#### **1.1.3. Development model**

The Contractor shall obtain approval by the Engineer of his proposed development model(s) prior to commencing any software development. The mechanism by which this is to be achieved is the mapping, in the Software Quality Plan, of the proposed development model(s) against the reference model. All the requirements described in Clauses 1.1 to 1.18 shall be addressed during this mapping.

#### **1.1.4. Third party software**

Where the software is to be provided by an organization other than the Contractor, then the Contractor shall pass on all requirements in their entirety and without modification. The commercial-off-the-shelf software with discontinue announcement of technical support shall not be chosen unless there is no alternative from market and explicit approval is sought from the Engineer.

## 1.2 Software Quality Plan

Within the timescales indicated in **Submission Schedule**, the Contractor shall submit the Preliminary Software Quality Plan for comment by the Engineer. The Preliminary Software Quality Plan shall clearly define those activities relating to the supply of software.

Within the timescales indicated in **Submission Schedule**, the Contractor shall submit a Final Software Quality Plan for approval by the Engineer. The Final Software Quality Plan shall include the Preliminary Software Quality Plan and shall take into account the Engineer's comments on the Preliminary Software Quality Plan.

If the Software Quality Plan is revised at any time during the Contract then the proposed changes shall be submitted to the Engineer for review. Changes to the Software Quality Plan shall only be made with the approval of the Engineer. Any changes made to the Software Quality Plan shall accord to the Contractor's configuration management procedures.

The Software Quality Plan covers not only the Contractor but also Subcontractor and Suppliers as well.

The Software Quality Plan shall use the same terminology as used in this Particular Specification and shall include the requirements described below:

- a) Clearly define the responsibilities and authorities of the key personnel responsible for the development, testing and integration of the software. The interfaces between the personnel identified in the Software Quality Plan and the personnel specified in the Quality Plan shall be shown.
- b) Clearly define the organizational and working relationships between the Contractor, sub-contractor and all the suppliers.
- c) Clearly define the minimum skill and experience levels required for engineering personnel involved in modifying and developing software, including auditing, testing and Metrics activities.
- d) Make reference to the Software Definition Specification which will identify the software products and identify and justify the software development status and Confidence Level that has been assigned to each.
- e) Identify the software work packages(s) to be produced and the Development Level that have been assigned with detailed justification. If prototyping techniques are employed for development, then the associated software work package(s) shall be of Development Level A and detailed development and control procedures shall be submitted.
- f) Clearly define the scope and extent of software re-use.

- g) Clearly define the software lifecycle(s), including mapping against the reference model, (refer 1.4), that shall be used to control the supply and development of each software product.
- h) List the inputs into and the outputs from each lifecycle phase. The list shall contain both software and documentation, (refer 1.5).
- i) List all the contractual deliverables.
- j) Specify the guidelines, standards, Codes of Practice, methodologies, languages and tools to be applied at each lifecycle phase.
- k) Make reference to the Contractor's quality control and quality assurance procedures, including the procedures for configuration management that will apply to this Contract.
- l) Clearly state the review activities and schedule; this shall clearly differentiate between internal activities and those which involve the Engineer.
- m) Discuss all the internal and external risks including programme slip, uncontrollable external factor, supplier's staffing and experience involved and the contingency planned.
- n) Specify or reference the procedures to be adopted to ensure the security of the software.
- o) Identify the quality control methods for software work products. Suggested method of presentation is given in the following table:

No.	Software Work Product	Review	Test
1	Requirement Specification	✓	
2	Project Plan & other plans	✓	
3	Design documents	✓	
4	Test Specification / data	✓	
5	Program code	✓	✓
6	Integrated code		✓
7	Final product code		✓
8	User Manual	✓	

### 1.3 Software Definition Specification

In accordance with the timescales indicated in **Submission Schedule**, the Contractor shall produce a Software Definition Specification which shall be submitted to the Engineer for review.

The Contractor shall maintain the Software Definition Specification in a current state throughout the Contract and shall resubmit to the Engineer for review if any revisions shall occur. The Software Definition Specification shall fully describe for each standard, customized and developed software product the following information:

- a) Product name.
- b) The current version number with release date.
- c) Manufacturer and country of manufacture.
- d) Description, including product type (e.g. database, operating system, alarm handling application) and principal features together with how they are implemented (e.g. records entered and displayed in a Windows environment).
- e) System requirements, including operating system (name and version), disk and memory requirements and hardware platform.
- f) The particular item(s) of equipment on which it is loaded, including name, model, manufacturer, main function.
- g) The software development status with justification.
- h) The software Confidence Level with justification.
- i) Compliance to national or international standards, including title, reference number and standards organizations.

For customized and developed software the following additional information shall be included:

- j) The software language(s) used.
- k) The development tool(s) used, including name, manufacturer, version and release date for each tool.
- l) The development machine(s) used, including name, model and manufacturer.

## 1.4 Software lifecycle

### 1.1.5. Software lifecycle mapping

The Contractor shall define in the Software Quality Plan a software lifecycle, or lifecycles, to be used for the development, test and integration of software. The basis on which the Contractor chooses a particular lifecycle(s) shall include the system technology, available development methodologies and the software classification. The Contractor shall map the phases of the defined software lifecycle(s) against the phases of the lifecycle described in Figure 1. The reference model lifecycle in Figure 1 is not intended to imply that a strict sequential development must be used; lifecycles incorporating elements of concurrency shall be proposed.

### 1.1.6. Individual software lifecycles

The development of the Delivered System may be composed of a number of smaller developments each having their own lifecycle which come together at an integration phase. The Contractor shall show clearly, in the Software Quality Plan, how the individual lifecycles are inter-related.

### 1.1.7. Software classifications

When developing systems which contain software products with different software classifications, the Contractor shall make it clear in the Software Quality Plan which phases and activities apply to the different classifications. All software within a software product shall have the same development status.

### 1.1.8. Contractor's activities

For the purpose of this Particular Specification the activities to be performed by the Contractor have been stated in terms of the phases identified in Figure 1, the Contractor shall ensure the requirements stated in Figure 1 are incorporated within the defined lifecycle.

### 1.1.9. Software lifecycle model

In terms of Figure 1 the software lifecycle phases are described below:

- a) Requirements Definition and Analysis, the Contractor shall refine both the Engineer's conceptual and precise requirements, as set out in the contract documents, into the System Requirements Specification. This specification shall detail both the functional and non-functional requirements for the system and shall be complete and precise. This phase shall include hazard analysis and risk assessment activities.
- b) Overall System Design, the Contractor shall define the basic system and associated test requirements. Based on the overall Delivered System design the Contractor shall express the requirements and functions of the software.
- c) Software Architectural Design, the Contractor shall define the software architecture to achieve the software requirements. In this phase the Contractor shall identify all software modules.
- d) Detailed Software Design, the Contractor shall completely specify the software modules identified during the architectural phase.
- e) Software Module Coding, the Contractor shall code the individual software modules. The module testing performed to ensure that the modules fulfil their specification shall be in accordance with 1.11.6.1.
- f) Software Integration, the Contractor shall integrate the tested software modules, programs, and software products, to produce the complete software. The software integration testing shall conform to the requirements of 1.11.6.2.
- g) System Integration, the Contractor shall integrate the tested software with the hardware to form a complete system. The testing of the complete system shall be in accordance with the requirements of 1.11.6.3.
- h) System Acceptance, during this phase the Delivered System will be formally accepted by the Engineer.
- i) Maintenance, during the period of maintenance, the Contractor shall implement a controlled cycle of procedures for software maintenance.
- j) Validation, the Contractor shall validate the software.

## 1.5 Documentation

### 1.1.10. Documentation mapping

The Contractor shall state in the Software Quality Plan the documentation to be produced during each lifecycle phase. The documentation associated with the lifecycle phases shown in Figure 1 is specified in Tables 4 and 5. The Contractor shall map in the Software Quality Plan all the documentation to be produced for this Contract to Tables 4 and 5. Changes in name, documents that incorporate more than one of the documents presented in Tables 4 and 5, and documents not to be produced due to a reduced software lifecycle shall be identified.

### 1.1.11. Other documents

The following documentation shall be submitted for approval by the Engineer:

- a) System Design Specification.
- b) Software Requirements Specification.
- c) Software Design Specification.
- d) Test Plans, Specifications and Reports for software and system integration.
- e) Verification Plans and Reports.
- f) Validation Plans and Reports.
- g) Factory Acceptance Test Plan and Report(s)
- h) Site Acceptance Test Plan and Report(s)
- i) Post acceptance documentation.

### 1.1.12. Control of software documents

The Contractor shall ensure that the software and supporting documents are held under the configuration management procedures applicable to the Contract.

### 1.1.13. Design documentation

The design documentation required for this Contract is described below:

#### 1.1.13.1. Software Requirements Specification

Within the timescales indicated in **Submission Schedule**, the Contractor shall submit a Software Requirements Specification for approval by the Engineer. The Software Requirements Specification shall define what the software is to do, including operational requirements, and how it shall interface with other systems and the outside world. The specification shall state the requirements completely, clearly and unambiguously, such that each requirement can be verified.

#### 1.1.13.2. Software Design Specification

Within the timescales indicated in **Submission Schedule**, the Contractor shall submit a Software Design Specification for review by the Engineer. The Software Design Specification shall describe the functions, structure and content of the software from its highest to its lowest level (module). Included within the Software Design Specification shall be detailed data structures.

A variety of descriptive techniques shall be used within the Software Design Specification, as appropriate to the development methodology and techniques available. The descriptive techniques shall include the following:

- a) Data flow diagrams.
- b) Data dictionary/entity relationships.
- c) Object oriented notations.
- d) State transitions.

#### 1.1.13.3. Software Module Design Specification

Within the timescales indicated in **Submission Schedule**, the Contractor shall submit a Software Module Design Specification for review by the Engineer. The Software Module Design Specification shall define the internal processing of each software module identified in the Software Design Specification.

A variety of descriptive techniques shall be used within the Software Module Design Specification, as appropriate to the development methodology and techniques available. The descriptive techniques shall include the following:

- a) Pseudo code.
- b) Structure chart.
- c) Flow chart.

#### 1.1.13.4. Software Requirement Matrix

Each life cycle phase produces documents except the coding phase, which produces source code. The Requirement Traceability Matrix document (or documents) shall trace each requirement to source code and test script / test specification / parameter file. Requirements get mapped to Software Requirement Specification, Software Design Specification, Software Module Design Specification and Test Documentation.

#### 1.1.14. Test documentation

The purpose of the test documentation is to progressively demonstrate that the technical requirements have been met for the corresponding design phase. The documents defining the tests shall be produced alongside the corresponding design specification. The testing required to be performed by the Contractor is defined in 1.11.

##### 1.1.14.1. Test Plans

Test Plan(s) shall define the philosophy, objectives and schedule of the test activities to be performed. The Test Plan shall state the roles and responsibilities for those involved in the testing, the test methods to be used and the resources required for the testing. Test limitations should also be identified.

Test Plan(s) shall describe the testing commensurate with the level of software design. The Contractor shall combine the individual Test Plans within the overall System Acceptance Test Plan.

##### 1.1.14.2. Test Specifications

Test Specification(s) shall define in complete detail the testing to be conducted on the Delivered System. Test Specifications shall be produced for each test phase and derived from the associated Test Plan and design documentation.

Test Specification(s) shall describe the actual tests to be performed, the test configuration, expected outputs and acceptable limits for defined inputs, and the Metrics to be calculated. Test Specification(s) shall cover error and fault conditions as well as normal operation. Each test defined shall clearly reference the design item within the design documentation which is being tested.

#### 1.1.14.3. Test Reports

Following completion of the tests the Contractor shall prepare a Test Report. The Test Report shall list all the test results, including version details, Metrics, unexplained incidents, and non-conformances to the Test Specification, if any, with reasons and follow-up actions.

#### 1.1.15. Verification documentation

The Verification conducted during a design phase shall be governed by a Verification Plan. The Verification Plan for each phase shall be combined into an overall Verification Plan.

The results of the verification shall be recorded in a Verification Report. Rather than presenting a Verification Report for each design phase, the Contractor shall combine the individual reports into an overall Verification Report.

Within the timescales indicated in **Submission Schedule**, the Contractor shall submit all Verification Plans for approval by the Engineer.

Within the timescales indicated in **Submission Schedule**, the Contractor shall submit all Verification Reports to the Engineer for review.

#### 1.1.16. Validation documentation

The Contractor shall define in the Validation Plan, the Validation to be undertaken to demonstrate compliance with the technical requirements.

The results of the Validation shall be recorded in the Validation Report.

Within the timescales indicated in **Submission Schedule**, the Contractor shall submit all Validation Plans for approval by the Engineer.

Within the timescales indicated in **Submission Schedule**, the Contractor shall submit all Validation Reports to the Engineer for review.

#### 1.1.17. Post acceptance documentation

The purpose of post acceptance documentation is to describe the Delivered System as installed and to provide sufficient information for users, maintainers and developers to execute their responsibilities throughout the working life of the Delivered System.

#### 1.1.18. Development documentation

A full set of documentation shall be provided for each development environment, including standard software packages, which shall include the following:

- a) System Manual
- b) Reference Manual
- c) User Manual
- d) Installation Manual
- e) Programming Manual
- f) Quick Reference Guide
- g) Tutorial Manual
- h) Release Note

Within the timescales indicated in the approved Design Plan, the Contractor shall submit the development documentation for approval by the Engineer. Any deviations from this list shall be subject to prior written approval of the Engineer.

### **1.6 Project management**

The Contractor shall create and maintain a software programme for each software product linked to the Contractor's Detailed Programme. The activities shown on the software programme shall as a minimum separately show each defined lifecycle phase for each software product, and the manpower resources allocated to each individual activity. The software programme shall show all review points.

The Contractor shall decide the control points in the project life cycle where measurement results will be compared with the performance target range. The followings are suggested measurements:

- a) Effort variance for project life cycle phases can be checked at the end of the phase.

- b) Schedule slippage can be checked for work products including mid term deliveries.
- c) Document quality can be checked at the end of document review activity.
- d) Program / Module code quality can be checked at the end of code walkthrough and test activity.

## **1.7 Software configuration management**

### **1.1.19. Configuration management tools**

At contract award, the Contractor shall place all software items under the control of a software configuration management tool.

Configuration management tools shall be used to assist with the configuration management process. These shall include the use of automated software source code management tools to control the development of individual software modules.

### **1.1.20. Configuration management software items**

The Contractor shall define and implement a mechanism to enable the unique identification, content and build state to be determined for each software product and its constituent parts down to module level. The software product and its constituent parts down to module level shall form the configured items held under configuration control. The configuration control process shall identify the current and historic status of each configured item. The Contractor shall be able to demonstrate that a specific configuration of software can be rebuilt.

## **1.8 Software development**

The software development shall be in accordance with the requirements described below:

### **1.1.21. Quality management system**

The Contractor shall develop or modify the software under an established quality management system meeting the requirements of ISO 9000-3 "Guidelines for the application of ISO 9001 to development, supply and maintenance of software", unless otherwise agreed with the Engineer. In the event of a conflict between ISO 9000-3 and the Particular Specification, the requirement of the Particular Specification shall take precedence.

If the Contractor's quality system is not registered by an accredited third party as meeting ISO 9001 "Quality Systems - Model for quality assurance in design, development, production, installation and servicing" July 1994 with a scope which specifically includes the software development process to be used for the project, then the Contractor shall demonstrate conformance to ISO 9001 (using ISO 9000-3 as guidance) to the Engineer or his representative.

The Contractor shall inform the Engineer of any need to reclassify the software in terms of the software development status or Confidence Level.

#### 1.1.22. Analysis & design methods

The Contractor shall adhere to recognized analysis and design methods during the software requirements phase and throughout the design process. The methods shall be supported by a CASE tool. These tools shall provide automated facilities to verify the system requirements throughout the phases of the lifecycle.

#### 1.1.23. Software languages

The Contractor shall use high level strongly typed languages defined in an internationally recognized standard for all software developments.

- a) For industrially based control equipment, such as Programmable Logic Controllers (PLC's), proven programming languages and methods defined in an internationally recognized standard, such as IEC-61131, sequential function charts, function block diagrams, structured text, or ladder diagram, shall be used. Low level control languages equating to assembly or machine code, such as instruction list, shall not be used for any part of the software development without the prior approval of the Engineer.
- b) Where object oriented programming is employed, as part of an overall object oriented analysis and design methodology, an extension to an ISO/ANSI language standard is recommended.
- c) For systems which provide database facilities an ISO Structured Query Language (SQL) compliant interface shall be provided.

#### 1.1.24. Choice of software development framework

The Contractor shall choose a suitable framework based on considerations such as popularity and community use, design philosophy, system domain, technical support, security, licensing compliance, documentation availability, resources on market, etc.

#### 1.1.25. Customized middleware

In circumstances where the Contractor proposes to acquire customized middleware, the Contractor shall make sure the customized middleware is written in the same language as the original code and/or that areas of code are written in a different language if special constraints apply, for example timing or input/output operations, or knowledge based systems. The Contractor shall make a written proposal to the Engineer and shall obtain his approval prior to using any such language.

#### 1.1.26. Codes of Practice

The Contractor shall modify or develop software to defined Codes of Practice for each language used. The Codes of Practice shall define the design rules, prohibited features and layout rules appropriate to the language or programming method. These rules should address the followings:

- a) Source code or diagram layout
- b) Commenting
- c) Module header blocks
- d) Module length and complexity
- e) Naming and type conventions
- f) Use of common/global data
- g) Loop and condition constructs
- h) Defining and prohibiting bad practice specific to each language
- i) Avoidance of the use of unconditional jumps
- j) Excluding the use of recursive structures
- k) Excluding the use of pointers based on arithmetic calculations
- l) Excluding the use of software interrupts

#### 1.1.27. Compiler/Code generators

The Contractor shall only use compiler/code generators which have at least one of the followings:

- a) An independent compliance certificate against a recognized industry standard for the compiler or code generator, or
- b) Demonstrable evidence of widespread use in the current version, or

- c) Demonstrable evidence of widespread use in the previous version with a description of the modifications and testing performed in developing the current version.

The Contractor shall use the latest version of a compiler. No undocumented or non-standard feature of the language, compiler/code generator, or operating system shall be used.

If Integrated Development Environment (IDE) project file or script/make file is not developed, configuration of compiler/code generator shall be properly documented and included in the source code and package baseline.

#### 1.1.28. Software re-use

For software of Development Level A and B, the Contractor shall employ software reuse techniques wherever practicable in order to minimize the development, coding, testing, documentation, and maintenance activities. The Contractor shall identify in the Software Quality Plan the scope and extent of software re-use within the development for each software product and adhere to the requirements described below:

- a) The first instantiation, i.e. the original or parent, of any software design, module, program or product which is to be modified and re-used shall be developed in line with all the requirements for its software classification.
- b) Software shall not be re-used for any application requiring a higher Confidence Level than that for which it was originally developed.
- c) Re-usable software shall not be issued for re-use until its development lifecycle and documentation are complete, including reviews, testing, and Metrics analysis (if appropriate).
- d) The Contractor shall not modify any aspect of a re-used item of software.
- e) All re-used software items shall be clearly identified as such and shall include a reference allowing traceability to the original.
- f) The Contractor shall not be required to repeat for each instantiation of a re-usable software item those phases of the development lifecycle which have been completed for the first (original) instantiation. Integration testing shall be required.

## **1.9 Development methodologies & tools**

The development methodologies and tools to be used on this Contract are described below:

### 1.1.29. Structured analysis & design methods

Structured analysis and design methods shall provide for the following:

- a) Requirements capture.
- b) Consistency checking.
- c) Decomposition development in manageable stages.
- d) Verification facilities.
- e) Traceability between representations.
- f) Control and data flow diagrams.
- g) Real time extensions.
- h) Entity relationships for database definition.
- i) State transition diagrams.
- j) CASE tools supporting structured analysis and design methods shall have the following features:
  - i. Strong support for the Contractor's development methodology utilizing as many of the CASE tool facilities as beneficial in support of such methodology.
  - ii. Output merge into documentation.
  - iii. Diagram generation.
  - iv. Data dictionary.
  - v. Leveling.

### 1.1.30. Object oriented analysis & design methods

Object oriented analysis and design methods and associated CASE tools shall provide for and support the following:

- a) Object definition.
- b) Attribute definition.
- c) Representation of inheritance.

- d) Object communications.
- e) Definition of class structures.
- f) Definition of subsets.
- g) Definition of instance connection and message paths.
- h) Use of programming languages with inherent data structures for Classes, Operations, and Inheritances.

#### 1.1.31. Industrial control equipment

Analysis and design methods for industrially based control equipment shall possess the same features as defined for structured analysis and design. At the detailed design level the Contractor shall include structured techniques such as Grafset and sequential function charts.

CASE tools used for industrially based control equipment shall be the equipment manufacturer's proprietary product. Third party tools may be proposed, with a written justification, by the Contractor but shall be subject to the Engineer's agreement.

### 1.10 Reviews

The Contractor shall define the review programme as part of the software programme. In establishing the review programme the Contractor and Engineer shall agree which activities shall be attended by the Engineer or designated representative. All of the Contractor's review activities shall be conducted to defined procedures. Reviews to be performed include:

#### 1.1.32. Specification reviews

The specification review is concerned with ensuring that the requirements, design and test specifications generated during the lifecycle adequately specify the software to be produced and the criteria on which the software shall be judged. A record of a specification review shall be kept. A minimum of two specification review shall occur to determine the following:

- a) Ensure the document conforms to project standards.
- b) Confirm the adequacy of the technical solution.
- c) Ensure the document is complete, clear and unambiguous.

#### 1.1.33. Module code review

All coded software shall be examined critically to ensure the code follows the software design and conforms to the required programming standards. As a minimum the module code review shall 'walk-through' the software listings. A record of a module code review shall be kept. The module code review shall include the following items:

- a) Proper translation of design into code
- b) Proper use of language conventions
- c) Compliance with coding Standards for language style
- d) Use of meaningful variable name
- e) Use of structured coding practice (e.g. avoid GOTO statement)
- f) Program statement are optimized
- g) Spelling and typing mistakes
- h) Incorrect or ambiguous comments
- i) Memory leaks are removed
- j) Proper data types and data declarations

#### 1.1.34. Verification

During each design phase the Contractor shall verify that the refined design which represents the output of that phase meets the requirements of the previous phase.

### **1.11 Testing**

#### 1.1.35. Test programme

The Contractor shall define a test programme as part of the software programme.

#### 1.1.36. Automated test tools

The Contractor shall use automated test tools (including simulators and metrics tools) where possible and appropriate. The Contractor shall submit to the Engineer for review the details of any automated test tools that he proposes to use.

#### 1.1.37. Testing pre-requisites

Prior to entering a testing phase all previous lifecycle phases for the item(s) under test shall be complete, including all verification activities and phase documentation. All item(s) included or referenced in the test shall be under the control of the Contractor's configuration management procedures.

#### 1.1.38. Software modification

The software shall not be modified during the testing unless there is an exceptional need to do so in order to perform the test. Any such requirement shall have been detailed in the test specification in advance of the testing commencing, and the test specification shall include further tests to ensure that the modification is reversed on completion of the test whether successful or otherwise.

#### 1.1.39. Test specification modification

The test specification shall not be modified during the actual test. If the test specification is found to be incorrect during testing this shall be explained in the test record, and the test specification shall be amended and resubmitted to the appropriate review and approval procedure. The test shall then be repeated.

#### 1.1.40. Test requirements

Testing to be performed shall include the following:

##### 1.1.40.1. Module testing

Every module (customized or developed) shall be tested to ensure it accurately represents the program design and it performs to the requirements of its specification. The tests shall be designed to demonstrate that:

- a) Any valid input or combination of inputs produces a correct output.
- b) Any invalid input is handled in a controlled manner.
- c) Error messages are meaningful.

Every module shall be tested after it has been successfully reviewed and before integration. The records of the test, which form part of the project documentation, shall include details of the test specification, any test harnesses used, the input test parameters and the output results. Versions of modules tested and related amendments to the previous versions shall be documented.

##### 1.1.40.2. Software integration testing

Software undergoing integration shall be combined in a controlled manner and tested to ensure that the combination accurately represents the software design and that it performs in accordance with the specification.

Standard software products which do not have a proven history of interfacing with each other in the same manner as used on the current application shall be included in, and subjected to, software integration testing. The tests shall be designed to demonstrate that:

- a) Any valid input or combination of inputs produces a correct output.
- b) Message dialogues and sequencing between integrated modules are correct.
- c) Error messages are meaningful.
- d) Any invalid input is handled in a controlled manner.

The records of the test, which form part of the project documentation, shall include details of the test specification, versions of software items under test or referenced in the test, any test harnesses used, the input test parameters and the output results.

#### 1.1.40.3. System integration testing

The software and the hardware shall be combined and tested to ensure the Delivered System accurately represents the system design and it performs in accordance with the specification.

The system integration testing shall include checking that the Delivered System will successfully pass all the Factory Acceptance Tests prior to the Factory Acceptance Test itself.

The records of the test, which form part of the project documentation, shall include details of the test specification, versions of software, any test harnesses used, the input test parameters and the output results.

#### 1.1.40.4. Factory acceptance testing

The Delivered System's software shall be subject to factory acceptance testing as described in the Factory Acceptance Test Plan.

#### 1.1.40.5. Site acceptance testing

The Delivered System's software shall be subject to site acceptance testing as described in the Installation Plan and Commissioning Plan.

#### 1.1.40.6. Software validation

The Contractor shall perform validation to demonstrate compliance with the technical requirements. Validation of the integrated software shall take place prior to factory acceptance testing.

The Contractor shall record all test results, limitations, observations and anomalies. Fault records shall show any subsequent corrective actions undertaken.

#### 1.1.40.7. Endurance & loading tests

Endurance and loading tests shall be conducted as described in the approved Test Plans.

#### 1.1.40.8. Regression testing

The Contractor shall conduct regression testing through the testing phases following changes to the software. Regression testing shall show that unmodified software has not been affected by the change, and the software meets its technical requirements.

## 1.12 Software audit

Auditing of the Contractor's software development activities shall be carried out by the Engineer, or delegated representatives. The Contractor shall co-operate with the audit team and shall provide timely and reasonable access to all personnel, activities, software, documentation, and records connected with the development activities. This shall include documentation which is not required to be submitted for formal review, and the Contractor's internal documentation and procedures governing the technical, quality and project management aspects of the contract.

The Contractor shall provide support to the audit team during any visit to the Contractor's site. Such support shall include the use of office space and facilities, telephone and fax machine, and the provision of a member(s) of the Contractor's staff sufficiently familiar with the project and the Contractor's procedures to enable the auditing activity to be progressed in an efficient manner.

An Audit Plan will be advised to the Contractor by the Engineer. Dependent on the Contractor's performance during the contract the Engineer may escalate or de-escalate the auditing activities. The software audits required are summarized in Table 1 below:

<b>Audit Schedule</b>	<b>Standard Software (1 man day per visit)</b>	<b>Non-Essential Software (2 man days per visit)</b>	<b>Essential or Safety Related Software (2 man days per visit)</b>
Design phase	Required	Required	Required
Integration phase	-	-	Required
Prior to Factory Acceptance Test	-	Required	Required
Completion of Factory Acceptance Test	-	-	Required
Prior to System Acceptance Test	Required	Required	Required

Table 1 Software Audit Summary

Where more than one Factory Acceptance Test and/or Site Acceptance Test is programmed, the above audits shall be applied at each stage.

## 1.13 Maintenance

Maintenance of software shall be as described below:

- a) All maintenance activities conducted during the period of maintenance shall conform to the development and test requirements.

- b) All changes made to the software shall accord to the defined configuration management procedures.
- c) The Contractor shall define how upgrade media is to be delivered to site, installed and tested.
- d) The maintenance of the Delivered System software shall not require the Delivered System to be non-operation.

## **1.14 Software licenses & ownership**

### 1.1.41. Standard software

In respect of standard software the Contractor shall ensure, prior to procurement, that all licenses can be transferred to the Employer. Where possible the Employer shall be a sub-licensee on all software licenses when they are originally procured by the Contractor. All licenses shall be transferred to the Employer following site acceptance.

### 1.1.42. Contractor's standard software

In respect of the Delivered System's software source code, following site acceptance, the Contractor shall deliver to the Engineer a complete set of software source code, editors, compilers, linkers, and software libraries. The Contractor shall enter into a Software Agreement (as given in **System Safety Engineering Standard**) with the Employer within one month from Contract award for the provision of such software as described in the "Software Agreement".

### 1.1.43. Developed software

In respect of developed software the ownership of, and intellectual property rights to, the software shall reside with the Employer. On completion of site acceptance the Contractor shall deliver to the Engineer all source and executable code, all software development documentation, and all specialist development tools required for maintenance, including but not limited to editors, compilers and linkers. The Contractor shall enter into a Software Agreement with the Employer for the provision of such software as described in the "Software Agreement".

### 1.1.44. Contractor's Copy

In respect of customized and developed software the Contractor shall retain a copy of all delivered items of software.

## **1.15 Essential software**

### 1.1.45. Additional requirements

Contractors supplying Essential Software shall adhere to the requirements described in 1.1 to 1.14.

#### 1.1.46. Metrics

The Contractor shall define and implement a procedure covering the production, collation and analysis of software Metrics. The Contractor shall define the Metrics and their acceptance criteria for customized or developed software as part of the test specifications. The Metrics and acceptance criteria shall be appropriate to the development methods and software in use and shall be approved by the Engineer.

##### 1.1.46.1. Minimum requirements

As a minimum Metrics which indicate the complexity and structure of the software as defined in Table 2, or their equivalent, shall be calculated.

Metric	Acceptance Criteria
Cyclomatic complexity	$\leq 20$
Module size (lines of code)	$\leq 50$
Comment frequency	0.25 to 1.0

Table 2 Complexity, Structure Metrics & Acceptance Criteria

##### 1.1.46.2. Test coverage

As a minimum the test coverage Metrics defined in Table 3, or their equivalent, shall be calculated.

Metric	Acceptance Criteria
Module calls	100%
Number of decision paths tested	$\geq 75\%$
Number of statements tested	$\geq 75\%$

Table 3 Test Metrics & Acceptance Criteria

##### 1.1.46.3. Application of Metrics

Metrics shall be applied at the software module and software integration level as part of the testing activities. As a result of software changes the Metrics shall be re-calculated as part of the regression testing programme.

#### 1.1.46.4. Test report

The Metrics shall be recorded in the test report.

#### 1.1.46.5. Deviation from acceptance criteria

Where a Metric falls outside of the agreed acceptance criteria the Contractor shall either justify the deviation or modify the software. Any justification for a deviation shall be approved by the Engineer.

### **1.16 Safety related software**

*(for safety related systems only)*

#### 1.1.47. Compiler certificate

Compilers/code generators shall have a certificate as described in 1.8.7 in addition to at least one of the other criteria described in that Clause.

#### 1.1.48. Additional requirements

Contractors supplying safety related software shall adhere to the requirements presented in 1.1 to 1.18, and the requirements of prEN 50128 or similar standard agreed with the Engineer.

#### 1.1.49. Acceptance criteria

The acceptance criteria for test coverage Metrics defined above shall be increased to 100% decision path coverage and 100% of statements executed.

### **1.17 Software management**

#### 1.1.50. Software obsolescence management

The Contractor shall employ virtualization / web-based techniques wherever practicable in order to minimize the hardware dependence, operating system dependence, asset replacement process, and maintenance activities. The Contractor shall identify the design of usage of virtualization / web-based techniques for each software product and adhere to the requirements described below:

- a) Vendor unique technology shall not be used, and shall not be limited to one single industrial mainstream product with good interoperability but without being locked-in by the supplier.

- b) The delivered system shall be designed in such a manner that, by running on virtualization / web-based platform, its function can be extended without degradation in delivered system performance.
- c) The hypervisor shall be able to host multiple Operating Systems (OS) within a Virtual Machine (VM) and multiple instances of these OS. The OS shall include but not limited to Windows and Linux.
- d) All images of Virtual Machines shall comply fully with Open Virtualization Format (OVF) 1.1 or later version.
- e) The hypervisor shall sit directly on top of the server hardware (bare metal type) with no dependence on the underlying brand of hardware or OS.
- f) The virtualization platform shall be able to provide the function of High Availability for all the VM hosted inside it. If any guest VM fails, the virtualization platform shall automatically restart the VM in any server within the virtualization platform.
- g) The web-based HMI shall be constructed by using HTML5.

## **1.18 Software expansion requirements**

### **1.1.51. Design considerations**

The Contractor shall use a suitable design method embracing partitioning and modularization techniques in order to enable the software to be easily modified to cope with additional functionality, I/O dialogues, peripheral equipment and controlling equipment.

The software design shall be modularized so as to prevent the modification of a particular module resulting in the compilation of the complete system.

### **1.1.52. Design expansion provisions**

The Contractor shall ensure software databases regardless of the mode of operation shall be designed to allow for ease of expansion. The Delivered System database structures shall be able to be expanded by 100% without the purchase of any additional license, memory, storage or software.

### **1.1.53. Software portability**

The Contractor shall develop software with provision for porting to other hardware platforms. Where appropriate, the operating system and software shall be consistent with an open systems approach, and shall be compliant with internationally recognized standards for portability and connectivity.

The Contractor shall be able to demonstrate the Delivered System can run on more than one brand of OS.

In circumstances where PLC is deployed within the Delivered System, the Contractor shall demonstrate the Delivered System is able to communicate with more than one manufacturer of PLC.

#### 1.1.54. Software interface

The Contractor shall ensure the interface or interface protocol between subsystems of the Delivered System and external systems are adopting an internationally recognized open standard protocol as the message exchange protocol. Non-open standard protocol shall not be used without the prior approval of the Engineer. Detailed format of the protocol shall be well documented in Detailed Interface Specification.

The Contractor shall adopt message-based interface protocol between subsystems and these interfaces shall be RESTful Application Programming Interface (API) or JSON API unless explicit exemption is granted.

The Contractor shall ensure all subsystems are connected via TCP/IP.

#### 1.1.55. Software logging

The delivered system shall store a complete log of all activities in particular the actions carried out by subsystems, software modules and interface communications.

The log shall be retrievable through any consumer-grade computers without translation or decryption. The log shall contain the followings as a minimum:

- a) Operator position or any logged in user;
- b) Date and time of the action;
- c) The identity of the machine or IP address (in the case of web interface) from which the action is taken or initiated;
- d) Details of the action taken; and
- e) All alarms and unauthorized attempt for access at any of the interfaces of the delivered system
- f) All alerts, events, triggers, Simple Network Management Protocol (SNMP), Simple Mail Transfer Protocol (SMTP) and logs from hardware level (servers, switches, storage, sensor readings, etc.) as well as application level, OS level, database level and 3rd party software package / library.

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The Delivered System shall be able to replicate events, logs, data and alerts completely via RESTful API or JSON API for the purpose of availing data to suitable platform (supplied by third party) for subsequent data analytics

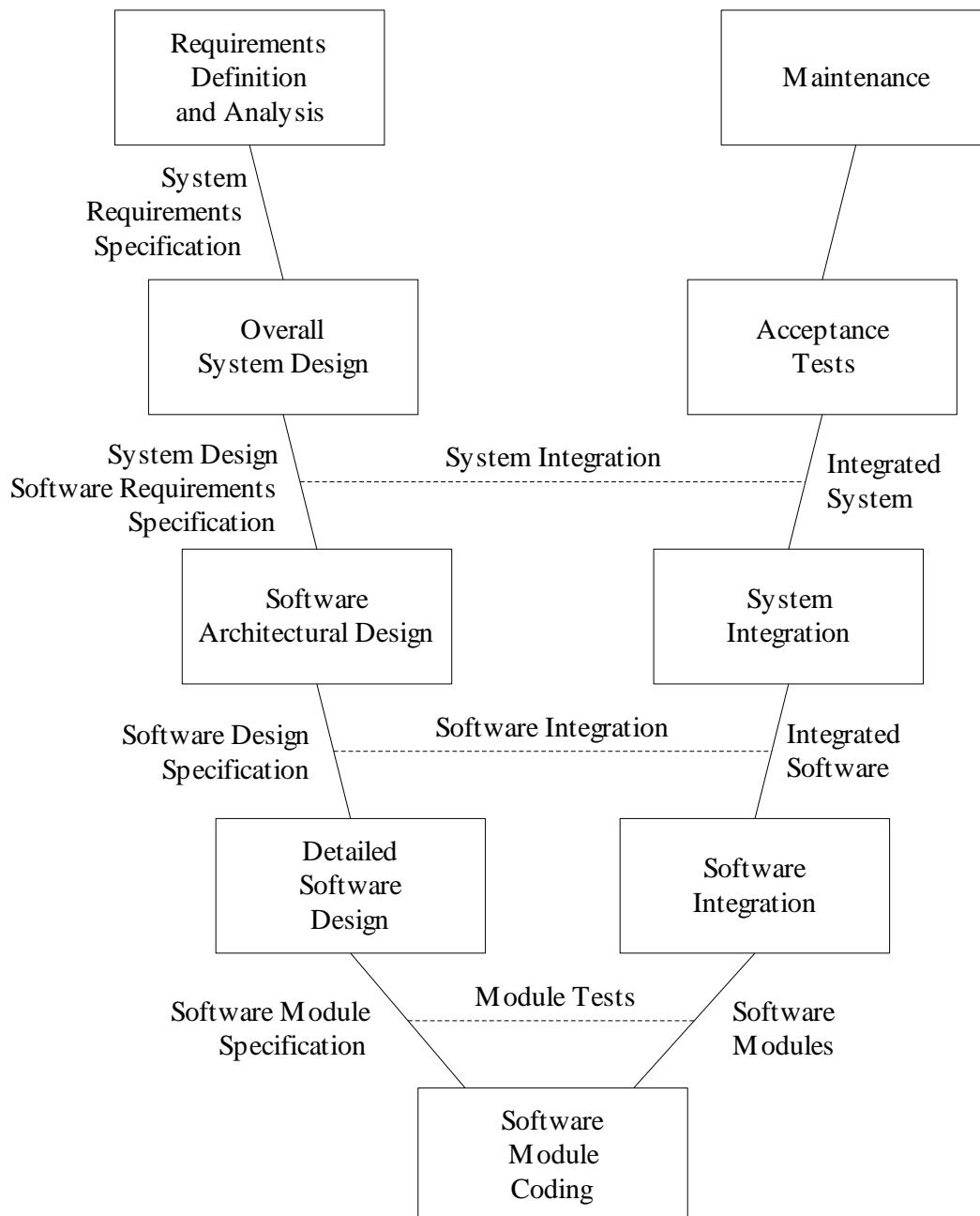


Figure 1 Software Lifecycle

Phase	Requirements Definition and Analysis	Overall System Design	Software Architectural Design	Detailed Software Design
System Requirements Specification	O	I		
Hazard Analysis Report	O	I	I	
System Design Specification		O	I	
System Acceptance Test Plan		O	U	U
System Design Test Specification		O		
Software Requirements Specification		O	I	
Factory Acceptance Tests Specification		O		
Site Acceptance Tests Specification		O		
Software Validation Plan		O		
Software Verification Plan		O	U	U
Software Verification Report		O	U	U
Software Maintenance Plan		O		
Software Design Specification			O	I
Software Design Test Specification			O	I
Software Module Design Specification				O
Software Module Test Specification				O
Software Module Review Plan				O
Software Module Review Report				O
Source Code				
Code Review Plan				
Code Review Report				
Software Module Test Report				
Software Validation Report				
Software Integration Test Report				
System Integration Test Report				
Factory Acceptance Tests Report				
Site Acceptance Tests Report				
Software Maintenance Records				

Key: I - Input to phase

O - Output from phase

U - Updated during phase

Table 4 Design Documentation / Lifecycle Mapping

Phase	Software Module Coding	Software Integration	System Integration	Acceptance Tests	Maintenance
System Requirements Specification				I	
Hazard Analysis Report					
System Design Specification			I		
System Acceptance Test Plan	I	I	I	I	
System Design Test Specification			I		
Software Requirements Specification		I			
Factory Acceptance Tests Specification				I	
Site Acceptance Tests Specification				I	
Software Validation Plan	U	U	U		
Software Verification Plan					
Software Verification Report					
Software Maintenance Plan					I
Software Design Specification		I			
Software Design Test Specification		I			
Software Module Design Specification	I				
Software Module Test Specification	I				
Software Module Review Plan					
Software Module Review Report					
Source Code	O	I	I	I	
Code Review Plan	O				
Code Review Report	O				
Software Module Test Report	O				
Software Validation Report	O	U	U		
Software Integration Test Report		O			
System Integration Test Report			O		
Factory Acceptance Tests Report				O	
Site Acceptance Tests Report				O	
Software Maintenance Records					O

Key: I - Input to phase      O - Output from phase      U - Updated during phase

Table 5 Coding &amp; Test Documentation / Lifecycle Mapping

Issue : 1

Rev. : 0 01/02/2023

Contract C3855-22E  
Provision of In-Train Remote CCTV System  
and Train Car Loading Indicator for M-Trains  
Particular Specification

**Appendix F Materials and Workmanship Standard for Rolling Stock**  
**Electrical Equipment**

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# Operations Engineering Standard

S/CC-gen/MW/01(99)

Former number: S/C&C/MW/001(3)

**Title:**

Materials and Workmanship Standard

**Revision:** D

**Date:** 2018-10-12

Safety related standard

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This standard is mandatory and applied from the date of issue.

## ENDORSEMENT & AUTHORIZATION

Approved by standards owner:

Thomas Lam

Communications & Network Engineering Manager

Date: 21 Dec. 2018

Endorsed by (for safety related standard only):

N/A

Date: \_\_\_\_\_

Chairman – Technical Standards Sub-committee

Authorized for issue by:

Michael Leung

Deputy General Manager – Technical & Asset  
Engineering

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## Revision Record

This standard will be updated when necessary by issuing a complete document. Amendments to the former issue will be summarized in the revision record below. The latest revision of this standard is mandatory and applied immediately from the authorized date for issue unless otherwise stated in the document.

Rev.	Date	Amendment	Writer
A	2009-02-02	Rationalized to cope with post merger MTR system.	D Li
B	2012-06-05	Updated to the latest Standards	D Sin
C	2015-08-20	3-yearly regular review with Clauses 1 and 12.1 updated.	KK Cheung
D	2018-10-12	3-yearly regular review with Clauses 1, 4.13, 6.5 and 21.4 updated	KK Cheung

## Summary of Applicable Railway Lines

Check this box for common standards and leave blank to all railway lines below.

Please check the appropriate box(es) preceding the railway lines to which this standard shall apply; provide comments and/or any particulars / exceptions if applicable:

Railway Line	Abbreviation	Comment
<input checked="" type="checkbox"/> Operating Railway	OPR	
<input type="checkbox"/> East Rail Lines:	ERL	
<input type="checkbox"/> East Rail Line	EAL	
<input type="checkbox"/> Ma On Shan Line	MOL	
<input type="checkbox"/> Airport Express, Tung Chung & Disneyland Resort Lines:	AT&D	
<input type="checkbox"/> Airport Express Line	AEL	
<input type="checkbox"/> Disneyland Resort Line	DRL	
<input type="checkbox"/> Tung Chung Line	TCL	
<input type="checkbox"/> Light Rail	LR	
<input type="checkbox"/> Urban Lines:	URL	
<input type="checkbox"/> Island Line	ISL	
<input type="checkbox"/> Kwun Tong Line	KTL	
<input type="checkbox"/> Tseung Kwan O Line	TKL	
<input type="checkbox"/> Tsuen Wan Line	TWL	
<input type="checkbox"/> West Rail Line	WRL	

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## 1. Scope and Purpose

This Standard covers the requirements for common materials specifications and general workmanship standards for C&R works as performed by or for **Communications and Control** Engineering Section.

Requirements for special materials and particular methods of working relating to unusual or project-specific tasks are detailed in the Particular Specification.

Any deviations from this standard shall be subject to the prior Approval of the Engineer.

## 2. Definitions

There are no special definitions required for the understanding of this document.

## 3. Safety Considerations

- 3.1. The requirements set out in this Standard must be complied with for selection and installation of equipment for C&R works and railway development work.
- 3.2. Failure to comply with the requirements could affect the safety, reliability, maintenance and operation of the Railway. Any deviation from this Standard regarding safety critical system and safety related system should be approved by Technical Standards Sub-committee (TSS).
- 3.3. Special care should be taken to ensure that the requirements of other Operations Standards are also complied with where appropriate.

## 4. General

- 4.1 All materials and components to be used, whether incorporated in equipment at the manufacturer's works or used for installation on site, shall comply with the specified requirements. In addition, every effort shall be made to ensure that the design of all equipment and installations are sound, and that all materials and components are suitable for their intended purposes and environments.
- 4.2 All equipment and installations shall be designed to conform to the best engineering practice. Manufacturer's standard designs shall be used for all items for which standard designs are available provided that they conform to the specified requirements.
- 4.3 All materials, components, equipment, and installations shall be asbestos and CFC free.

- 4.4 Unless otherwise specified or approved, all Power, Signalling, Control and Communications cables shall have low smoke, low fume and zero halogen properties.
- 4.5 All parts shall be designed to withstand the maximum stresses under the most severe service conditions after loss of any corrosion allowance for a lifetime of not less than 15 years unless otherwise specified.
- 4.6 All materials, equipment, and installations shall be designed to minimize fire risk and damage in the event of fire.
- 4.7 Adequate safe-guards shall be provided to prevent accidental contact with rotating machinery, hot surfaces, electrical live parts and any other hazardous components or content of equipment and installations.
- 4.8 All equipment and installations shall be designed to prevent the entry of vermin and to minimize the entry of dust and dirt.
- 4.9 All equipment and installations shall be designed for simplicity and reliability to give economy, long continuous service with minimum maintenance.
- 4.10 The equipment and installations as a whole shall be designed for neat appearance and tidy arrangement. The style and finish of the workmanship shall be consistent throughout. Unless otherwise specified, the colours for all paint work and finishes to be applied to any part of the equipment and installations shall be subject to approval.
- 4.11 The names of the manufacturers of materials, installations and equipment together with performance, capacities, certified test reports, approval letters and other significant information pertaining to the same, shall be furnished. Any items which is unsatisfactory or not in compliance with the specified requirements shall be replaced.
- 4.12 Whenever samples of materials, components, equipment, or installations are submitted for approval, those materials, components, equipment, and installations shall not be used before the approval is granted.
- 4.13 Unless otherwise stated, the relevant **International or equivalent British Standards** shall apply. The Contractor shall give notice where Standards other than **International or equivalent British Standards** apply to his plant or equipment and shall supply copies of such Standards in English as required by the Engineer. Standards submitted shall be Subject to the Approval of the Engineer.
- 4.14 The Engineer's Representative will examine and confirm as Approved or Not Approved the quality and workmanship of the first installation for each configuration of the Works. The installation, if Approved, will establish the minimum acceptable standard for the Contractor's Works.

## 5. Statutory Requirement, Regulation and Code

- 5.1 All equipment, installations, and works shall conform to all Statutory Ordinances, Orders, and Regulations in force. In particular, the following requirements of Hong Kong shall be complied with as a minimum wherever applicable:
- 5.1.1 The Building Regulations issued under the Building Ordinance.
  - 5.1.2 The Building (Ventilation System) Regulations issued under Building Ordinance.
  - 5.1.3 The requirements of the Fire Services Department for Fire Prevention in Buildings as defined in the "Code of Practice for Minimum Fire Service Installations and Equipment", and all current Fire Services Department Circular Letters.
  - 5.1.4 The Construction Fire (Safety) Regulations issued by the Labour Department.
  - 5.1.5 The Electricity Ordinance and subsidiary legislation made under this Ordinance.
  - 5.1.6 The requirements of the Environmental Protection Department issued under relevant memoranda and incorporated into legislation.
- 5.2 In the event of conflict between any technical requirements, the order of precedence shall be as follows:
- 5.2.1 Government Ordinances, Orders, Regulations and Codes.
  - 5.2.2 Particular Specification of the Contract.
  - 5.2.3 MTR Standards.
  - 5.2.4 Other standards and codes of practice.

## 6. Material – General

- 6.1 All materials shall be suitable for the duties concerned, brand new and of recent manufacture, of highest grade and first class commercial quality, free from defects and imperfections, and selected for long life and minimum maintenance under the specified working conditions.
- 6.2 Where standard specifications do not exist, materials shall be to the highest grade currently adopted in the industry and shall be subject to approval.
- 6.3 All equipment supplied shall be of current, well-proven design and have at least 2 years proven record of service.
- 6.4 In addition to other requirements for the material to be used as stipulated on above, all equipment, housing, cables, cable ties and brackets supplied shall be resistant to ultra-violet if they are installed at locations exposed to sunlight.
- 6.5 Whilst relaxations may be permissible for detailed components, the following general requirements shall be satisfied:
- 6.5.1 Structural steel and iron

**Heavy protecting finish or galvanized.**

- 6.5.2 Unpainted steel parts  
**Passivated cadmium plate galvanized or zinc plated as appropriate.**
- 6.5.3 Screw, nut, bolt and washer  
**Steel components springs shall be zinc or chromium plated or sheradised. All non-ferrous screws shall be electro-tinned or have nickel or chromate finish. Springs shall be of phosphor bronze or nickel silver.**
- 6.5.4 Insulating material  
**Non-impregnated paper, fabric, wood or press-palm shall not be used for insulating purposes. Where synthetic resin bonded insulating boards are used, all cut edges shall be sealed with an approved varnish.**

## **7. Workmanship – General**

- 7.1 During manufacture and installation, workmanship and quality control shall be of the highest order, and materials shall be adequately dimensioned and in every way suitable for their purpose throughout the range of operating conditions.
- 7.2 Workmanship and general finish shall be of first class quality and in accordance with best workshop and trade practice.
- 7.3 All similar items of equipment and their component parts shall be completely interchangeable. Spare parts shall be manufactured from materials similar to the originals and shall fit all similar items of equipment. Where machining is necessary before fitting renewable parts, the machining fits with their tolerances shall be shown on the drawings accompanying the instruction manuals.
- 7.4 All revolving parts shall be truly balanced both statically and dynamically so that when running at normal speeds and at any load up to the maximum, there will be no significant vibration due to out-of-balance forces.
- 7.5 All parts which are subject to wear or damage by dust shall be totally enclosed in dust-proof housings.
- 7.6 All equipment shall operate without excessive vibration and with minimum noise.
- 7.7 Particular attention should be paid to the workmanship employed in making joints, terminations and enclosures

- 7.7.1 Cable joints of any type along cable runs in final circuits are not allowed.  
“Looping-in” wiring system should be used such that the cables or conductors are properly terminated at the junction box or equipment.
- 7.7.2 All joints and terminations should have durable electrical continuity and adequate mechanical strength.
- 7.7.2 Ferrules, compression connectors and bare portions of cable core resulting from a jointing or terminating process should be insulated with an insulating tape or heat shrinkable tubing after completion the jointing or terminating process. Such insulating tape or heat shrinkable tubing should have equal or better electrical and mechanical properties than those of the original insulation removed, and should be adhered to the cores etc. securely and permanently. The final thickness should be in smooth contour throughout the whole length of the joint or termination.

## 8. Tropicalisation

- 8.1 All equipment and installations shall be tropicalised to suit the conditions prevailing in Hong Kong in general; and the conditions within tunnels, substations, and plantrooms of the MTR in particular.
- 8.2 All components of electrical systems shall be housed in suitable enclosures which provide the specified degree of protection (IP) IEC 60529.

## 9. Enclosures, Cubicles and Cabinets

- 9.1 This Clause specifies the general requirements of enclosures for electrical apparatus, including cubicles, cabinets, and wall mounted material cases for such purpose.
- 9.2 Enclosures shall be symmetrically arranged as far as possible with projections kept to a minimum and extendible from either end.
- 9.3 The arrangements of the equipment within each enclosure shall be such that all normal maintenance can be carried out through hinged access doors or removable covers, and wherever possible from the front.
- 9.4 Where two or more enclosures are fitted together, they shall form a flush-fronted continuous suite of uniform height when viewed from the front.
- 9.5 Each suite of enclosures shall be fitted with a designation label giving voltage rating and duty. Such labels shall be fitted on the front and rear of the enclosure.

- 9.6 Where a number of equipment are in close proximity, the enclosure shall be grouped to form a single suite or a composite enclosure shall be provided.
- 9.7 Enclosures shall be made of sheet steel of adequate thickness, which shall be not less than 2 mm unless otherwise specified, and suitably braced to form a rigid structure. Exterior corners and edges shall be rounded to give a smooth overall appearance. Interior edges shall be smooth. All surfaces of the sheet steel shall be protected against corrosion by suitable treatment such as zinc electroplating, bichromating, or epoxy coated.
- 9.8 Enclosures shall be of uniform appearance. An approved first-class method of construction shall be employed. Designs involving the use of externally visible assembly bolts and screws shall not be used.
- 9.9 Unless otherwise specified, enclosures shall provide a degree of protection not less than that defined by characteristic IP54 in IEC 60529 for indoor applications and IP65 and or above for outdoor applications.
- 9.10 Individual sections of enclosures shall be fully segregated to comply with the safety requirements of IEC 60439-1 or BS EN 60439-1.
- 9.11 The design of enclosures shall be such as to ensure adequate ventilation and air circulation without permitting the entry of vermin. Dust penetration shall be kept to a minimum by the provision of recessed rubber seals around doors and removable panels, and air filters at ventilation louvers.
- 9.12 Cable entries to enclosures shall be closed and made vermin-proof by approved means such as non-magnetic, fire-proof barrier plates cut away where required to fit the cables.
- 9.13 The front door of all enclosures shall be able to be opened only when the functional unit is locked off.
- 9.14 All enclosures shall be provided with lifting facilities, such as lifting lugs at top of enclosures, as specified. The lifting facilities shall be capable of withstanding the total loading of the enclosures with all internal components installed.
- 9.15 Each enclosure shall be provided with a wiring diagram suitably treated to prevent deterioration from dirt or age. The diagrams shall be drawn as if viewed from the point of access to the enclosure, and shall be securely fastened to the inside of the access door.
- 9.16 All terminals, connections, relays, and other components which may be "live" when access doors of enclosures are open shall be adequately screened. It shall not be possible to obtain access to an adjacent enclosure when any door is opened.

9.17 Components within enclosures shall be fully labelled.

## 10. Welding Structures and Electric Welding

### 10.1 Approval of Welding

- 10.1.1 Details of proposed procedures for factory and site welding and quality control shall be submitted for Approval by the Engineer. Factory welding shall be undertaken only by welders certified by a national railway authority, or similar approved body. Site welding shall be limited to small part steelwork, repairs and minor modifications. Site welding shall only be carried out by certified welders.
- 10.1.2 The welder certificates endorsed by an inspecting authority acceptable to the Engineer shall be submitted to the Engineer at least one week before fabrication of steelwork begins. At the discretion of the Engineer, testing and inspection shall be carried out by a testing agent employed by the Contractor and Approved by the Engineer.

### 10.2 Weld Joint Design

- 10.2.1 The design of welded joints and connections, and the fabrication of welded steel parts, shall conform to the requirements of an approved code for structural steelwork and unless otherwise agreed by the Engineer, shall incorporate stress relief to an approved code.

### 10.3 Weld Assembly Design

- 10.3.1 The design of welded assemblies shall be such as to ensure galvanising in accordance with other sections of this Standard and shall include provision for filling, venting and draining etc. At corners and joints where galvanising may not reach, or where welds and members cannot be cleaned adequately, sealed welds shall be used.

### 10.4 Alignment

- 10.4.1 Members to be joined by welding shall be cut to size and where required, shall be rolled or pressed to curvature in accordance with Approved dimensioned drawings. Edges of members shall be suitably machined for the required type of welding and to permit penetration of the weld to the base material.

10.4.2 Particular care shall be exercised in aligning and separating edges of members to be joined by butt-welding in order to assure complete penetration and fusion at the bottom of the joint. Where fillet welds are employed, members shall fit together allowing no more than a 1mm gap before welding and be held together during welding.

#### 10.5 Preparation

10.5.1 Surfaces prepared for welding shall exhibit sound metal without laminations and other injurious defects. Surfaces of plates to be welded shall be free from rust, grease, mill scale and other foreign matter over a distance of at least 25 mm back from the welded edges.

#### 10.6 Welding Electrodes

10.6.1 Electric arc welding shall be used unless Approved by the Engineer or shown on Approved drawings. Welding electrodes for manual electric arc welding shall be of the coated type, suitable for all positions of welding.

#### 10.7 Cleaning and Inspection

10.7.1 After deposition, welds shall be cleaned of slag and shall show uniform section, smoothness of weld metal, feather edges without overlay and freedom from porosity, inclusions and undercut. Visual inspection at the edges and ends of welds shall indicate sound fusion with the parent metal.

#### 10.8 Examination

10.8.1 Components shall be subject to such radiographic examinations in accordance with BS EN 1435 as may be stipulated by the Engineer.

### 11. Galvanising

#### 11.1 Coating Density

11.1.1 All steel and iron components in tunnels and above ground track sections shall be galvanised by the hot dip process, and tested, in accordance with BS EN ISO 1461 with a uniform zinc coating density of 300 g/m<sup>2</sup> (as tested in accordance with BS EN ISO 1461) on each side of the surface. For steel wire the coating shall be of such thickness as to comply with the tests of BS EN 10244-2. Where electroplating has been specified and this shall be complied with BS EN ISO 2081.

#### 11.2 Coating Finish

11.2.1 Galvanising shall be carried out as the last manufacturing process, except for pre-galvanised tubes and wire. The coating shall be clean, smooth and continuous and free from acid spots, burrs, blisters or other blemishes.

### 11.3 Preparation

11.3.1 The Preparation for galvanising and the galvanising itself shall not adversely affect the mechanical properties of the component.

### 11.4 Use of Zinc-Rich Paints

11.4.1 Areas of galvanising damaged during delivery or erection shall be thoroughly cleaned of all corrosion and loose material and two coats of a zinc-rich paint Approved by the Engineer applied. Cut ends of pre-galvanised tubes or wire shall be treated in a similar manner. Threads cut onto pre-galvanised tubes shall be treated with a coat of a zinc-rich paint Approved by the Engineer immediately before the tube is fitted into the female threaded component, and a second coat shall be applied later to the area of the joint between the tube and the component.

## 12. Painting

### 12.1 Paints

**PU (Polyurethane) painting system shall be applied to all of the metal work.  
Materials of paint shall be subject to the Approval of the Engineer.**

### 12.2 Preparation

All surfaces must be clean and free from grease and dirt, and all oxidation rust and / or mill scale shall be removed prior to painting. Any additional special preparation indicated by the paint manufacturer shall be undertaken also.

### 12.3 Coatings

A minimum of three coats of cellulose enamel shall be applied. Where the paint manufacturer indicates, an undercoat of a type suitable to the surface and as indicated by the paint manufacturer shall be applied. The Engineer will advise any special locations or equipment that shall have a fourth coat of paint applied.

Floor standing or wall-mounted equipment cabinets shall be degreased, primed and stove enamelled with a textured, high durability finish to the Approval of the Engineer. Where cabinets have been manufactured from zinc-coated steel, the surface shall be etch primed and all cut edges and welds treated with two coats of zinc-rich paint containing at least 90% zinc dust, before stove enamelling.

#### 12.4 Adhesiveness of Paint Finish

Adhesiveness of paint finishes shall be tested in accordance with BS EN ISO 2409:2007.

#### 12.5 Colour

The colour of the final coat of painted surfaces shall be as indicated in the Particular Specification for the project. Housings and brackets visible in station public areas shall be in black RAL 9005 semi-matt. Conduits and trucking in public areas shall be painted in colours to co-ordinate with the requirements of the station colour scheme.

#### 12.6 Touch-up and Restoration

The surfaces of all painted components shall have damage to paint work made good by the Contractor on completion of installation.

### 13. Wood

The used of wood shall be subject to the Approval of the Engineer. When used, woodwork shall be thoroughly seasoned teak or other Approved hardwood resistant to fungicidal decay and entirely free of knots, splits, sap, warps and any other defects. All woodwork shall be treated in a manner Approved by the Engineer to protect it against the ingress of moisture, growth of fungus or other forms of deterioration, and to be fire resistant. Joints shall be dove-tailed or tongued and pinned except where Approved by the Engineer. All metal fittings shall be non-ferrous of stainless material.

### 14. Corrosion Resistant Steel

#### 14.1 Stainless Steel

14.1.1 Arc welding shall be undertaken in accordance with BS EN ISO 15614 part 1. Stainless steels adversely affected by welding shall not be used. All Stainless materials shall be subject to the Approval of the Engineer.

14.1.2 Where cladding with stainless steel is proposed, the method of application shall be subject to the Approval of the Engineer.

14.1.3 Stainless steel for use in Automatic Fare Collection equipment shall be grade 303/304 or equivalent.

## **15. Aluminium and Aluminium Alloys**

### **15.1 Aluminium for Electrical Purposes**

Wrought aluminium and aluminium alloys for electrical purposes shall comply with BS EN 755-3, 755-4, 755-5 & 755-6.

### **15.2 Coatings**

Aluminium or aluminium alloy, where used for components, shall either be painted or be anodised to give a deposit of not less than 50 g/m<sup>2</sup>. Aluminium and aluminium alloys shall not be in direct contact with dissimilar metals. The treatment of any such contact points shall be agreed with the Engineer.

## **16. Adhesives**

All adhesives shall be specially selected to ensure use of types which are impervious to moisture, resistant to mould growth and other forms of attack or deterioration. Synthetic-resin cement only shall be used for jointing wood.

## **17. Threaded Components**

### **17.1 Plating**

Steel threaded components, except those used in tunnel or overhead track sections, shall be plated with zinc or cadmium to BS EN ISO 2081:2008 or BS 7371-12.

### **17.2 Finishes**

Bolts, screws and nuts with a diameter over the threads of 5 mm or more for use in tunnels or overhead sections of track shall be zinc sheradized to BS 4921. Smaller threaded components shall be of stainless steel.

### **17.3 Manufacture**

Bolts, studs and nuts shall be suitably machined. Rolled threads will be considered acceptable if conforming to an Approved standard.

### **17.4 Use of Washers**

Plain and spring washers shall be provided under all nuts and also bolt heads. Bolts and studs shall protrude by at least one thread pitch beyond the outside face of the nut.

## 17.5 Locking Devices

Nuts, bolts, tap-bolts, set pins and any other item subject to vibration shall be secured with Approved locking devices.

## 18. Name Plates

The Contractor shall provide and attach to each major piece of equipment of his manufacture a metal name and rating plate to be Approved by the Engineer. Each plate shall quote the name and address of the manufacturer, serial number, full rating and the date of manufacture, the name and type of unit, and serial number where applicable.

## 19. Labels

### 19.1 Description

Descriptive labels shall be provided for all instruments, gauges, devices, fuses, motors, cubicles and panels and the main apparatus contained therein. Such labels shall be fitted to the front and rear of all equipment cabinets. Labels shall be of engraved type, with durable markings. This requirement is not applicable to OEM items.

### 19.2 Lettering

Labels for normal situations shall be of Approved material, suitable to site conditions and securely fixed by means of rivets or bolts. Lettering and sizes of lettering shall be to the Approval of the Engineer.

### 19.3 Wording

The designation on these labels shall be clear and shall, where practicable, incorporate the appropriate device number along with concise descriptive wording in English and Chinese. The Chinese wording will be supplied to the Contractor by the Engineer.

### 19.4 Warning Signs

Electrical and other warning signs shall be provided with graphic symbols and wording in red. Warning signs shall be in accordance with BS ISO 7010.

## 20. Drag on Suspended Fixture

- 20.1 Unless otherwise specified or as required by more adverse site environments, all fixtures, particularly CCTV, PIDS and Loudspeaker fittings, suspended from ceiling soffits in underground station public areas and overhead station totally enclosed public areas shall be capable of withstanding an air flow with a drag of not less than 100 Pa normal to the projected area of the surfaces of the fixtures facing the airflow.
- 21.2 For overhead stations, all fixtures, particularly CCTV, PIDS and Loudspeaker fittings, suspended from ceiling soffits in unenclosed or semi-enclosed station public areas shall be capable of withstanding a maximum gust speed of 160 km/h.

## 21. Fixing

- 21.1 Fixings to brickwork shall be made in the bricks and not in the bond. Wooden screws shall be zinc coated and machine-threaded screws shall be solid brass and greased before installation. Accessories mounted in fixed equipment shall incorporate adjustable slotted fixing holes.
- 21.2 Heavy equipment shall be fixed with approved purpose-made clamp brackets, ragbolts or patent fixing bolts. Plugs or shot bolts shall not be used without approval.
- 21.3 No structural steelwork shall be drilled for any purpose without approval. In general all fixings to steelwork shall be by means of studs welded to the steelwork or by clamp brackets or hook bolts. Exterior steelwork fixings shall be of stainless steel.
- 21.4 Should the Contractor use anchor fixing method, an anchor Pull Out Test shall be conducted for expansion anchors in concrete and masonry elements for structural supports of all equipment including associated supporting frames. This shall exclude distribution services such as pipeworks, ductworks, cables and cable containment which are installed in accordance with relevant standards. The test shall cover at least 5% of the expansion anchors installed on site (on individual station basis) by applying load tests to a factor of safety of 1.5 of the manufacturer's recommended load for the anchor type proposed, or by applying load tests to a factor of safety of **3** of the actual load. Method statements and selected samples of the test shall be submitted for the Engineer's approval.

## 22. Sealing of Penetration Through Floor and Wall

- 22.1 Whenever a penetration is made through a fire resistant structural element, such as a floor, ceiling, and wall forming as fire compartmentation, the opening thus formed shall be sealed after services being installed with approved type of fire resisting materials according to the appropriate degree of fire protection required.

Sealing methods shall be subject to approval and shall not impair the fire rating of the structural element. In addition, suitable internal fire barriers shall also be provided to prevent the spread of fire and smoke through inner spaces of the penetration.

- 22.2 Whenever a penetration is made through a wall or partition which does not form a fire compartmentation element, the opening thus formed shall be sealed after services being installed with approved waterproof sealant.
- 22.3 Where sealing of duct entry to building is required, the sealing material for cables and ducts shall be of proven type to form a gastight and watertight fire barrier with a fire resistant period same as the building element.
- 22.4 Holes formed in concrete surfaces by formwork supports or the like shall be filled with dry-pack mortar made from one part by weight of ordinary cement and three parts of fine aggregate passing a BS number 14 sieve. The mortar shall be mixed with only just sufficient water to make the materials stick together when being moulded in the hands.
- 22.5 The holes to be filled with dry-pack mortar shall be thoroughly cleaned. Where the surface has been damaged, any loose, broken or cracked concrete or aggregate shall be broken out. The concrete surrounding the hole shall then be thoroughly soaked after which the surface shall then be dusted lightly with ordinary cement by means of a small dry brush until the whole surface that will come into contact with the dry-pack mortar has been covered and darkened by absorption of the free water by the cement. Any dry cement in the hole shall be removed.
- 22.6 The dry-pack material shall be placed and packed in layers with a compacted thickness not more than 12 mm. The compaction shall be carried out by use of a hardwood stick and a hammer and shall extend over the full area of the layer, with particular care to be taken to compact the dry-pack against the sides of the hole. After compaction, the surface of each layer shall be scratched before further loose material is added. The hole shall not be over-filled and the surface shall be finished by laying a hard-wood block against the dry-pack fill and striking the block several times. Steel finishing tools shall not be used and water shall not be added to facilitate finishing.
- 22.7 Penetrations through services transformer bund walls shall be sealed using approved fire-resisting and silicone oil-resisting materials.
- 22.8 No sealing material containing any asbestos shall be used.

### 23. Locking Facilities

Locks and padlocks shall be of a design and form Approved by the Engineer. Two keys shall be provided for each lock supplied.

## 24. References

### 24.1 British Standards

BS 7371-12:2008	Coatings on metal fasteners – Part 12: Requirements for imperial fasteners
BS EN 10244-2:2009	Steel Wire and Wire Products – Non Ferrous Metallic Coating on Steel Wire – Part 2 : Zinc or Zinc Alloy Coating
BS EN 1435:1997 +A1:2002+A2:2003	Non-destructive testing of welds – Radiographic testing of welded joints
BS EN 60439-1:1999 / IEC 60439-1:1999 +A1 :2004	Low-voltage switchgear and controlgear assemblies — Part 1: Type-tested and partially type-tested assemblies
BS EN 755-3:2008	Aluminium and aluminium alloys — Extruded rod/bar, tube and profiles —Part 3: Round bars, tolerances on dimensions and form
BS EN 755-4:2008	Aluminium and aluminium alloys — Extruded rod/bar, tube and profiles — Part 4: Square bars, tolerances on dimensions and form
BS EN 755-5:2008	Aluminium and aluminium alloys — Extruded rod/bar, tube and profiles — Part 5 Rectangular bars, tolerances on dimensions and form
BS EN 755-6:2008	Aluminium and aluminium alloys — Extruded rod/bar, tube and profiles — Part 6: Hexagonal bars, tolerances on dimensions and form
BS EN ISO 1461:2009	Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods
BS EN ISO 15614-1 :2004 +A2:2012	Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys
BS EN ISO 2081:2008	Metallic and other inorganic coatings — Electroplated coatings of zinc with supplementary treatments on iron or steel
BS EN ISO 2409:2007 / BS 3900-E6:2007	Paints and varnishes — Cross-cut test
BS ISO 7010:2011	Graphical symbols - Safety colours and safety signs - Registered safety signs
BSI BS 4921:1988	Specification for Sherardized Coatings on Iron and Steel
IEC 60529:2009	Degrees of Protection Provided by Enclosures (IP Code) – Edition 2.1

Issue : 1

Contract C3855-22E

Rev. : 0 01/02/2023

Provision of In-Train Remote CCTV System  
and Train Car Loading Indicator for M-Trains  
Particular Specification

**Appendix G      Engineering Drawing Standard**

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# Operations Engineering Standard

S/NT-prm/CS/01(00)

Former number: S/COM/GP/010

**Title:**

Operations Engineering Drawing Numbering Standard

**Revision:** F

**Date:** 2017-03-10

Safety related standard

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This standard is mandatory and applied from the date of issue.

## ENDORSEMENT & AUTHORIZATION

Approved by standards owner:

Harry Wu

Manager-Digital Engineering

Date: 24/3/2017

Endorsed by (for safety related standard only):

N/A

Chairman – Technical Standards Sub-committee

Date: \_\_\_\_\_

Authorized for issue by:

John William Manho

Deputy General Manager-Train Services & Systems  
Engineering

Date: 28/3/2017



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## Revision Record

This standard will be updated when necessary by issuing a complete document. Amendments to the former issue will be summarized in the revision record below. The latest revision of this standard is mandatory and applied immediately from the authorized date for issue unless otherwise stated in the document.

Rev.	Date	Amendment	Writer
A	2012-02-08	Re-issued for format and number changed. General revision to retain only the OED Drawing Numbering Standard of the former “S/COM/GP/010 Engineering Drawing Standard”	Harry Wu
B	2012-09-21	Revised on the OED drawing numbering format. Addition to the Major Equipment System Codes, Geographical Location Codes and Subsystem Codes for Signalling System	Harry Wu
C	2013-01-21	Addition to the Major Equipment System Codes and Subsystem Codes for Rolling Stock. General update of the Geographical Location Codes.	Harry Wu
D	2013-05-14	Addition to the Major Equipment System Code and Subsystem Codes for Rolling Stock.	Harry Wu
E	2016-02-22	<ul style="list-style-type: none"><li>• Addition to the Major Equipment System Codes and Subsystem Codes for Signage &amp; Facility Information System (SFIS).</li><li>• Inclusion of Gas Service System to the existing Major Equipment System Code – Plumbing and Drainage System.</li><li>• Addition to the Subsystem Codes for Telecommunication System.</li><li>• Revise LRL Geographical Location Codes.</li></ul>	Harry Wu
F	2017-03-10	<ul style="list-style-type: none"><li>• <b>Addition to the Geographical Location Codes and Subsystem Codes for Signalling System.</b></li><li>• <b>Addition to the Geographical Location Codes for SIL and WCD.</b></li><li>• <b>Addition to the Major Equipment System Code for Rolling Stock EMU (C-train).</b></li></ul>	Harry Wu

## Summary of Applicable Railway Lines

Check this box for common standards and leave blank to all railway lines below.

Please check the appropriate box(es) preceding the railway lines to which this standard shall apply; provide comments and/or any particulars / exceptions if applicable:

Railway Line	Abbreviation	Comment
<input type="checkbox"/> Operating Railway	OPR	_____
<input type="checkbox"/> East Rail Lines:	ERL	_____
<input type="checkbox"/> East Rail Line	EAL	_____
<input type="checkbox"/> Ma On Shan Line	MOL	_____
<input type="checkbox"/> Airport Express, Tung Chung & Disneyland Resort Lines:	AT&D	_____
<input type="checkbox"/> Airport Express Line	AEL	_____
<input type="checkbox"/> Disneyland Resort Line	DRL	_____
<input type="checkbox"/> Tung Chung Line	TCL	_____
<input type="checkbox"/> Light Rail	LRL	_____
<input type="checkbox"/> Urban Lines:	URL	_____
<input type="checkbox"/> Island Line	ISL	_____
<input type="checkbox"/> Kwun Tong Line	KTL	_____
<input type="checkbox"/> South Island Line	SIL	_____
<input type="checkbox"/> Tseung Kwan O Line	TKL	_____
<input type="checkbox"/> Tsuen Wan Line	TWL	_____
<input type="checkbox"/> West Rail Line	WRL	_____

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## 1 Scope and Purpose

The Drawing Numbering System described shall only be used by MTR internally. For Drawing and CADD standards or requirements, users should refer to the MTR Drawing and CADD Manual.

This instruction sets out the OED Drawing Numbering standards to be followed when preparing OD drawings.

## 2 Responsibilities

### 2.1 Manager-Digital Engineering (M-DE)

Manager of the Corporate Digital Engineering Section and administrator of the CADD standards, system and the Drawing Management System (DMS) for the Corporation.

M-DE is responsible for the maintenance and administration of the drawing standards. Any updates to the standards need to be made. It is the M-DE who shall determine the changes to the standards and ensure that changes are made promptly.

M-DE will also be responsible for reviewing these standards to ensure that they reflect the current needs of the Operations Design and Implementation Sections, and for issuing revisions as required.

### 2.2 Section Managers

The Section Managers of all Operations Design and Implementation Sections will be responsible for ensuring that staff members in their Section are aware of and adhere to these standards.

### 2.3 Users

The users of these standards are responsible for reporting any errors or omissions which they discover in these standards and for suggesting new coding which might be useful.

## 3 Definitions

### 3.1 Drawing

Information presented in a graphical manner, which may include annotation. Drawings require checking and approval before issuing for tender, executions of work, fabrication, etc.

### 3.2 Drawing & CADD Manual (D&CM)

The document specifying the generic standards to which all drawings and CADD (Computer-Aided Design and Drafting) files for use by the Corporation shall conform.

### 3.3 Drawing Management System (DMS)

The Corporation maintains a central Drawing Management System (DMS) to keep all CADD files of a project, including preliminary design, detailed design, tender, construction, as-built, operations and maintenance, and asset modification/upgrade. The DMS serves as a database for all completed drawings of these stages.

## 4 Drawing Numbering Standards

### 4.1 Drawings

Drawings produced by or for Operations shall be numbered according to the Operations Engineering Department Drawing Numbering System included in Appendix of this document for the purpose of maintaining their information integrity, consistency and backward compatibility. It is essential that drawings are numbered according to this system so that they can be stored in and managed by the Drawing Management System (DMS).

### 4.2 Drawing File Name

The file naming convention shall correspond to the drawing number plus revision, except that the individual codes shall be separated by an underscore instead of "/" and an underscore in-between the Serial Number and the revision. The file extension shall be determined by the native format of the Drawings files.

Examples:

Drawing No. & Revision	Drawing File Name
OD4/305/00041/0016 rev. B	OD4_305_00041_0016_B.PDF
OD4/432/31603/443 rev. A	OD4_432_31603_0443_A.DWG
OD4/204/12305/0004 rev. A	OD4_204_12305_0004_A.DWG
OD4/203/110106/0001 rev. A1	OD4_203_110106_0001_A1.DGN

## 5 Reference

MTR Drawing and CADD Manual.

## **Appendix**

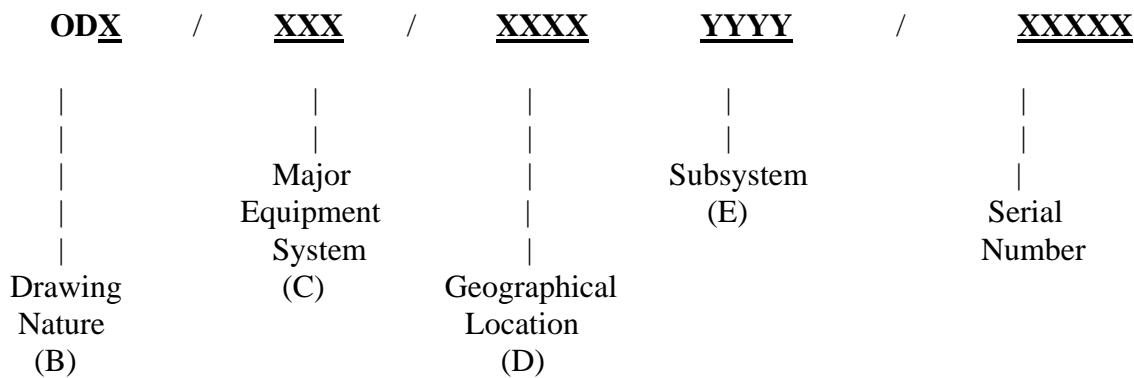
### **Operations Engineering Department Drawing Numbering System**

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## A) Format

The following numbering format will be used for OED drawings excluding sketches:



where Xs are numeric codes.

Ys are alphanumeric codes (type of Major Equipment System Dependence)

## B) Nature Codes

- 1 - Design Drawing
- 2 - Tender Drawing
- 3 - Working Drawing
- 4 - As Constructed Drawing
- 5 - Spare Parts Drawing
- 6 - Statutory Record Drawing
- 7 - EDOCs - Drawing Records
- 8 - Standards Drawing

## C) Major Equipment System Codes

### 000 Standard Borders

### 050 Drawing Standards

### 100 General Symbols

### 200 E&M Services

- 201 - HV Power Supply System
- 202 - Overhead Line System
- 203 - LV Electrical Services System
- 204 - Environmental Control System
- 206 - Fire Detection and Suppression System
- 207 - Hydraulic Lifts
- 208 - Escalators
- 209 - Floodgates
- 210 - Generators
- 211 - Plumbing & Drainage System / Gas Service System
- 212 - Gas Purging System
- 213 - Lifting Facilities
- 214 - Conveyor System - Cash Transfer, Baggage & Pneumatic Tube
- 215 - Mechanical Ventilation & Air Conditioning (Estate)
- 216 - Plumbing and Drainage (Estate)
- 217 - Refuse Handling (Estate)
- 218 - Security System

### 300 Rolling Stock

- 301 - EMU
- 302 - EMU MELCO Chopper Equipment
- 303 - EMU GEC Chopper & Inverter
- 304 - EMU Airport Rail Link
- 305 - EMU Chopper Conversion
- 306 - EMU Additional Rolling Stock (H-Stock)
- 307 - EMU Modernization
- 308 - Calibration
- 309 - **EMU (C-Train)**

- 311 - Diesel Locomotives
- 312 - Battery/Electric Locomotive (Mark 1 & Mark II)
- 313 - Battery/Electric Locomotive (Mark III)

- 321 - Cash Wagon & 'Kawasaki' Engineering Wagon
- 322 - Track Cleaning Wagon
- 323 - Ultrasonic Testing Vehicle (UTV994)
- 324 - Tunnel Repair Wagon
- 325 - 'Zhuzhou' Long Flat Wagon

- 326 - 'Zhuzhou' Well Wagon
- 327 - Hydraulic High Level Platform Wagon
- 328 - Track Cleaning Vehicle (TCV 1029, 1038)
- 331 - Rail Grinding Unit (RGU 995A - RGU 995C)
- 332 - Tamping Machine (TMS 992)
- 333 - New Grinding Car (RGU1052 & RGU1053)
- 334 - Tamping Vehicle (TMS1049)
- 335 - Ultrasonic Testing Vehicle (UTV 996)
- 336 - Track and Overhead Line Geometry Recording Vehicle (TOV1050)
- 337 - Rail Handing Crane Vehicle (RHV1067, RHV1068)
- 338 - Ballast Hopper Wagon (BHW1061 to 1066)
- 339 - Bridge Inspection Vehicle (BIV1051)
- 340 - Overhead Line Inspection Vehicles (OIV1069, OIV1070)
- 341 - Overhead Line Emergency Rescue Wagon
- 342 - Advertising Train Carriage
- 343 - Overhead Line Inspection Vehicles (OIV Geismar)

#### **350 Rolling Stock (AEL & TCL)**

- 351 - EMU (AEL)
- 352 - EMU (TCL)
- 353 - EMU (AEL/TCL)
- 354 - APM
- 355 - EMU (DRL)

#### **360 Rolling Stock (TKE/TCL/EAL)**

- 361 - EMU (TKE)
- 362 - EMU (TCL K-train)
- 367 - EMU(MLR 3094)
- 368 - EMU(MLR K01)
- 369 - EMU(MLR K03)
- 370 - EMU(MLR K05)

#### **370 Rolling Stock (WELM)**

- 371 - EMU (ERL MLR)
- 372 - EMU (SP1900)
- 373 - EMU (SP1950)
- 374 - EMU (KRS991)
- 375 - EMU (LRV Phase I)
- 376 - EMU (LRV Phase II)
- 377 - EMU (LRV Phase III)
- 378 - EMU (LRV Phase IV)
- 379 - EMU (LRV Phase I MLR)

#### **380 Locomotive (KTT)**

- 381 - Coach (KTT)
- 382 - Locomotive (GM)
- 383 - Locomotive (SIEMENS)
- 384 - Locomotive (Schoma)
- 385 - Locomotive (CZ)
- 386 - Grinder C (HTT)
- 387 - RGV (Speno)
- 388 - Tamper (Plasser)
- 389 - TRC (Plasser)
- 390 - UTV
- 391 - MPV (Plasser)
- 392 - OLE (Geismar)
- 393 - VE (Enviro-Vac)
- 394 - VIU (MOOG)
- 395 - OIV (XF)
- 396 - VEM
- 397 - RV (Geismar)
- 398 - Wagon (ER)
- 399 - Wagon (ZZ)

3A1 - EAL EMU

## **400 Control and Communication**

- 401 - AFC Equipment
- 411 - Signals and Control Equipment
- 412 - Training School Signalling Equipment
- 413 - NSL/EAL Signalling System
- 414 - LRL Signalling System
- 415 - MOS Signalling System
- 416 - WRL Signalling System
- 417 - EWL Signalling System
- 421 - Telecommunication System
- 431 - Building Automation System
- 432 - Environmental Control System
- 433 - Power Remote Control System
- 434 - Signalling Control System
- 435 - Headquarters Building
- 436 - KBD Emergency Generator
- 441 - Equipment Layout
- 451 - Central Control System
- 452 - SMS - Station Management System
- 461 - Automatic Train Control
- 471 - Security/Public Address/CABD (Estate)
- 481 - Station Modification Projects (C&C Services)
- 491 - Station Management System

## **500 Civil and Architectural**

- 501 - Permanent Way
- 502 - Civil
- 503 - Architectural
- 504 - Structures (CWS)
- 505 - Building (Estate)
- 506 - Structure (Estate)
- 507 - Road (Estate)
- 508 - Landscape (Estate)
- 512 - Civil (BDS)
- 513 - Architectural (BDS)

## **600 Depot Maintenance Facilities**

## **700 Co-ordination Drawings**

- 701 - Combined Services Drawing
- 702 - Structural E&M Drawing
- 703 - Cable/Pipe Bracket Drawing
- 704 - Cast-In-Conduit Drawing
- 705 - Railway Inspection Drawing
- 706 - Projects In-Progress Information System

## **800 Statutory Record Drawings**

- 801 - BOO Approval Plans
- 811 - FSD Compartmentation Drawings
- 812 - FSD Ventilation Drawings
- 813 - Fire Services Equipment Approval Drawings
- 814 - Land Terrier Plans
- 815 - Master Layout Plans (Estate)

## **900 Miscellaneous**

- 901 - Operating
- 902 - Digitalised Survey Map
- 903 - Station Improvement Projects
- 904 - Marketing
- 905 - Platform Screen Doors
- 906 - Station Modification Projects (E&M Services)
- 907 - Operations Safety
- 908 - Station Facilities
- 909 - Signage & Facility Information System (SFIS) Master Drawing

## D) Geographical Location Codes

- 000 - General/Typical
- 001 - KTL Common/EHC Common
- 002 - TWL Common
- 003 - ISL Common
- 004 - AEL Common
- 005 - TCL Common
- 006 - AEL/TCL Common
- 007 - TKE Common
- 008 - QBR Common
- 009 - TWL/ISL Common
- 010 - DRL Common
- 011 - EAL
- 012 - WRL
- 013 - MOL
- 014 - LRL
- 015 - ERL
- 016 - EWL
- 019 - SIL**

1001 - Common to all station (EAL)  
1002 - EAL Common/MOL Common (ERL)  
1003 - EAL Common/WRL Common

2001 - Common to all station (WRL)  
2002 - WRL Common/LRL Common

3000 - Common to all station (LRL)

4001 - Common to all station (MOL)

5001 - Common to all Station(EWL)  
5002 - WRL Common/EWL Common  
5003 - MOS Common/EWL Common

## **100 - Stations**

- 101)
- 102) Reserved
- 103)
  
- 104 - Lam Tin (LAT)
- 105 - Kwun Tong (KWT)
- 106 - Ngau Tau Kok (NTK)
- 107 - Kowloon Bay (KOB)
- 108 - Choi Hung (CHH)
- 109 - Diamond Hill (DIH)
- 110 - Wong Tai Sin (WTS)

- 111 - Lok Fu (LOF)
- 112 - Kowloon Tong (KOT)
- 113 - Shek Kip Mei (SKM)
- 114 - Tsuen Wan (TSW)
- 115 - Tai Wo Hau (TWH)
- 116 - Kwai Hing (KWH)
- 117 - Kwai Fong (KWF)
- 118 - Lai King (LAK) & LAR interchange
- 119 - Mei Foo (MEF)
- 120 - Lai Chi Kok (LCK)
- 121 - Cheung Sha Wan (CSW)
- 122 - Sham Shui Po (SSP)
- 123 - Prince Edward (PRE)
- 124 - Mong Kok (MOK)
- 125 - Yau Ma Tei (YMT)
- 126 - Jordan (JOR)
- 127 - Tsim Sha Tsui (TST)
- 128 - Chai Wan (CHW)
- 129 - Heng Fa Chuen (HFC)
- 130 - Shau Kei Wan (SKW)
- 131 - Sai Wan Ho (SWH)
- 132 - Tai Koo (TAK)
- 133 - Quarry Bay (QUB)/Quarry Bay East Plant Building (QEX)
- 134 - North Point (NOP)
- 135 - Fortress Hill (FOH)
- 136 - Tin Hau (TIH)
- 137 - Causeway Bay (CAB)
- 138 - Wan Chai (WAC)
- 139 - Admiralty (ADM)
- 140 - Central (CEN)
- 141 - Sheung Wan (SHW)
- 142 - **Sai Ying Pun Station (SYP)**
- 143 - **HKU Station (HKU)**
- 144 - **Kennedy Town Station (KET)**
- 145 - AsiaWorld-Expo Station (AWE)
- 146 - AIR SER CLK
- 146 - Airport (AIR)
- 147 - TUC SER TUC
- 147 - Tung Chung (TUC)
- 148 - Disneyland Resort Station (DIS)
- 149 - Sunny Bay (SUN)
- 150 - Tai Ho Wan (THW)
- 151 - Tsing Yi (TSY)
- 153 - Nam Cheong (NAC)
- 154 - Olympic (OLY)
- 155 - Kowloon (KOW)
- 156 - Hong Kong (HOK)/Central Subway (CES)
- 157 - LAK-TCL, LAK-Siding

158) to 169) Reserved for future extension  
170 - Po Lam (POA)  
171 - Hang Hau (HAH)  
172 - Tseung Kwan O (TKO)  
173 - Tiu Keng Leng (TIK)  
174 - Yau Tong (YAT)  
175 - LOHAS Park (LHP) formerly named Tseung Kwan O South (TKS)  
180 - Hang Hau Passenger Transport Interchange (HHI)  
181 - Tiu Keng Leng Passenger Transport Interchange (TKI)  
182 - Tseung Kwan O Passenger Transport Interchange (TOI)

1101 - Hung Hom Station (HUh) (EAL)  
1102 - Mong Kok East Station (MKK)  
1103 - Kowloon Tong Station (KOT) (EAL)  
1104 - Tai Wai Station (TAW) (EAL)  
1105 - Sha Tin Station (SHT)  
1106 - Fo Tan Station (FOT)  
1107 - Racecourse Station (RAC)  
1108 - University Station (UNI)  
1109 - Tai Po Market Station (TAP)  
1110 - Tai Wo Station (TWO)  
1111 - Fanling Station (FAN)  
1112 - Sheung Shui Station (SHS)  
1113 - Lo Wu Station (LOW)  
1114 - Lok Ma Chau Station (LMC)  
1120 - Admiralty Station (NSL)  
1121 - Exhibition Station (NSL)  
1122 - Hung Hom Station (NSL)  
1123 - Mong Kok East Station (NSL)  
1124 - Kowloon Tong Station (NSL)  
1125 - Tai Wai Station (NSL)  
1126 - Sha Tin Station (NSL)  
1127 - Fo Tan Station (NSL)  
1128 - Racecourse Station (NSL)  
1129 - Ho Tung Lau Depot (NSL)  
1130 - University Station (NSL)  
1131 - Tai Po Station (NSL)  
1132 - Tai Wo Station (NSL)  
1133 - Fanling Station (NSL)  
1134 - Sheung Shui Station (Up) (NSL)  
1135 - Sheung Shui Station (Down) (NSL)  
1136 - Lo Wu Station (NSL)  
1137 - Sheung Shui Ventilation Building SER (NSL)  
1138 - Kwu Tung Station (NSL)  
1139 - Chau Tau Ventilation Building SER (NSL)  
1140 - LMC Emergency Access Point 7 SER (NSL)  
1141 - Lok Ma Chau Station (NSL)

2101 - Tuen Mun station (TUM)

2102 - Siu Hong station (SIH)  
2103 - Tin Shui Wai station (TIS)  
2104 - Long Ping station (LOP)  
2105 - Yuen Long station (YUL)  
2106 - Kam Sheung Road station (KSR)  
2107 - Tsuen Wan West station (TWW)  
2108 - Mei Foo station (MEF) (WRL)  
2109 - Nam Cheong station (NAC) (WRL)  
2110 - Austin Station (AUS)  
2111 - East Tsim Sha Tsui Station (ETS)  
2112 - Hung Hom Station (HUH) (WRL)

3001 - Stop 001 Ferry Pier Terminus 屯門碼頭總站  
3010 - Stop 010 Melody Garden 美樂  
3015 - Stop 015 Butterfly 蝴蝶  
3020 - Stop 020 LRT Depot 輕鐵車廠  
3030 - Stop 030 Lung Mun 龍門  
3040 - Stop 040 Tsing Shan Tsuen 青山村  
3050 - Stop 050 Tsing Wun 青雲  
3060 - Stop 060 Kin On 建安  
3070 - Stop 070 Ho Tin 河田  
3075 - Stop 075 Choy Yee Bridge 蔡意橋  
3080 - Stop 080 Affluence 澤豐  
3090 - Stop 090 Tuen Mun Hospital 屯門醫院  
3100 - Stop 100 Siu Hong 兆康  
3110 - Stop 110 Kei Lun 麒麟  
3120 - Stop 120 Ching Chung 青松  
3130 - Stop 130 Kin Sang 建生  
3140 - Stop 140 Tin King 田景  
3150 - Stop 150 Leung King 良景  
3160 - Stop 160 San Wai 新圍  
3170 - Stop 170 Shek Pai 石排  
3180 - Stop 180 Shan King (N) 山景北  
3190 - Stop 190 Shan King (S) 山景南  
3200 - Stop 200 Ming Kum 鳴琴  
3212 - Stop 212 Tai Hing (N) 大興北  
3220 - Stop 220 Tai Hing (S) 大興南  
3230 - Stop 230 Ngan Wai 銀圍  
3240 - Stop 240 Siu Hei 兆禧  
3250 - Stop 250 Tuen Mun Swimming Pool 屯門泳池  
3260 - Stop 260 Goodview Garden 豐景園  
3265 - Stop 265 Siu Lun 兆麟  
3270 - Stop 270 On Ting 安定  
3275 - Stop 275 Yau Oi 友愛  
3280 - Stop 280 Town Centre 市中心

3295 - Stop 295 Tuen Mun 屯門  
3300 - Stop 300 Pui To 杯渡  
3310 - Stop 310 Hoh Fuk Tong 何福堂  
3320 - Stop 320 San Hui 新墟  
3330 - Stop 330 Prime View 景峰  
3340 - Stop 340 Fung Tei 凤地  
3350 - Stop 350 Lam Tei 藍地  
3360 - Stop 360 Nai Wai 泥圍  
3370 - Stop 370 Chung Uk Tsuen 鍾屋村  
3380 - Stop 380 Hung Shui Kiu 洪水橋  
3385 - Stop 385 Hung Tin Road 洪天路  
3390 - Stop 390 Tong Fong 塘坊村  
3400 - Stop 400 Ping Shan 屏山  
3425 - Stop 425 Hang Mei Tsuen 坑尾村  
3430 - Stop 430 Tin Shui Wai (Interchange) 天水圍  
3435 - Stop 435 Tin Tsz 天慈  
3445 - Stop 445 Tin Yiu 天耀  
3448 - Stop 448 Locwood 樂湖  
3450 - Stop 450 Tin Wu 天湖  
3455 - Stop 455 Ginza 銀座  
3460 - Stop 460 Tin Shui 天瑞  
3468 - Stop 468 Chung Fu 頌富  
3480 - Stop 480 Tin Fu 天富  
3490 - Stop 490 Chestwood 翠湖  
3500 - Stop 500 Tin Wing / Terminus 天榮  
3510 - Stop 510 Tin Yuet 天悅  
3520 - Stop 520 Tin Sau 天秀  
3530 - Stop 530 Wetland Park 濕地公園  
3540 - Stop 540 Tin Heng 天恒  
3550 - Stop 550 Tin Yat / Terminus 天逸  
3560 - Stop 560 Shui Pin Wai 水邊圍  
3570 - Stop 570 Fung Nin Road 豐年路  
3580 - Stop 580 Hong Lok Road 康樂路  
3590 - Stop 590 Tai Tong Road (S) 大棠路  
3600 - Stop 600 Yuen Long Terminus 元朗總站  
3920 - Stop 920 Sam Shing Terminus 三聖總站  
3888 - Stop 888 Tuen Mun Maintenance Centre 屯門維修中心

4101 - Tai Wai Station (TAW) (MOL)  
4102 - Che Kung Temple Station (CKT)  
4103 - Sha Tin Wai Station (STW)  
4104 - City One Station (CIO)  
4105 - Shek Mun Station (SHM)  
4106 - Tai Shui Hang Station (TSH)  
4107 - Heng On Station (HEO)

4108 - Ma on Shan Station (MOS)  
4109 - Wu Kai Sha Station (WKS)

5101 - Tuen Mun Station(EWL)  
5102 - Siu Hong Station(EWL)  
5103 - Tin Shui Wai Station(EWL)  
5104 - Long Ping Station(EWL)  
5105 - Yuen Long Station(EWL)  
5106 - Kam Sheung Road Station(EWL)  
5107 - Tsuen Wan West Station(EWL)  
5108 - Mei Foo Station(EWL)  
5109 - Nam Cheong Station(EWL)  
5110 - Austin Station(EWL)  
5111 - East Tsim Sha Tsui Station(EWL)  
5112 - Hung Hom Station(EWL)  
5113 - Ho Man Tin Station(EWL)  
5114 - Ma Tau Wai Station(EWL)  
5115 - To Kwa Wan Station(EWL)  
5116 - Kai Tak Station(EWL)  
5117 - Diamond Hill Station(EWL)  
5118 - Hin Keng Station(EWL)  
5119 - Tai Wai Station(EWL)  
5120 - Che Kung Temple Station(EWL)  
5121 - Sha Tin Wai Station(EWL)  
5122 - City One Station(EWL)  
5123 - Shek Mun Station(EWL)  
5124 - Tai Shui Hang Station(EWL)  
5125 - Heng On Station(EWL)  
5126 - Ma On Shan Station(EWL)  
5127 - Wu Kai Sha Station(EWL)

## 200 Open/Tunnel Sections

201 - QUB Overrun  
202 - QVB to QUB Both  
203 - CVB to QVB Both  
204 - LAT to CVB Both/LAT to YAT Both  
205 - KWT to LAT Both and all  
206 - NTK to KWT Both and all  
207 - KOB to NTK Both  
208 - KBD Arrival, Departure & Reception Tracks, Both & all  
209 - CHH to KOB Both and all  
210 - DIH to CHH Both and all  
211 - WTS to DIH Both  
212 - LOF to WTS Both  
213 - KOT to LOF Both  
214 - SKM to KOT Both  
215 - PRE to SKM Both and all  
216 - MOK to PRE Both KWT Line

- 217 - YMT to MOK Both and all KWT Line
- 218 - YMT Overrun
- 219 - TSW Headshunts Both and all
- 220 - TWD Reception Tracks Both
- 221 - TWH to TSW Both
- 222 - KWH to TWH Both and all
- 223 - KWF to KWH Both
- 224 - LAK to KWF Both
- 225 - MEF to LAK Both and all
- 226 - LCK to MEF Both
- 227 - CSW to LCK Both
- 228 - SSP to CSW Both
- 229 - PRE to SSP Both
- 230 - MOK to PRE Both TSW Line
- 231 - MOK Upper Level Interlocking Area
- 232 - MOK Lower Level Interlocking Area
- 233 - YMT to MOK Both TSW Line
- 234 - JOR to YMT Both
- 235 - TST to JOR Both and all
- 236 - NVB to TST Both
- 237 - SVB to NVB Both (Immersed Tube)
- 238 - ADM to SVB Both
- 239 - ADM to CEN Sidings Both and all
- 240 - CEN to ADM Both and all TSW Line
- 241 - CEN Overrun
- 242 - CHW Overrun
- 243 - HFC to CHW Both and all
- 244 - CWD Reception Tracks
- 245 - SKW to HFC Both
- 246 - SWH to SKW Both
- 247 - TAK to SWH Both and all
- 248 - QUB to TAK Both and all
- 249 - NOP to QUB Both
- 250 - FOH to NOP Both
- 251 - TIH to FOH Both
- 252 - CAB to TIH Both
- 253 - WAC to CAB Both and all
- 254 - ADM to WAC Both
- 255 - CEN to ADM Both Island Line
- 256 - ADM Upper and Lower Level Interlocking Area
- 257 - SHW to CEN Both
- 258 - SHW Overrun
- 259) to 260) Reserved for future extension
- 261 - AIR overrun
- 262 - AIR to TUC and both
- 263 - TUC overrun
- 264 - TUC to TSY and both (Rambler Channel Bridge)
- 265 - Reserved for future extension
- 266 - SUN to TSY and both

- 267 - TUC to SUN and both
- 268 - TSY to LAK and both
- 269 - LAK to OLY and both
- 270 - LAK to NAC and both
- 271 - NAC to OLY and both
- 272 - OLY to KOW and both
- 273 - KOW to HOK and both (Western Immersed Tube)
- 274 - HOK Overrun / TSY to TYP and both
- 275) to 286) Reserved for future extension
- 287 - POA Overrun
- 288 - POA to HAH and both
- 289 - HAH to TKO and both
- 290 - TKO TO TIK and both
- 291 - TIK to YAT and both
- 292 - YAT to QVB and both
- 293 - YAT to LAT and both
- 295 - TKO to LHP and both
- 296 - NOP Overrun
- 298 - SUN to DIS and both
- 299 - DIS Overrun
  
- 1201 - HUH to T1A Both
- 1202 - T1A to MKK Both
- 1203 - HUH to MKK Both
- 1204 - MKK to KOT Both
- 1205 - KOT to T02 Both
- 1206 - T02 to TAW Both
- 1207 - KOT to TAW Both
- 1208 - TAW to SHT Both
- 1209 - SHT to FOT Both
- 1210 - SHT to RAC Both
- 1211 - SHT to HTD Both
- 1212 - FOT to UNI Both
- 1213 - RAC to UNI Both
- 1214 - HTD to UNI Both
- 1215 - UNI to T05 Both
- 1216 - UNI to T05A Both
- 1217 - UNI to TAP Both
- 1218 - T05 to TAP Both
- 1219 - T05A to TAP Both
- 1220 - TAP to TWO Both
- 1221 - TWO to FAN Both
- 1222 - FAN to SHS Both
- 1223 - SHS to LOW Both
- 1224 - SHS to LMC Both
- 1225 - SHS to LMT Both
- 1226 - LMT to LMC Both
- 1227 - Tunnel 1
- 1228 - Tunnel No.1A (Ho Man Tin)

- 1229 - Tunnel No.2 (Beacon Hill Tunnel)
- 1230 - Tunnel No.5 (Tai Po Kau - Down Track)
- 1231 - Tunnel No.5A (Tai Po Kau - Up Track)
- 1232 - Chau Tau Tunnel (Lok Ma Chau)
- 1233 - Tunnel No. 2 South Portal
- 1234 - Tunnel No. 2 North Portal
- 1235 - Tunnel No. 5/5A South Portal
- 1236 - Tunnel No. 5/5A North Portal
- 1237 - Kowloon Goods Yard Section
- 1238 - Hum Hom Section
- 1239 - Mong Kok East Section
- 1240 - Kowloon Tong Section
- 1241 - Beacon Hill Section
- 1242 - Tai Wai Section
- 1243 - Sha Tin North Section
- 1244 - Sha Tin South Section
- 1245 - Fo Tan Section
- 1246 - Racecourse North Section
- 1247 - Racecourse South Section
- 1248 - Ho Tung Lau Section
- 1249 - Pak Shek Kok Section
- 1250 - Tai Po Kau Section
- 1251 - Tai Po Market Section
- 1252 - Fanling Section
- 1253 - Sheung Shui Section
- 1254 - Lo Wu Section
- 1255 - Lok Ma Chau Section
- 1256 - Sheung Shui Abattoir Siding
- 1257 - Kowloon Goods Yard Departure & Reception Tracks
- 1258 - Ho Tung Lau Depot Departure & Reception Tracks
- 1259 - Lo Wu Goods Yard Departure & Reception Tracks
- 1260 - Training Track at University North
- 1261 - Ho Tung Lau South
- 1262 - Ho Tung Lau North
  
- 2201 - TUM to SIH Both
- 2202 - SIH to TIS Both
- 2203 - TIS to LOP Both
- 2204 - LOP to YUL Both
- 2205 - YUL to KSR Both
- 2206 - KSR to PHD Both
- 2207 - PHD to TWW Both
- 2208 - KSR to TWW Both
- 2209 - TWW to MEF Both
- 2210 - MEF to NAC Both
- 2211 - NAC to AUS Both
- 2212 - AUS to ETS Both
- 2213 - ETS to HUH Both
- 2214 - Tai Lam Tunnel

- 2215 - Kwai Tsing Tunnel  
2216 - Tai Lam Tunnel South Portal  
2217 - Tai Lam Tunnel North Portal  
2218 - Pat Heung Depot Departure and Reception Tracks Both  
2219 - ETS Turnback  
2220 - Austin Turnback  
2221 - NAC Turnback  
2222 - TIS Turnback
- 3201 - Wu Chui Rd. / Mei Lok Lane  
3202 - Wu Chui Rd. / Tip King Rd. (Entrance of Melody Garden)  
3203 - Lung Mun Rd. (LRT Depot Emergency Exit)  
3204 - Lung Mun Rd. (LRT Depot Entrance / Exit)  
3205 - Tsing Wun Rd. / Hing Choi St.  
3206 - Ming Kum Rd. / Yeung King Rd.  
3207 - Ming Kum Rd. (Shan King Estate South Entrance / Exit)  
3208 - Tin King Rd. (Leung King Estate South Entrance / Exit)  
3209 - Tin King Rd. (Leung King Estate North Entrance / Exit)  
3210 - Ming Kum Rd. / Tin King Rd.  
3211 - Yau Oi Rd. / Oi Yung St. Entrance  
3213 - Yau Oi Rd. / Oi Fai House Carpark Entrance / Exit  
3214 - Yau Oi Rd. / Oi Lok House North Entrance  
3215 - Yau Oi Rd. / Oi Lok House South Exit  
3216 - Yau Oi Rd. / Oi Chi House Carpark Entrance / Exit  
3217 - Yau Oi Rd. / Oi Yung St. Exit  
3218 - Tuen Mun Heung Sze Wui Rd. / Yau Oi Rd.  
3219 - Tai Fong St. (Tai Hing Bus Terminus Entrance)  
3221 - Tai Fong St. (Tai Hing Bus Terminus Exit)  
3222 - Tai Fong St. (Tai Hing Estate Carpark Entrance / Exit)  
3223 - Tai Fong St. / Tai Hing St.  
3224 - Tai Fong St. (Carpark Entrance / Exit Opposite to Tai Hin Estate Hing Tai House)  
3225 - Tai Fong St. (Carpark Entrance / Exit next to Leung Choi Lane)  
3226 - Tai Fong St. / Leung Choi Lane  
3227 - Tsun Wen Rd. / Tsing Lun Rd.  
3228 - Leung Wan St. (Kin Sang Estate Entrance)  
3229 - Tsing Lun Rd. (Tuen Mun Hospital, LRT Interchange)  
3231 - Tsing Lun Rd. (Siu Hong LRT Station Entrance / Exit)  
3232 - Castle Peak Rd. - Lam Tei (Rd. Entrance / Exit opposite to Miu Fat Buddhist Monastery)  
3233 - Castle Peak Rd. - Lam Tei / Ng Lau Rd. (Tsing Chuen Wai Entrance / Exit)  
3234 - Castle Peak Rd. - Lam Tei (Rd. Entrance / Exit opposite to Kam Cheong Garden)  
3235 - Castle Peak Rd. - Hung Shui Kiu / Shun Tat St.  
3236 - Castle Peak Rd. - Hung Shui Kiu / Yick Yuen Rd. (Ling Liang Church)  
3237 - Castle Peak Rd. - Hung Shui Kiu (Opposite to Kwong Tin St.)  
3238 - Castle Peak Rd. - Hung Shui Kiu / Hung Shui Kiu Main St.  
3239 - Castle Peak Rd. - Hung Shui Kiu (Hung Tai Rd. Entrance / Exit)  
3241 - Castle Peak Rd. - Hung Shui Kiu / Hung Tin Rd.

- 3242 - Castle Peak Rd. - Ping Shan (Petrol Station Entrance / Exit)  
3243 - Castle Peak Rd. - Ping Shan (Century Centre Entrance / Exit)  
3244 - Castle Peak Rd. - Ping Shan / Yung Yuen Rd.  
3245 - Castle Peak Rd. - Ping Shan (Entrance / Exit Opposite to Villa Sunshine)  
3246 - Castle Peak Rd. - Ping Shan (Entrance / Exit of Hong Ping Garden)  
3247 - Wu Chui Rd. (Tuen Mun Ferry Pier Bus Terminus Exit)  
3248 - Wu Chui Rd. (Under the Footbridge of Richland Garden)  
3249 - Tsing Lun Rd. / Kei Tsing St.  
3251 - Siu Hong Rd. (Siu Hong Court Bus Terminal to Siu Hong West Rail Station Emergency Access)  
3252 - Ming Kum Rd. (LRT to Shan King Estate Interchange)  
3253 - Pui To Rd. (Kin On St. Pedestrian Crossing)  
3254 - Castle Peak Rd. - Yuen Long Section (Ping Lok Path Pedestrian Crossing)  
3255 - Tuen Mun Heung Sze Wui Rd. / Siu Lun Court (Opposite to Wing Lung House)  
3256 - Tuen Mun Heung Sze Wui Rd. / Siu Lun St.  
3257 - Tuen Mun Heung Sze Wui Rd. / Town Centre South (Opposite to Tuen Mun Magistracy)  
3258 - Tuen Mun Heung Sze Wui Rd. / Town Centre North (Opposite to the Trend Plaza)  
3259 - Tuen Mun Heung Sze Wui Rd. / Pui To Rd. (Viaduct)  
3261 - Chak Fung St. (Affluence Garden / Chelsea Heights)  
3262 - Pui To Rd. Near Tuen Mun Police Station (Viaduct)  
3263 - Tsing Lun Rd. / Tuen Mun Hospital North  
3264 - Siu Hong Court / Stop Siu Hong  
3266 - Lung Mun Rd. / Wu Chui Rd.  
3267 - Lung Mun Rd. / Stop Lung Mun (Opposite to Glorious Garden)  
3268 - Pui To Rd. / Ming Kam Rd.  
3269 - Ming Kam Rd. / Shek Pai Tau Rd.  
3271 - Ming Kam Rd. / Tin King Rd.  
3272 - Tuen Mun Heung Sze Wui Rd. (Yau Oi Rd. Entrance)  
3273 - Tsun Wen Rd. / Tai Fong St.  
3274 - Tsing Chung Koon Rd. / Tsing Lun Rd.  
3276 - Castle Peak Rd. - Hung Shui Kiu / Tin Ha Rd.  
3277 - Castle Peak Rd. - Ping Shan / Ping Ha Rd.  
3278 - Castle Peak Rd. - Yuen Long / Ma Wang Rd.  
3279 - Castle Peak Rd. - Yuen Long / Ma Miu Rd.  
3281 - Castle Peak Rd. - Yuen Long / Kik Yeung Rd.  
3282 - Castle Peak Rd. - Yuen Long / Hong Lok Rd. Pedestrian Crossing  
3283 - Castle Peak Rd. - Yuen Long / Tai Tong Rd. (Kuk Ting St.)  
3284 - Castle Peak Rd. - Yuen Long / Fung Cheung Rd.  
3285 - Castle Peak Rd. - Yuen Long / On Lok Rd.  
3286 - Tin Yiu Rd. (Tin Yiu Estate Bus Terminus Entrance)  
3287 - Tin Shing Rd. / Tin Yau Court Entrance / Exit  
3288 - Tin Shui Rd. (Tin Shui Estate Bus Terminus Entrance)  
3289 - Tin Shui Rd. (Tin Shui Estate Carpark Entrance)  
3290 - Tin Wing Rd. / Tin Yan Rd.  
3291 - Tin Yan Rd. / Tin Cheung Rd.  
3292 - Tin Shui Rd. / Tin Tan Rd.  
3293 - Ping Ha Rd. / Kiu Wong St. (Hang Mei Tsuen)

3294 - Ping Ha Rd. / Tsui Sing Rd.  
3296 - Ping Ha Rd. / Tin Fuk Rd.  
3297 - Choi Yee Bridge (Kin Shing Lane)  
3298 - Tin Yiu Rd. / Tin Wu Rd.  
3299 - Wetland Park Rd. (Grandeur Terrace Emergency Exit)  
3301 - Tin Shing Rd. / Tin Wu Rd.  
3302 - Tin Shui Rd. / Tin Wing Rd.  
3303 - Tin Wing Rd. / Tin Shing Rd.  
3304 - Wu Chui Rd. (Tuen Mun Ferry Pier Bus Terminus Entrance)  
3305 - Hoi Wong Rd. / Wu Shan Rd.  
3306 - Hoi Wong Rd. / Hoi Wing Rd.  
3307 - Tuen Mun Heung Sze Wui Rd. / Hoi Chu Rd.  
3308 - Tuen Mun Heung Sze Wui Rd. / Hoi Wing Rd.  
3309 - Castle Peak Rd. - San Hui / San Sau St.  
3311 - Castle Peak Rd. - San Hui / San Hui Path  
3312 - Castle Peak Rd. - San Hui/ King Fung Path  
3313 - Tin Shui Rd. (Chung Fu Shopping Centre Pedestrian Crossing)  
3314 - Tin Shui Rd. (Chung Fu Shopping Centre Pedestrian Crossing)  
3315 - Tin Wah Rd. / Tin Shing Rd.  
3316 - Tin Shing Rd. / Tin Yan Rd.  
3317 - Tin Shui Rd. / Grandeur Terrace Entrance / Exit  
3318 - Tin Sau Rd. / Yat Fu House  
3319 - Tin Sau Rd. / Tin Shui Rd. (near Stop Tin Yat)  
3321 - Wetland Park Rd. / near Vianni Cove  
3322 - Castle Peak Rd. - Ping Shan / near Fui Sha Wai  
3323 - Castle Peak Rd. - Ping Shan / Ping Kwai Rd.

4201 - WKS to MOS Both  
4202 - MOS to HEO Both  
4203 - HEO to TSH Both  
4204 - TSH to SHM Both  
4205 - SHM to CIO Both  
4206 - CIO to STW Both  
4207 - STW to CKT Both  
4208 - CKT to TAW Both  
4209 - TAW to TAD Both  
4210 - TAD Arrival & Departure Tracks Both  
4211 - TAW turnback  
4212 - CIO Pocket Track  
4213 - HEO turnback

5200 - Hung Hom Stabling Sidings(EWL)

### **300 Ancillary Buildings & Signal Interlocking Area**

301 - Quarry Bay Ventilation Building (QVB)  
302 - Cha Kwo Ling Ventilation Building (CVB)  
303 - Cha Kwo Ling Portal (CKP)  
304 - Kai Tin Traction Substation (KTT)/Kai Tin Portal (KTP)

- 305 - Choi Shek Portal Ventilation Building (CSP)
- 306 - Ping Shek Ventilation Building (PSK)
- 307 - Kwun Tong Road Ventilation Building (KWR)
- 308 - Hammer Hill Road Ventilation Building (HHR)
- 309 - Gascoigne Road Traction Substation/Vent.Building (GAR)
- 310 - West Portal Ventilation Building-TSW (WPV)
- 311 - East Portal Ventilation Building-KWH (EPV)
- 312 - Kwai Fong Distribution Centre (KDC)
- 313 - Mid Tunnel Ventilation Building (MTV)
- 314 - Tai Kok Tsui Intake Cell (TIC)
- 315 - Cheung Sha Wan Traction Substation (CST)
- 316 - Central Refrigeration Plant (CRP)
- 317 - North Ventilation Building (NVB)
- 318 - North Intake Cell (NIC)
- 319 - South Intake Cell (SIC)
- 320 - South Ventilation Building (SVB)
- 321 - Chai Wan Portal Ventilation Building (CWV)
- 322 - Sai Wan Ho Traction Substation (SHT)
- 323 - Pak Fuk Distribution Substation (PFD)
- 324 - Tin Hau Traction Substation (THT)
- 325 - Admiralty Distribution Substation (ADD)
- 326 - Sheung Wan Traction Substation (SWT)
- 327 - Beacon Hill (BEH)
- 328 - Quarry Bay Infeed Substation (QIS)
- 329 - NOP New Plant Building (NPB)
- 340 - Chek Lap Kok Traction Substation (CHT)
- 341 - Tung Chung Traction Substation (TUT)
- 342 - Tung Chung Tunnel Portal (TCP)
- 343 - Siu Ho Wan Depot Traction Substation (SDT)
- 344 - Sham Shui Kok Traction Substation (SST)
- 345 - Yam O Traction Substation (YOT)
- 346 - East Lantau Tunnel (East) Traction Substation (ELT)
- 347 - East Lantau Tunnel (West) Ventilation Building (ELV)
- 348 - Tsing Yi Ventilation Building with Traction Substation (TVB)
- 349 - Tsing Yi Cooling Water Intake for Station (TYI)
- 350 - Tsing Yi Traction Substation (TYT)
- 351 - AEL/TCL Operation Control Centre (OCC)
- 351 - TSY OCC & CER
- 352 - Lai King Traction Substation (LKT)
- 353 - Lai King Ventilation Building (LVB)
- 354 - Lai Chi Kok Traction Substation (LCT)
- 355 - Tai Kok Tsui Traction Substation (TTS)
- 356 - Tai Kok Tsui Ventilation Building (TKV)
- 357 - Kowloon Ventilation Building with Traction Substation (KVB)
- 358 - Kowloon Cooling Water Intake for Station (KIC)
- 359 - Hong Kong Power Supply Building (HPB)
- 360 - Hong Kong Ventilation Building with Traction Substation (HVB)
- 361 - Hong Kong Cooling Water Intake for Station (HIC)
- 362 - Hong Kong Cooling Water Intake for Development (HID)

370 - New Cha Kwo Ling Ventilation Building (NCB)  
371 - Yau Tong Ventilation Building (YVB)  
372 - TKO Traction Infeed Substation (TTI)  
373 - Pak Shing Kok Ventilation Building (PVB)

375 - HOK AEL Platform Level  
376 - HOK TCL Platform Level  
377 - KOW AEL Platform Level  
378 - KOW TCL Platform Level  
379 - TSY UP Platform  
380 - TSY DN Platform

1301 - MTR Hung Hom Freight Terminal  
1302 - Hung Hom Bay Freight Yard  
1303 - MTR Freight Head Office  
1304 - MTR Freight Operations Building  
1305 - Hung Hom Ventilation Building  
1306 - Hung Hom Station Car Park  
1307 - Kowloon Goods Yard STA Building  
1308 - Kowloon Goods Yard Signal Cabin  
1309 - Ho Man Tin Feeder Station  
1310 - Ho Man Tin Goods Yard  
1311 - MTR Mong Kok Freight Terminal  
1312 - Kowloon Tong Ventilation Building  
1313 - Tai Wai Ventilation Building  
1314 - Tai Wai Feeder Station  
1315 - MTR Sha Tin Freight Terminal  
1316 - MTR Fo Tan Freight Terminal  
1317 - ERL Operation Control Centre & CER  
1318 - Tai Po Kau Track Section Cabin  
1319 - Tai Po Railway Museum  
1320 - Fanling Feeder Station  
1321 - Sheung Shui Ventilation Building  
1322 - MTR Lo Wu Marshalling Yard  
1323 - Chau Tau Ventilation Building  
1324 - Lok Ma Chau Track Section Cabin  
1325 - LMC Emergency Access Point 1  
1326 - LMC Emergency Access Point 2  
1327 - LMC Emergency Access Point 3  
1328 - LMC Emergency Access Point 4  
1329 - LMC Emergency Access Point 5  
1330 - LMC Emergency Access Point 6  
1331 - LMC Emergency Access Point 7

1501 - KY00/38Y  
1502 - KY00/52Y  
1503 - KN00/04L

1504 - KN00/04M  
1505 - KN00/36M  
1506 - KN00/55M  
1507 - KN00/79M  
1508 - KN00/96M  
1509 - MK01/12M  
1510 - MK01/51M  
1511 - MK01/85M  
1512 - MK02/12M  
1513 - MK02/32M  
1514 - MK02/51M  
1515 - MK02/85M  
1516 - KT03/04M  
1517 - KT03/32M  
1518 - KT03/76M  
1519 - KT04/17M(A)  
1520 - KT04/17M(B)  
1521 - BH04/56M(A)  
1522 - BH04/56M(B)  
1523 - BH04/71A  
1524 - BH04/71B  
1525 - BH05/09M  
1526 - BH05/25M  
1527 - BH05/60M  
1528 - BH05/76M  
1529 - BH06/11M  
1530 - BH06/23M  
1531 - BH06/60M  
1532 - BH06/71M  
1533 - BH07/08M(A)  
1534 - BH07/08M(B)  
1535 - TW07/16M  
1536 - TW07/57M  
1537 - TW07/85M  
1538 - TW08/14M  
1539 - TW08/53M  
1540 - TW08/96M  
1541 - ST09/15M  
1542 - ST09/73M  
1543 - ST09/45M  
1544 - ST09/95A  
1545 - ST09/95B  
1546 - ST09/95C  
1547 - SN10/37M(A)  
1548 - SN10/37M(B)  
1549 - SN10/37M(C)  
1550 - SN10/65M  
1551 - SN10/99M  
1552 - FT11/26M

1553 - FT11/62M  
1554 - FT11/83M  
1555 - FT12/21M  
1556 - FT12/48M  
1557 - FT12/80M  
1558 - HL12/56  
1559 - RC11/81R  
1560 - RC12/00R  
1561 - RC12/24R  
1562 - RC12/50R  
1563 - RC12/60R  
1564 - RN12/94R  
1565 - RN13/14M  
1566 - RN13/21R  
1567 - RN13/37M  
1568 - RN13/74M  
1569 - PS13/99M  
1570 - PS14/25M  
1571 - PS14/50M  
1572 - PS14/81M  
1573 - PS15/23M  
1574 - PS15/55M  
1575 - PS16/04M  
1576 - PS16/43M  
1577 - PS16/77M  
1578 - PS17/02M  
1579 - TK17/25M  
1580 - TK17/54M  
1581 - TK17/96M  
1582 - TK18/61M  
1583 - TK18/90M  
1584 - TK19/38M  
1585 - TK19/70M  
1586 - TK20/14M  
1587 - TP20/49M  
1588 - TP20/72M  
1589 - TP21/10M  
1590 - TP21/37M  
1591 - TP21/60M  
1592 - TP21/85M  
1593 - TP22/11M  
1594 - TP22/36M  
1595 - FL22/70M  
1596 - FL23/06M  
1597 - FL23/76M  
1598 - FL24/08M  
1599 - FL24/70M  
1600 - FL24/95M  
1601 - FL25/30M

1602 - FL25/60M  
1603 - FL25/88M  
1604 - FL26/10M  
1605 - FL26/64M  
1606 - FL27/02M  
1607 - FL27/48M  
1608 - FL27/70M  
1609 - FL28/15M  
1610 - FL28/51M  
1611 - SS28/80M  
1612 - SS29/11M  
1613 - SS29/47M  
1614 - SS29/70M  
1615 - SS30/10M  
1616 - SS30/88M  
1617 - SS31/16M  
1618 - SS31/57M  
1619 - SSCER  
1620 - LW32/10M  
1621 - LW32/40M  
1622 - LW32/65M  
1623 - LW32/92M  
1624 - LW33/08M  
1625 - LW33/47M  
1626 - LMC30/90E  
1627 - LMC32/85E  
1628 - LMC34/80E  
1629 - LMC35/93E  
1630 - LMC37/19E  
1631 - KNCER  
1632 - MKCER  
1633 - STCER  
1634 - RCCER  
1635 - TAPCER  
1636 - LWCER  
1637 - KN 00/37M  
1638 - SS 31/90M  
  
1651 - HTLD-PSA  
1652 - HTLD-PSB  
1653 - HTLD-PCA  
1654 - HTLD-PCB  
1655 - HTLD-PNA  
1656 - HTLD-PNB  
1657 - HTLD-L01A  
1658 - HTLD-L01B  
1659 - HTLD-L02A  
1660 - HTLD-L02B  
1661 - HTLD-L03A

- 1662 - HTLD-L03B
- 1663 - HTLD-L03C
- 1664 - HTLD-L04A
- 1665 - HTLD-L05A
- 1666 - HTLD-L05B
- 1667 - HTLD-L06A
- 1668 - HTLD-L07A
- 1669 - HTLD-L08A
- 1670 - HTLD-L08B
- 1671 - HTLD-L08C
- 1672 - HTLD-L09A
- 1673 - HTLD-L09B
- 1674 - HTLD-L09C
- 1675 - HTLD-L09D
- 1676 - HTLD-L10A
- 1677 - HTLD-L10B
- 1678 - HTLD-L11A
- 1679 - HTLD-L11B
- 1680 - HTLD-L12A
- 1681 - HTLD-L12B
- 1682 - HTLD-L14A
- 1683 - HTLD-L14B
- 1684 - HTLD-L16A
- 1685 - HTLD-L16B
- 1686 - HTLD-L16C
- 1687 - HTLD-L18A
- 1688 - HTLD-L18B
- 1689 - HTLD-L20A
- 1690 - HTLD-L20B
- 1691 - HTLD-L20C
- 1692 - HTLD-L22A
- 1693 - HTLD-L22B
- 1694 - HTLD-L24A
- 1695 - HTLD-L24B
- 1696 – SSSS L01
- 1697 – SSSS L02A
- 1698 – SSSS L02B
- 1699 – SSSS L03
  
- 2301 - Tuen Mun Track Section Cabin
- 2302 - Tin Shui Wai Feeder Station
- 2303 - Pat Heung Maintenance Centre Track Section Cabin
- 2304 - Hoi Pui Ventilation Building
- 2305 - Hoi Pui Track Section Cabin
- 2306 - Hoi Pui Electric Substation
- 2307 - Chai Wan Kok Ventilation Building
- 2308 - Kwai Fong Ancillary Building
- 2309 - Kwai Fong Feeder Station
- 2310 - Kwai Fong Ventillation Building

- 2311 - Lai Wan Chiller Plant Building
- 2312 - Prince Edward Ventilation Building
- 2313 - Yau Ma Tei Ventilation Building
- 2314 - Tsim Sha Tsui Ventilation Building
- 2315 - Pat Heung Maintenance Centre Locomotive Maintenance Building
- 2316 - Pat Heung Maintenance Centre Infrastructure & Building Maintenance Building
- 2317 - Pat Heung Maintenance Centre EMU Maintenance Building
- 2318 - Canton Road Emergency Access Point
- 2319 - Peking Road Emergency Egress point
- 2320 - WRL Emergency Access Point 7
- 2321 - WRL Emergency Access Point 8 (Shaft D)
- 2322 - WRL Emergency Access Point 9/10 (Wing Kei Road CH.13.550)
- 2323 - WRL Emergency Access Point 15
- 2324 - WRL Emergency Access Point 16
- 2325 - WRL Emergency Access Point 17
- 2326 - WRL Emergency Access Point 20
- 2327 - WRL Emergency Access Point 21
- 2328 - WRL Emergency Access Point 23
- 2329 - WRL Emergency Access Point 24
- 2330 - WRL Emergency Access Point 25
- 2331 - WRL Emergency Access Point 26
- 2332 - WRL Emergency Access Point 28
- 2333 - Tai Lam Tunnel TLT1 Niche
- 2334 - Tai Lam Tunnel MX13.5 Niche
- 2335 - Tai Lam Tunnel TLT2 Niche
- 2336 - WRL Operation Control Centre & CER
- 2337 - Pat Heung Depot TER
- 2338 - HA KWAI CHUNG(WKR EVA)
- 2339 - HA KWAI CHUNG TUNNEL NICHE
  
- 3401 - Ferry Pier Terminus Rectifier Station
- 3402 - Tsing Wun Rectifier Station
- 3403 - Oi Lin Loop Rectifier Station
- 3404 - Ho Tin Rectifier Station
- 3405 - Ming Kum Rectifier Station
- 3406 - Siu Hong Rectifier Station
- 3407 - Nai Wai Rectifier Station
- 3408 - Ping Shan Rectifier Station
- 3409 - Shui Pin Wai Rectifier Station
- 3410 - Yuen Long Terminus Rectifier Station
- 3411 - Tuen Mun Maintenance Centre Rectifier Station
- 3412 - Hoh Fuk Tong Rectifier Station
- 3413 - Tin Shui Rectifier Station
- 3414 - Tin Tsz Rectifier Station
- 3415 - Tin Wing Rectifier Station
- 3416 - Tin Yat Rectifier Station
- 3417 - Ho Tin CL&P Primary Sub-Station
- 3418 - Shui Pin Wai CL&P Primary Sub-Station
- 3419 - Tin Yat CL&P Primary Sub-Station

3420 - LRL Operation Control Centre & CER

- 4301 - Wu Kai Sha Feeder Station
- 4302 - Wu Kai Sha Public Transport Interchange
- 4303 - City One Track Section Cabin
- 4304 - Tai Wai Public Transport Interchange
- 4305 - MOL Emergency Access Point 1
- 4306 - MOL Emergency Access Point 7
- 4307 - MOL Emergency Access Point 8
- 4308 - MOL Emergency Access Point 12

#### **400 Headquarters and Depots**

- 401 - Headquarters Building (HQ) - (Demolished)
- 402 - Kowloon Bay Depot (KBD)
- 403 - Tsuen Wan Depot (TWD)
- 404 - Chai Wan Depot (CWD)
- 405 - World Trade Square (WTQ)
- 406 - Chevalier Commercial Centre (CCC)
- 407 - MTR Tower (HQ)
- 410 - Siu Ho Wan Depot (SHD)
- 411 - Tseung Kwan O Depot (TKD)
- 415 - THW TAT Mainline
- 416 - SHD TAT
- 417 - SHD AB3
- 418 - SHD Main Building
- 419 - SHD Training Track
- 430 - Wong Chuk Hang Depot (WCD)

- 1401- MTR Hung Hom Building
- 1402 - Citylink Plaza
- 1403 - Fo Tan Railway House (formerly KCRC House)
- 1404 - MTR Fo Tan Bus Depot
- 1405 - Ho Tung Lau Depot
- 1406 - Trackside Villas (Tai Po Kau Staff Quarter)

- 2401 - MTR Pat Heung Depot
- 2402 - MTR Kam Tin Building (formerly West Rail Building)

- 3501 - Tuen Mun Maintenance Centre
  - 3502 - Tuen Mun Bus Depot
  - 3503 - Tuen Mun Building
  - 3504 - Hung Shui Kiu Bus Depot
- 
- 4401 - Tai Wai Depot
  - 4402 - Tai Wai Depot EMU Maintenance Building
  - 4403 - Tai Wai Depot Infrastructure & Building Maintenance Building
  - 4404 - Tai Wai Depot Locomotive Maintenance Building

## **500 Estates**

- 501 - Telford Gardens
- 502 - Telford Centre
- 503 - Luk Yeung Sun Chuen
- 504 - Luk Yeung Sun Chuen - Shopping Arcade
- 505 - New Kwai Fong Gardens
- 506 - Admiralty Centre
- 507 - World Wide House
- 508 - Fairmont House
- 509 - Hongway Garden
- 510 - Southorn Garden
- 511 - Kornhill
- 512 - Kornhill Gardens (PSPS)
- 513 - Fortress Metro Tower
- 514 - Felicity Garden
- 515 - Heng Fa Chuen
- 516 - Heng Fa Chuen - Shopping Centre
- 517 - Heng Fa Chuen - Club
- 518 - Perfect Mount Gardens
- 519 - Service Duct (Luk Yeung Sun Chuen)
- 520 - Two IFC (International Finance Centre)

## **E) Subsystem Codes**

### **000 Standard Borders**

- 00 - A0 Size
- 01 - A1 Size
- 02 - A2 Size
- 03 - A3 Size
- 04 - A4 Size

### **050 Drawing Standards**

- 00 - Standard Drawing
- 01 - Standard Linework
- 02 - Standard Lettering
- 03 - Standard Dimensioning
- 10 - Plotter Pen Tables
- 20 - CAD DWG File Naming System

### **100 General Standards**

- 00 - Standard Drawing
- 01 - General Symbols
- 02 - Reference Symbols
- 03 - Welding Symbols
- 11 - Material Indications
- 21 - Flow Charts

## **200 E&M Services Standards**

- 00 - Standard Drawing
- 01 - HV Symbols
- 02 - OHL Symbols
- 03 - LV Symbols
- 04 - ECS Symbols
- 06 - FS Symbols

## **201 HV Power Supply System**

- 00 - General/Typical
- 01 - System Schematics
- 02 - Equipment Location Plan Layout
- 03 - Cable, Cable Fixing & Cable Bracket
- 04 - Earthing Connections
  
- 11 - 33kV Circuit Breaker and Control Panel
- 12 - k Bus Zone Protection
- 13 - 11kV VCB, RMU and Control Panel
- 14 - 11kV Bus Zone Protection
- 15 - DCCB and Control Panel
- 16 - 3.3kV Vacuum SW/GR
- 17 - Protection Trip Block
- 21 - Distribution Transformer
- 22 - Tap Changer Control
- 23 - Substation Transformer
- 24 - Rectifier Transformer and Rectifier Unit
- 25 - 50Hz Detector
- 26 - Negative Bar and Leakage Return Equipment
- 27 - Inverter Transformer and Regenerative Inverter
- 31 - Cable Interconnection and Cable Schedule
- 32 - Fire and Emergency Control
- 33 - 110 V DC Distribution
- 34 - Battery and Battery Charger
- 35 - Transient/Disturbance Recorder
  
- 90 - Station Box
- 91 - Current Projects in-progress

## **202 Overhead Line System**

- 00 - General/Typical
- 01 - Arrangements of OLE
- 02 - Layouts of Tension Lengths
- 03 - Mast Schedules
- 04 - Broken Wire Detector
- 05 - Isolator
- 06 - Insulator
- 07 - Protection Arrangement
- 08 - Trip Wire Protection System

- 90 - Station Box
- 91 - Current Projects in-progress

## **203 L.V. Electrical Services System**

- 00 - General/Typical
- 03 - L.V. Switchboard General Arrangement/Busbar Diagram
- 04 - Schematic Distribution Diagram/Switchboard Control Circuit
- 06 - Electrical/Earthing Arrangements & Layout
- 07 - Cable Chart & Cable Routing/Cable Schedule
- 08 - Control Cable Block Diagram/Control Panel
- 09 - Battery & Charger
- 11 - Advertising Panels, Station Signs & Clock Layout
- 12 - Lighting & Power Layout, Fixing
- 13 - Arrangement of Lighting & Sign Control Cubicle
- 14 - MIS LV Supply: Lighting, Station Sign, Clock & Advertising Panel
- 15 - Electrical Equipment & Details
- 16 - Uninterruptible Power Supply ( UPS )
- 17 - Installation Details
- 18 - MCS Interface Details
- 90 - Station Box
- 91 - Current Projects in-progress

## **204 Environmental Control System**

- 00 - General/Typical
- 01 - Schematic - Air Flow, Water Flow, Pneumatic & Power Supply
- 02 - A/C Plant and A/C Layout - Duct & Pipe
- 03 - Route Layout - Power Cable, Control Cable & Pneumatic Pipe
- 04 - Electrical & Pneumatic Panels/Control Wiring Diagram
- 05 - A/C Equipment Schedules and Details
- 06 - Installation details - Mechanical, Electrical & Pneumatic
- 07 - MCC Power/Control Diagram
  
- 90 - Station Box
- 91 - Current Projects in-progress
- 92 - Simplified Arch.- Station Box for ECS

## **206 Fire Detection and Suppression Equipment**

- 00 - General/Typical
- 01 - System Schematic
- 02 - Fire Control Panel
- 03 - Fire Services (Dry & Wet System)
  
- 11 - Fire Detection and Alarm System
- 12 - BTM Extinguishing System
- 13 - FM200 Gaseous Extinguishing System

- 21 - Pump House & Hydrant Tanks/Power & Control Schematic
- 22 - Hydrant and Hose Reel
- 23 - Sprinkler System
- 24 - Water Spray System
- 25 - Drencher System
- 31 - Portable Fire Extinguisher
- 32 - Installation Details
  
- 90 - Station Box
- 91 - Current Projects in-progress

## **207 Hydraulic Lift**

- 00 - General/Typical
- 01 - Equipment Location Plan Layout
- 02 - Mechanical Arrangement
- 03 - Hydraulic Equipment
- 04 - Power and Control Wiring Diagram
  
- 90 - Station Box
- 91 - Current Projects in-progress

## **208 Escalator**

- 00 - General/Typical
- 01 - Equipment Location Plan Layout
- 02 - Mechanical Parts and Details
- 03 - Power and Control Wiring Diagram
- 04 - Specification/Definition/Test Report
  
- 90 - Station Box
- 91 - Current Projects in-progress

## **209 Floodgates**

- 00 - General/Typical
- 01 - General Arrangement & Details
  
- 90 - Station Box
- 91 - Current Projects in-progress

## **210 Generator**

- 00 - General/Typical
- 01 - Generator Arrangement & Details
- 02 - Power & Control Schematic

## **211 Plumbing and Drainage System / Gas Service System**

- 00 - General/Typical
- 01 - Equipment Layout & System Schematic
- 02 - Pump Control Panels
- 03 - Power & Control Schematic
  
- 90 - Station Box
- 91 - Current Projects in-progress

## **212 Gas Purging System**

- 00 - General/Typical
- 01 - System Schematic
- 02 - Equipment Plan Layout
- 03 - Power and Control

## **213 Lifting Facilities**

- 00 - General/Typical
- 01 - Equipment Layout
- 02 - Mechanical Arrangement and Details
- 03 - Power and Control

## **214 Conveyor System - Cash Transfer, Baggage & Pneumatic Tube**

- 00 - General/Typical
- 01 - Equipment Layout
- 02 - Mechanical Arrangement and Details
- 03 - Power and Control
- 04 - System Schematic

## **215 Mechanical Ventilation & Air-Conditioning (Estate)**

- 01 - System Schematic
- 02 - A/C Plant and A/C Layout - Duct & Pipe
- 03 - Route Layout - Power Cable, Control Cable
- 04 - Equipment and Details
- 05 - Installation Details

## **216 Plumbing and Drainage (Estate)**

- 01 - System Schematic
- 02 - Layout
- 03 - Equipment and Details
- 04 - Installation Details

## **217 Refuse Handing (Estate)**

- 01 - System Schematic
- 02 - Layout

- 03 - Equipment and Detail
- 04 - Installation Details

## **218 Security System**

- 00 - General/Typical
- 01 - System Schematic & Control Panel
- 02 - Equipment Layout & Cabling
- 03 - Installation Details
  
- 90 - Station Box
- 91 - Current Projects in-progress

## **300 Rolling Stock Standards**

- 00 - Standard Drawing
- 01 - Rolling Stock Symbols

## **301 Electric Multiple Unit**

- 00 - General/Typical

### **01-19 Body and Structure**

- 01 - Car General Layout
- 02 - Roof
- 03 - Body Side
- 04 - Underframe
- 05 - Intercar Gangway
- 06 - Cab Shape and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior
- 11 - Cab Interior
- 12 - Underframe Equipment Layout
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler

### **21-29 Power Pick Up**

- 21 - Pantograph

### **31-39 Traction Drives**

- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension

### **41-49 Control**

- 41 - Power & Control Circuit Diagram and Wiring Diagram

- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab

#### **61-69 Auxiliary**

- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Cases
- 68 - Rail Lubricating Equipment

### **302 EMU MELCO Chopper Equipment**

- 00 - General/Typical
- 01 - Power & Control Equipment General Arrangement
- 02 - Traction Motor
- 03 - Power & Control Circuit Diagram and Wiring Diagram
- 04 - Performance & Characteristic Curves
- 05 - Specifications

### **303 EMU GEC Chopper Equipment**

- 00 - General/Typical

#### **01-19 Body and Structure**

- 01 - Car General Layout
- 02 - Roof
- 03 - Body Side
- 04 - Underframe
- 05 - Intercar Gangway
- 06 - Cab Shape and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior
- 11 - Cab Interior
- 12 - Underframe Equipment Layout
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler

## **21-29 Power Pick Up**

21 - Pantograph

## **31-39 Traction Drives**

31 - Bogie  
32 - Traction Motors  
33 - Drive Gears  
34 - Primary and Secondary Suspension

## **41-49 Control**

41 - Power & Control Circuit Diagram and Wiring Diagram  
42 - Power and Control Equipment  
43 - Trainborne ATC Equipment Interface  
44 - Hostler  
45 - Brakes and Brake Control  
46 - Door Control  
47 - Encoder, Decoder and Control Unit  
48 - Driving Cab

## **61-69 Auxiliary**

61 - Air Conditioning Equipment and Control  
62 - Motor Alternator Set and Control  
63 - Electrical Auxiliary  
64 - Battery and Battery Charger  
65 - Pneumatics, Pneumatic Instrumentation and Fittings  
66 - Trainborne Telecommunication Equipment  
67 - Auxiliary Equipment Cases  
68 - Rail Lubricating Equipment

## **304 EMU Airport Rail Link**

01 - General Arrangement and Detail

## **305 Electric Multiple Unit - Chopper Conversion**

00 - General/Typical

## **01-19 Body and Structure**

01 - Car General Layout  
02 - Roof  
03 - Body Side  
04 - Underframe  
05 - Intercar Gangway  
06 - Cab Shape and Structure  
07 - Saloon Doors  
08 - Cab Doors  
09 - Emergency Doors  
10 - Saloon Interior

- 11 - Cab Interior
- 12 - Underframe Equipment Layout
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler

### **21-29 Power Pick Up**

- 21 - Pantograph

### **31-39 Traction Drives**

- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension

### **41-49 Control**

- 41 - Power & Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab

### **61-69 Auxiliary**

- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Cases
- 68 - Rail Lubrication Equipment

## **306 EMU - Additional Rolling Stock (H-Stock)**

- 00 - General/Typical

### **01-19 Body and Structure**

- 01 - Car General Layout
- 02 - Roof
- 03 - Body Side
- 04 - Underframe
- 05 - Intercar Gangway
- 06 - Cab Shape and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors

- 10 - Saloon Interior
- 11 - Cab Interior
- 12 - Underframe Equipment Layout
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler

### **21-29 Power Pick Up**

- 21 - Pantograph

### **31-39 Traction Drives**

- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension

### **41-49 Control**

- 41 - Power & Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab

### **61-69 Auxiliary**

- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Cases
- 68 - Rail Lubricating Equipment

## **307 EMU MODERNIZATION**

- 00 Index

### **01-19 Body and Structure**

- 01 - Car General Layout
- 02 - Roof
- 03 - Body Side
- 04 - Underframe
- 05 - Intercar Gangway
  
- 06 - Cab Shape and Structure
- 07 - Saloon Doors
- 08 - Cab Doors

- 09 - Emergency Doors
- 10 - Saloon Interior
- 11 - Cab Interior
- 12 - Underframe Equipment Layout
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler

### **21-29 Power Pick Up**

- 21 - Pantograph

### **31-39 Traction Drives**

- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension

### **41-49 Control**

- 41 - Power & Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab

### **51-59 Electronic System**

- 51 - General Arrangement
- 52 - PIS
- 53 - TIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 56 - SBPIS

### **61-69 Auxiliary**

- 61 - Air Conditioning Equipment and control
- 62 - Motor Alternation Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Cases
- 68 - Rail Lubricating Equipment

### **71-84 Saloon Interior**

- 71 - General Arrangement
- 72 - Ceiling Assembly

- 73 - Lighting Assembly
- 74 - Gangway Assembly
- 75 - Seat Bay Assembly
- 76 - Disabled Area Assembly
- 77 - Grabrail Assembly
- 78 - Cab End Arrangement
- 79 - Labels and Markings
- 80 - Linear Fan
- 81 - PIS Equipment Interface
- 82 - TIS Equipment Interface

#### **85-89 Cab Exterior and Interior**

- 85 - General Arrangement
- 86 - Cab Exterior
- 87 - Cab Interior

### **311 Diesel Locomotives**

- 00 - General/Typical
- 01 - General Arrangement and Details
- 02 - Power and Control Circuit Diagram
- 03 - Wheel and Axle
- 04 - Brake

### **312 Battery/Electric Locomotives (Mark I & Mark II)**

- 00 - General/Typical
- 01 - General Arrangement and Details
- 02 - Traction Motor
- 03 - M.A. Set
- 04 - Control Gear
- 05 - Circuit and Wiring Diagrams
- 06 - P.C.B. Circuit & G.A.

### **313 Battery/Electric Locomotives (Mark III)**

- 00 - General/Typical
- 01 - General Arrangement and Details
- 02 - Traction Motor
- 03 - M. A. Set
- 04 - Control Gear
- 05 - Circuit and Wiring Diagrams
- 06 - P.C.B. Circuit & G.A.

### **321 Cash Wagon &'Kawa saki' Engineering Wagons**

- 00 - General/Typical
- 01 - Body
- 02 - Underframe

- 03 - Bogie
- 04 - Brakes
- 05 - Coupling Device
- 06 - Door
- 07 - Electrical Equipment & Wiring
- 08 - Lettering
- 09 - Roller Conveyor

### **322 Track Cleaning Wagon**

- 00 - General/Typical
- 01 - General Arrangement & Details

### **323 Ultrasonic Testing Vehicle (UTV994)**

- 00 - General/Typical
- 01 - Carbody
- 02 - Underframe Equipment Arrangement
- 03 - Wheel and Axle
- 04 - Diesel Engine and Generator Set
- 05 - Air-conditioning Unit
- 06 - Brake System
- 07 - Painting Scheme
- 08 - Electrical Supply Schematic and Equipment
- 09 - Hydraulic Equipment for the Flow Detection Trolley
- 10 - Flow Detection Trolley/Equipment Details
- 11 - Rail Mark
- 12 - Wiring Details Ranks, Operator Console, Vehicle

### **324 Tunnel Repair Wagon**

- 00 - General/Typical
- 01 - General Arrangement and Layout Diagram
- 02 - Hydraulic Schematic
- 03 - Hydraulic Equipment
- 04 - Pneumatic Schematic
- 05 - Pneumatic Equipment
- 06 - Electrical Power and Control Circuit
- 07 - Electrical Power and Control Equipment
- 08 - Routing
- 09 - Brake
- 10 - Electrical Wiring Diagram
- 11 - Miscellaneous

### **325 'Zhuzhou' Long Flat Wagon**

- 00 - General/Typical
- 01 - Body
- 02 - Underframe

- 03 - Bogie
- 04 - Brake
- 05 - Coupling Device
- 06 - Door
- 07 - Electrical Equipment & Wiring
- 08 - Lettering
- 09 - Roller Conveyor

**326 'Zhuzhou' Well Wagon**

- 00 - General/Typical
- 01 - Body
- 02 - Underframe
- 03 - Bogie
- 04 - Brake
- 05 - Coupling Device
- 06 - Door
- 07 - Electrical Equipment & Wiring
- 08 - Lettering
- 09 - Roller Conveyor

**327 Hydraulic High Level Platform Wagon**

- 00 General/Typical
- 01 General Arrangement
- 02 Body and Structure
- 03 Main Platform
- 04 Scissors Platform
- 05 Fixed Platform
- 06 Hydraulic Schematic and Equipment
- 07 Pneumatic Schematic and Equipment
- 08 Electrical Schematic and Equipment
- 09 Water Pump Unit
- 10 Miscellaneous

**328 Track Cleaning Vehicle (TCV 1029, 1038)**

- 00 - General/Typical
- 01 - General Arrangement and Details
- 02 - Pneumatic & Water System
- 03 - Hydraulic System
- 04 - Brake System
- 05 - Electrical & Control System
- 06 - Miscellaneous

**331 Rail Grinding Unit (RGU 995A - RGU 995C)**

- 00 - General/Typical
- 01 - Air Schematics

- 02 - Hydraulic Schematics
- 03 - Electrical Schematics
- 04 - Cab
- 05 - Electrical Cab
- 06 - Carriages
- 07 - Running Gear
- 08 - Shrouds & Covers
- 09 - Air System
- 10 - Dust Collector
- 11 - Hydraulics
- 12 - Water System
- 13 - Power Unit
- 14 - Generator
- 15 - Electrical Chassis
- 16 - Miscellaneous
- 17 - LPMS System Layout
- 18 - LPMS Mounting Mechanism
- 19 - LPMS Laser/Camera Beam
- 20 - LPMS Laser Mount
- 21 - LPMS Camera Mount
- 22 - LPMS Electrical & Electronics

### **332 Tamping Machine (TMS 992)**

- 00 - General/Typical
- 01 - General Arrangement and Details

### **333 New Grinding Car**

- 00 - General/Typical
- 01 - Body
- 02 - Underframe
- 03 - Bogie
- 04 - Brakes
- 05 - Coupling Device
- 06 - Door
- 07 - Electrical Equipment & Wiring
- 08 - Lettering
- 09 - Roller Conveyor

### **334 Tamping Vehicle**

- 00 - General/Typical
- 01 - Pneumatic Schematic
- 02 - Hydraulic Schematic
- 03 - Electrical Power and Control Circuit
- 04 - Electrical Power and Control Equipment
- 05 - Cab
- 06 - A/C Control Schematic
- 07 - Brake

- 08 - Bogie
- 09 - Working Equipment
- 10 - Electrical Auxiliary
- 11 - Communication & Instrumentation
- 20 - Miscellaneous

### **335 Ultrasonic Testing Vehicle (UTV 996)**

- 00 - General/Typical
- 01 - Carbody Structure
- 02 - Underframe Equipment Arrangement
- 03 - Wheel & Axle
- 04 - Diesel Engine & Transmission
- 05 - Generator Set
- 06 - Air Conditioning Unit
- 07 - Brake & Pneumatic System
- 08 - Driving Cab & Control Console
- 09 - Vehicle Electrical System & Control Schematics/Wiring Diagram
- 10 - Test Carriage & Wheel Probes Arrangement
- 11 - Test Carriage Control Schematics/Wiring Diagram
- 12 - UFD Control Console Arrangement
- 13 - UFD Control Console Wiring Diagram
- 14 - RMS Equipment Cabinet Wiring Diagram
- 15 - RMS System Configuration
- 16 - Ancillary System Control Schematics/Wiring Diagram

### **336 Track and Overhead Line Geometry Recording Vehicle**

- 00 - General/Typical
- 01 - General Layout
- 02 - Carbody Structure
- 03 - Underframe and Bogie
- 04 - Wheel and Axle
- 05 - Generator Set and Battery
- 06 - Air Conditioning Unit
- 07 - Brake and Pneumatic System
- 08 - Electrical and Control System
- 09 - Door System
- 10 - Measuring System

### **337 Rail Handing Crane Vehicle**

- 00 - General/Typical
- 01 - Body
- 02 - Underframe
- 03 - Bogie
- 04 - Brakes
- 05 - Coupling Device
- 06 - Door

- 07 - Electrical Equipment & Wiring
- 08 - Lettering
- 09 - Roller Conveyor
- 10 - Remote control (Hetricnic)
- 11 - Air Conditioner unit

**338 Ballast Hopper Wagon**

- 00 - General/Typical
- 01 - Body
- 02 - Underframe
- 03 - Bogie
- 04 - Brakes
- 05 - Coupling Device
- 06 - Door
- 07 - Electrical Equipment & Wiring
- 08 - Lettering
- 09 - Roller Conveyor
- 10 - Hopper Assembly
- 11 - Chute Door
- 12 - Air Piping
- 13 - Transmission Mechanism
- 14 - Pneumatic Control System
- 15 - Water Sprinkling System

**339 Bridge Inspection Vehicle**

- 00 - General/Typical
- 01 - Body
- 02 - Underframe
- 03 - Bogie
- 04 - Brakes
- 05 - Coupling Device
- 06 - Door
- 07 - Electrical Equipment & Wiring
- 08 - Lettering
- 09 - Roller Conveyor

**340 Hydraulic Platform Wagon**

- 00 - General/Typical
- 01 - Body
- 02 - Underframe
- 03 - Bogie
- 04 - Brakes
- 05 - Coupling Device
- 06 - Door
- 07 - Electrical Equipment & Wiring
- 08 - Lettering
- 09 - Roller Conveyor
- 10 - Plates and Warning Lables
- 11 - Electrical Plant Layout

12 - Electrical Plant Schematic Diagram

**341 Overhead Line Emergency Rescue Wagon**

- 00 - General
- 01 - Body and Structure
- 02 - Electrical Equipment
- 03 - Schematics
- 04 - Electrical Circuit Diagram

**342 Advertising Train Carriage**

- 00 - General
- 01 - Body and Structure
- 02 - Electrical Equipment
- 03 - Schematics
- 04 - Electrical Circuit Diagram

**343 Overhead Line Inspection Vehicles (OIV Geismar)**

- 01 - Carbody & general
- 02 - Pneumatic System
- 03 - Hydraulic System
- 04 - Brakes
- 05 - Wheel and Axle
- 06 - Engine & Transmission
- 07 - Air-conditioning System
- 08 - Electrical System

**350 Rolling Stock ( AEL & TCL )**

- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior
- 11 - Cab Interior
- 12 - Underframe Equipment Layout
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 21 - Pantograph
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
  
- 41 - Power & Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment

- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab
  
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Cases
- 68 - Rail Lubricating Equipment

### **351 EMU (AEL)**

- 00 - General/Typical

#### **01-19 Body and Structure**

- 01 - Car General Layout
- 02 - Roof
- 03 - Body Side
- 04 - Underframe
- 05 - Intercar Gangway
- 06 - Cab Shape and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior
- 11 - Cab Interior
- 12 - Underframe Equipment Layout
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler

#### **21-29 Power Pick Up**

- 21 - Pantograph

#### **31-39 Traction Drives**

- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension

#### **41-49 Control**

- 41 - Power & Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface

- 44 - Hostler
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab

#### **51-59 Electronic System**

- 51 - General Arrangement
- 52 - PIS
- 53 - TIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 56 - SBPIS

#### **61-69 Auxiliary**

- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Cases
- 68 - Rail Lubricating Equipment

### **352 EMU (TCL)**

- 00 - General/Typical

#### **01-19 Body and Structure**

- 01 - Car General Layout
- 02 - Roof
- 03 - Body Side
- 04 - Underframe
- 05 - Intercar Gangway
- 06 - Cab Shape and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior
- 11 - Cab Interior
- 12 - Underframe Equipment Layout
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler

#### **21-29 Power Pick Up**

- 21 - Pantograph

#### **31-39 Traction Drives**

- 31 - Bogie

- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension

#### **41-49 Control**

- 41 - Power & Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab

#### **51-59 Electronic System**

- 51 - General Arrangement
- 52 - PIS
- 53 - TIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 56 - SBPIS

#### **61-69 Auxiliary**

- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
  
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Cases
- 68 - Rail Lubricating Equipment

### **353 EMU (AEL/TCL)**

- 00 - General/Typical

#### **01-19 Body and Structure**

- 01 - Car General Layout
- 02 - Roof
- 03 - Body Side
- 04 - Underframe
- 05 - Intercar Gangway
- 06 - Cab Shape and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior
- 11 - Cab Interior

- 12 - Underframe Equipment Layout
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler

### **21-29 Power Pick Up**

- 21 - Pantograph

### **31-39 Traction Drives**

- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension

### **41-49 Control**

- 41 - Power & Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab

### **51-59 Electronic System**

- 51 - General Arrangement
- 52 - PIS
- 53 - TIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 56 - SBPIS
- 57 - Cab Simulator

### **61-69 Auxiliary**

- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Cases
- 68 - Rail Lubricating Equipment

## **354 APM**

- 00 - General/Typical
- 01 - Car General Layout
- 02 - Roof
- 03 - Body Side

- 04 - Underframe
- 05 - Intercar Gangway
- 06 - Cab Shape and Structure
- 07 - Saloon Doors
  
- 10 - Saloon Interior
- 12 - Underframe Equipment Layout
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 21 - Power Collector
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Suspension
  
- 41 - Power & Control Circuit Diagram and Wiring Diagram
- 42 - Power & Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 45 - Brakes and Brake Control
- 46 - Door Control
- 48 - Driving Console
  
- 51 - General Arrangement
- 52 - Dynamic Route Map
- 53 - Monitoring Device
  
- 61 - Air Conditioning Equipment and Control
  
- 63 - Electrical Auxilliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
  
- 70 - Platform Screen Door
- 75 - Power Distribution System
  
- 80 - Guideway and Switches
- 85 - Communication and Control
  
- 90 - ATC Equipment
- 95 - Maintenance Plant/Facility

### **355 EMU (DRL)**

- 00 - Index
- 01 - Car General Layout
- 02 - Roof Structure

- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Car Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 21 - Pantograph
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
  
- 41 - Power & Control Circuit Diagram and Wiring Diagram
- 42 - Power & Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
  
- 52 - PIS
- 53 - TIS
- 54 - In-Cab CCTV
- 55 - Electronic System EIDS
- 57 - Cab Simulator
- 58 - In-saloon CCTV Interface
  
- 61 - Air Conditioning Equipment and Control
- 63 - Electrical Auxillary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxillary Equipment Cases
- 68 - Rail Lubricating Equipment
- 69 - Smoke Detection System

## 361 EMU (TKE)

- 00 - Index

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Car Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 21 - Pantograph
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
  
- 41 - Power & Control Circuit Diagram and Wiring Diagram
- 42 - Power & Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Investor & Control
  
- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS
  
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxilliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
  
- 67 - Auxilliary Equipment Cases
- 68 - Rail Lubricating Equipment

## 362 EMU (TCL K-train)

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 21 - Pantograph
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
  
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control
  
- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS
  
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment

- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

### **367 EMU (MLR 3094)**

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 20 - 25kV system
- 21 - Power Collector
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
  
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control
  
- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS
  
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary

- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

### **368 EMU (MLR K01)**

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 20 - 25kV system
- 21 - Power Collector
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
  
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control
  
- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS

- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

### **369 EMU (MLR K03)**

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 20 - 25kV system
- 21 - Power Collector
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
  
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control
  
- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS

- 58 - DVAS
- 61 - Air Conditioning Equipment and Control  
62 - Motor Alternator Set and Control  
63 - Electrical Auxiliary  
64 - Battery and Battery Charger  
65 - Pneumatics, Pneumatic Instrumentation and Fittings  
66 - Trainborne Telecommunication Equipment  
67 - Auxiliary Equipment Case  
68 - Rail Lubricating Equipment

### **370 EMU (MLR K05)**

- 01 - Car General Layout  
02 - Roof Structure  
03 - Saloon Exterior and Structure  
04 - Underframe Structure  
05 - Intercar Gangway  
06 - Cab Exterior and Structure  
07 - Saloon Doors  
08 - Cab Doors  
09 - Emergency Doors  
10 - Saloon Interior Equipment  
11 - Cab Interior Equipment  
12 - Underframe Equipment  
13 - Cables, Ducting and Wiring Layout  
14 - Air Piping  
15 - Coupler
- 20 - 25kV system  
21 - Power Collector
- 31 - Bogie  
32 - Traction Motors  
33 - Drive Gears  
34 - Primary and Secondary Suspension
- 41 - Power and Control Circuit Diagram and Wiring Diagram  
42 - Power and Control Equipment  
43 - Trainborne ATC Equipment Interface  
44 - Hostler Control  
45 - Brakes and Brake Control  
46 - Door Control  
47 - Encoder, Decoder and Control Unit  
48 - Driving Cab Control  
49 - Static Inverter & Control

- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS
  
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

### **371 EMU (ERL MLR)**

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 21 - Pantograph
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
  
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control

- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS
  
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

### **372 EMU (SP1900)**

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 20 - 25kV system
- 21 - Pantograph
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
  
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control

- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control
  
- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS
  
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

### **373 EMU (SP1950)**

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 20 - 25kV system
- 21 - Pantograph
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
  
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface

- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control
  
- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS
  
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

#### **374 EMU (KRS991)**

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 20 - 25kV system
- 21 - Pantograph
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension

- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control
  
- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS
  
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

### **375 EMU (LRV Phase I)**

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 21 - Pantograph
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears

- 34 - Primary and Secondary Suspension
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control
- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

### **376 EMU (LRV Phase II)**

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
- 21 - Pantograph

- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
  
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control
  
- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS
  
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

### **377 EMU (LRV Phase III)**

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler

- 21 - Pantograph
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control
  
- 51 - General Arrangement
- 52 - PIS
  
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS
  
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

### **378 EMU (LRV Phase IV)**

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping

- 15 - Coupler
- 21 - Pantograph
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control
- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

### **379 EMU (LRV Phase I MLR)**

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment

- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 21 - Pantograph
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
  
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control
  
- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS
  
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

### **380 Locomotive (KTT)**

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors

- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 21 - Pantograph
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
  
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control
  
- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS
  
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

### **381 Coach (KTT)**

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors

- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 21 - Pantograph
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
  
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control
  
- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS
  
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

## 382 Locomotive (GM)

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure

- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 21 - Pantograph
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
  
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control
  
- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS
  
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

### **383    Locomotive (SIEMENS)**

- 01 - Car General Layout
- 02 - Roof Structure

- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
- 21 - Pantograph
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control
- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

### 384 Locomotive (Schoma)

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 21 - Pantograph
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
  
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control
  
- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS
  
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case

68 - Rail Lubricating Equipment

**385 Locomotive (CZ)**

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 21 - Pantograph
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
  
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control
  
- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS
  
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment

- 67 - Auxiliary Equipment Case  
68 - Rail Lubricating Equipment

**386 Ginder C (HTT)**

- 01 - Car General Layout  
02 - Roof Structure  
03 - Saloon Exterior and Structure  
04 - Underframe Structure  
05 - Intercar Gangway  
06 - Cab Exterior and Structure  
07 - Saloon Doors  
08 - Cab Doors  
09 - Emergency Doors  
10 - Saloon Interior Equipment  
11 - Cab Interior Equipment  
12 - Underframe Equipment  
13 - Cables, Ducting and Wiring Layout  
14 - Air Piping  
15 - Coupler  
  
21 - Pantograph  
  
31 - Bogie  
32 - Traction Motors  
33 - Drive Gears  
34 - Primary and Secondary Suspension  
  
41 - Power and Control Circuit Diagram and Wiring Diagram  
42 - Power and Control Equipment  
  
43 - Trainborne ATC Equipment Interface  
44 - Hostler Control  
45 - Brakes and Brake Control  
46 - Door Control  
47 - Encoder, Decoder and Control Unit  
48 - Driving Cab Control  
49 - Static Inverter & Control  
  
51 - General Arrangement  
52 - PIS  
54 - In-Cab-CCTV  
55 - Electronic System EIDS  
57 - TMS  
58 - DVAS  
  
61 - Air Conditioning Equipment and Control  
62 - Motor Alternator Set and Control  
63 - Electrical Auxiliary

- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

**387 RGV (Speno)**

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 21 - Pantograph
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
  
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control
  
- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS
  
- 61 - Air Conditioning Equipment and Control

- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

### **388 Tamper (Plasser)**

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 21 - Pantograph
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
  
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control
  
- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS

- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

**389 TRC (Plasser)**

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 21 - Pantograph
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
  
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control
  
- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS

58 - DVAS

- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

**390 UTV**

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 21 - Pantograph
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
  
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control
  
- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS

- 57 - TMS
- 58 - DVAS
  
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

### **391 MPV (Plasser)**

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 21 - Pantograph
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
  
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control
  
- 51 - General Arrangement
- 52 - PIS

- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS
  
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

### **392 OLE (Geismar)**

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 21 - Pantograph
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
  
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control

- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS
  
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

### **393 VE (Enviro-Vac)**

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 21 - Pantograph
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
  
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control

- 49 - Static Inverter & Control
- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS
  
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

### **394 VIU (MOOG)**

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 21 - Pantograph
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
  
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control

- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control
  
- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS
  
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

### **395 OIV (XF)**

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 21 - Pantograph
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
  
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control

- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control
  
- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

## **396    VEM**

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 21 - Pantograph
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
  
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control

- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control
  
- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS
  
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

**397 RV (Geismar)**

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 21 - Pantograph
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
  
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface

- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control
  
- 51 - General Arrangement
- 52 - PIS
  
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS
  
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

### **398 Wagon (ER)**

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 21 - Pantograph
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears
- 34 - Primary and Secondary Suspension

- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control
  
- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS
  
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

**399    Wagon (ZZ)**

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 21 - Pantograph
  
- 31 - Bogie
- 32 - Traction Motors
- 33 - Drive Gears

- 34 - Primary and Secondary Suspension
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control
  
- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS
  
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

### **3A1 EMU (EAL)**

- 01 - Car General Layout
- 02 - Roof Structure
- 03 - Saloon Exterior and Structure
- 04 - Underframe Structure
- 05 - Intercar Gangway
- 06 - Cab Exterior and Structure
- 07 - Saloon Doors
- 08 - Cab Doors
- 09 - Emergency Doors
- 10 - Saloon Interior Equipment
- 11 - Cab Interior Equipment
- 12 - Underframe Equipment
- 13 - Cables, Ducting and Wiring Layout
- 14 - Air Piping
- 15 - Coupler
  
- 21 - Pantograph
  
- 31 - Bogie
- 32 - Traction Motors

- 33 - Drive Gears
- 34 - Primary and Secondary Suspension
  
- 41 - Power and Control Circuit Diagram and Wiring Diagram
- 42 - Power and Control Equipment
- 43 - Trainborne ATC Equipment Interface
- 44 - Hostler Control
- 45 - Brakes and Brake Control
- 46 - Door Control
- 47 - Encoder, Decoder and Control Unit
- 48 - Driving Cab Control
- 49 - Static Inverter & Control
  
- 51 - General Arrangement
- 52 - PIS
- 54 - In-Cab-CCTV
- 55 - Electronic System EIDS
- 57 - TMS
- 58 - DVAS
  
- 61 - Air Conditioning Equipment and Control
- 62 - Motor Alternator Set and Control
- 63 - Electrical Auxiliary
- 64 - Battery and Battery Charger
- 65 - Pneumatics, Pneumatic Instrumentation and Fittings
- 66 - Trainborne Telecommunication Equipment
- 67 - Auxiliary Equipment Case
- 68 - Rail Lubricating Equipment

## **400 Control & Communications Standards**

- 00 - Standard Drawing
- 01 - AFC Symbols
  
- 11 - Signalling Symbols
- 21 - Telecommunication Symbols
- 30 - CCS Symbols

## **401 AFC Equipment**

- 01 - General/Typical
- 02 - Analyser/Dispenser (A/D)
- 03 - Cash Collection Unit - ISL
- 04 - Coin Counter
- 05 - General Encoding Unit (Encoding Machine)
- 06 - Change Machine (CHM)
- 07 - Code Reader
- 08 - Cash Register
- 09 - Cathode-ray Tube (CRT)

- 10 - Disk Drive
- 11 - Encapsulator Machine
- 12 - Encoder/Sorter (E/S)
- 13 - Gate
- 14 - Line Printer
- 15 - Micro-computer Development System (MDS)
- 16 - Monitor Panel
- 17 - Multi-vend TIM (Multi-fare TIM)
- 18 - Passenger Ticket Reader
- 19 - Station Cash Trolley (SCT)
- 20 - Ticket Issuing Machine (TIM)
- 21 - Ticket Counting Machine
- 22 - Ticket Testing Machine
- 23 - Teletypewriter (TTY)
- 24 - Ticket Checker
- 25 - Max-sight Photo Machine
- 26 - New Power Supply Unit (PSU)
- 27 - Emergency Control Box
- 28 - Universal SAS Interface (USI)
- 29 - Cafe De Coral
- 30 - MIS/TWE power distribution unit
- 31 - New Generation TIM (NGTIM)
- 32 - AFC Floor Trunking
- 33 - ADD Value Machine (AVM)
- 34 - Office CSC Processor (OCP)
- 35 - Multi Processor (MPR)
- 36 - Power
- 37 - LAN
- 38 - IBP
  
- 60 - Common Assemblies
- 61 - Bank Coin Security
- 62 - Central Control Board Assembly (CEB)
- 63 - Feeder
- 64 - KDU
- 65 - Magazine
- 66 - Machine Cash Vault (MCV)
- 67 - Coin Acceptor (NRI)
- 68 - Power Supply Unit
- 69 - Stacker
- 70 - Trolley Cash Vault (TCV)
- 71 - Transport
- 72 - Contactless Smart Card
- 73 - Security Access Management System (SAMS)
- 74 - AFC Ducting & Trunking
- 75 - TIM Dumping Trolley
- 76 - Fare Saver
  
- 90 - Station Box

91 - Current Projects in-progress

#### **411 Signal and Control Equipment**

- 00 - General/Typical
- 01 - Composite Plans/Track Plans
- 02 - Points
- 03 - Signal Indicators
- 04 - Power Cubicles
- 05 - Control Panels/Console
- 06 - Platform Equipment
- 07 - Axle Counter Cubicle
- 10 - Drawing Index
- 11 - Relay Room General
- 12 - Relay Room Circuit
- 13 - Apparatus Case
- 14 - Location Case (SAB)
- 15 - Core Plan
- 16 - Cables/Cable Bracket
- 17 - Main Control Centre
- 18 - Telephone Power Socket Circuit
- 20 - Trackside Equipment
- 21 - Trackside ATP Equipment
- 22 - Track Circuit
- 23 - ATP Loop Configuration
- 24 - Trackside ATO Equipment
- 25 - EHC General/Typical
- 26 - EHC SER General/Typical
- 27 - EHC CER General/Typical
- 28 - ADM (ISL) General/Typical
- 29 - Scheme Plan
- 30 - CEN(ISL) General/Typical
- 31 - Trainborne ATP Safety Unit
- 32 - Trainborne ATP Non-vital Unit
- 33 - Trainborne ATO Controller
- 34 - Locomotive ATP Equipment
- 35 - ATP and ATO Test Equipment
- 36 - ATP and ATO Antennae
- 37 - Sacem (1)
- 38 - Sacem (2)
- 41 - Westronic S1 System Diagram
- 42 - Westronic S1 Addressing and Bit Allocation Tables
- 43 - Westronic S1 Electronic Circuit Diagrams  
and Printed Circuit Cards
- 44 - Westronic S1 Cubicle and Wiring
- 45 - Westronic S1 Office Backplate Wiring Diagrams
- 46 - Westronic S1 Field Backplate Wiring Diagrams
- 47 - Westronic S1 Panels and Unit Assemblies
- 48 - Westronic S1 Miscellaneous
- 49 - SDP (1)

- 50 - SDP (2)
- 51 - Signal Routes & Aspect Control
- 52 - Continuous Transmission (SACEM)
- 53 - Signal Module
- 54 - Terminal Block Analysis
  
- 61 - TD System and System Interconnection Cables
- 62 - TD Input and Output Group
- 63 - TD Power Group
- 64 - TD Electronic Circuit Diagrams and Printed Circuit Cards
- 65 - TD Cables, Units and Assemblies
- 66 - TD Station Equipment
  
- 71 - General/Typical
- 72 - CER General/Typical
- 73 - SER General/Typical

#### **80-89 Reserved for Project 3036**

- 90 - Station Box
- 91 - Current Projects in-progress
- 99 - Combined Services

#### **412 Training School Signalling Equipment**

- 00 - General/Typical

#### **414 LRL Signalling System**

- 0000 - General/Typical
- TRSI - Drawing List
- B4 - Communication & Control Equipment System (B4)
- INS - Installation Details of Communication & Control System (B4/INS)
- VIS - Installation Details of Communication & Control System (B4/VIS)
- C4 - LRT Stop (C4/xxx)
- C7 - LRT Terminus / Interchange (C7/xxx)
- 0110 - LRT Stop Cable Route Layout Drawing (011x)
- 8000 - Wiring Diagram (8xxx)
- 8100 - LRT Stop Cable Schematic Drawing (810x)
- 8110 - LRT Stop Track Circuit Layout (811x)
- 8150 - Point Controller Connection Scheme (815x)
- 9000 - Typical Mounting Detail / Installation (90xx)

#### **415 MOS Signalling System**

- TA - Index, Symbols, Abbreviations, Typical Installation Detail
- TC - Cable Plan, Interconnection Diagram
- TD - Equipment Room Layout
- TE - Derailment Detector
- TF - Station Control Equipment

TG - Trackside Equipment  
TH - Trainborne Equipment  
TJ - Equipment Room – Power Related Arrangement  
TK - Schematic  
TL - Equipment Rack  
TM - Track Map  
TS - Control Area – Signal Plan  
TT - Control Table

#### **416 WRL Signalling System**

TA - Index, Symbols, Abbreviations, Typical Installation Detail  
TC - Cable Plan, Interconnection Diagram  
TD - Equipment Room Layout  
TE - Derailment Detector  
TF - Station Control Equipment  
TG - Trackside Equipment  
TH - Trainborne Equipment  
TJ - Equipment Room – Power Related Arrangement  
TK - Schematic  
TL - Equipment Rack  
TM - Track Map  
TS - Control Area – Signal Plan  
TT - Control Table

#### **417 EWL Signalling System**

TA - Index, Symbols, Abbreviations, Typical Installation Detail  
TC - Cable Plan, Interconnection Diagram  
TD - Equipment Room Layout  
TE - Derailment Detector  
TF - Station Control Equipment  
TG - Trackside Equipment  
TH - Trainborne Equipment  
TJ - Equipment Room – Power Related Arrangement  
TK - Schematic  
TL - Equipment Rack  
TM - Track Map  
TS - Control Area – Signal Plan  
TT - Control Table

#### **421 Telecommunication System**

00 - General/Typical  
01 - Telephone System  
02 - CCTV System  
03 - PA System  
04 - MTRC Radio System  
05 - RHKP/FSD Radio System

- 06 - Pulse Code Modulation
- 07 - Trunk Cable
- 08 - Data Link Network
- 09 - Dictaphone
- 10 - Alarm System
- 11 - Teleprinter
- 12 - Power Supply System
- 13 - Intercom System
- 14 - Trainborne Equipment
- 15 - Multi Media Network
- 16 - Local Area Network
- 17 - Pager
- 18 - Optical Fibre Cable
- 19 - Integrated LCX Network
- 20 - General/Typical
- 21 - Copper Trunk Cable System
- 22 - Optical Trunk Cable System
- 23 - Radio Leaky Coaxial System
- 24 - MTRC Radio System
- 25 - FSD Radio System
- 26 - RHKP Radio System
- 27 - Closed Circuit Television System
- 28 - Public Address System
- 29 - Centralised Voice Recording System
- 30 - Direct Line System
- 31 - Private Automatic Branch Exchange
- 32 - Pulse Code Modulation System
- 33 - Integrated Data Network System
- 34 - Pressure Mat Alarm System
- 35 - Uninterrupted Power Supply System
- 36 - Intercom Communication System
- 37 - Teleprinter System
- 38 - Trainborne Communication System
- 39 - Passenger Information Display System
- 40 - Civil Co-ordination Centre (Radio Telephone System)
- 41 - Rado Clock
- 42 - Local Area Network For Headquarters and Depots
- 43 - Telecommunication Training Provisions
- 44 - Automatic Wheel Flat Detection System
- 45 - In-Cab CCTV Monitoring System
- 50 - General/Typical
- 51 - HKTCSL Cable System
- 52 - WCIL/NT&T Second Cable Network System
- 53 - MTRC Optical Cable System for Non-Operation Project
- 54 - Integrated Radio (2 LCX) Network System
- 55 - Pager Facilities System
- 56 - Personal Private Communication Service (PCS/PCN) System
- 57 - Cordless Service (CAS/PHS) System
- 58 - HCL/Infa Second Network System

- 59 - Timeslit System
- 60 - Cordless Telephone System (2nd Generation)
- 61 - HKTCSL Pay Phone System
- 62 - FTNS Optical Fibre Cable System
- 63 - CTER Power Distribution System
- 64 - Provision of FTNS Fixed Telecom Network Services in MTR Network
- 65 - Antenna Network for External Mobile Coverage
- 66 - 3G Mobile Equipment
- 67 - ATSS System
- 68 - FIDS - Flight Information Display System
- 69 - Station AFC LAN Network
- 70 - Telecom Equipment Room Facilities
- 71 - Integrated Control & Communications System (ICCS)
- 72 - Infotainment System
  
- 90 - Station Box
- 91 - Current Projects in-progress
- 99 - Combined Services for Comms in paper/manual format

#### **431 Building Automation System**

- 01 - General/Typical
- 02 - KBD
- 03 - TWD
- 04 - CWD

#### **432 Environmental Control System**

- 01 - General/Typical
- 02 - Central Subsystem
- 03 - Local (Data Control Local)
- 04 - Central Telemetry (Data Control Central)
- 05 - Constant Voltage Constant Frequency (CVCF)
- 06 - MCC Power & Control (Modified)

#### **433 Power Remote Control System**

- 01 - General/Typical
- 02 - Central CPU
- 03 - Master Terminal Unit (Central Telemetry)
- 04 - Remote Terminal Unit (Local CPU)
- 05 - Uninterrupted Power Supply (UPS)

#### **434 Signalling Control System**

- 00 - General/Typical
- 01 - Central CPU
- 02 - ATR System

- 03 - Training Simulators
- 04 - Main Control System

**435 Headquarters Building**

- 01 - Headquarters CPU

**436 KBD Emergency Generator**

- 01 - General/Typical

**441 Equipment Layout**

- 01 - General/Typical
- 90 - Station Box

**451 Computer Control System**

- 01 - General/Typical
- 02 - Passenger Information System
- 03 - Cab Simulator
- 04 - Building Automation System
- 05 - Station Management System
- 06 - ECS & PRC System Upgrade
- 07 - ECS Local Controller System
- 08 - PRC System
- 09 - Signalling Indication and Control Panel
  
- 90 - Station Box
- 91 - Current Projects in-progress

**452 Station Management System**

- 00 - General / Typical
- 01 - Marshalling Cubicle
- 02 - SMIBP
- 03 - PSIBP
- 04 - Equipment Rank
- 05 - Communication Backup Console
- 06 - SMSS
- 07 - SMCS
- 08 - PSCS
- 09 - Local Controller
  
- 90 - Station Box

**461 Automatic Train Control**

- 01 - General/Typical

## **471 Security/ Public Address/ CABD ( Estate )**

- 01 - System Schematic
- 02 - Layout
- 03 - Equipment and Details
- 04 - Installation and Details

## **481 Station Modification Projects (C&C Services)**

- 00 - General/Typical
- 10 - Computer Control System (CCS)
- 11 - Environmental Control System (ECS)
- 12 - Power Remote Control System (PRC)
- 13 - Passenger Information Display System (PIDS)
- 14 - Station Modification System (SMS)
- 20 - General/Typical
- 21 - Copper Trunk Cable System
- 22 - Optical Trunk Cable System
- 23 - Radio Leaky Coaxial System
- 24 - MTRC Radio System
- 25 - FSD Radio System
- 26 - RHPK Radio System
- 27 - Closed Circuit Television System
- 28 - Public Address System
- 29 - Centralised Voice Recording System
- 30 - Direct Line System
- 31 - Private Automatic Branch Exchange
- 32 - Pulse Code Modulation System
- 33 - Integrated Data Network System
- 34 - Pressure Mat Alarm System
- 35 - Uninterrupted Power Supply System
- 36 - Intercom Communication System
- 37 - Teleprinter System
- 38 - Trainborne Communication System
- 39 - Passenger Information Display System
- 40 - Civil Co-ordination Centre (Radio Telephone System)
- 41 - Radio Clock
- 42 - Local Area Network For Headquarters and Depots
- 43 - Telecommunication Training Provisions
- 44 - Automatic Wheel Flat Detection System
- 45 - In-Cab CCTV Monitoring System
- 50 - General/Typical
- 51 - HKTCSL Cable System
- 52 - WCIL/NT&T Second Cable Network System
- 53 - MTRC Optical Cable System for Non-Operation Project
- 54 - Integrated Radio (2 LCX) Network System
- 55 - Pager Facilities System
- 56 - Personal Private Communication Service (PCS/PCN) System

- 57 - Cordless Service (CAS/PHS) System
- 58 - HCL/Infa Second Network System
- 59 - Timeslit System
- 60 - Cordless Telephone System (2nd Generation)
- 61 - HKTCSL Pay Phone System
- 62 - FTNS Optical Fibre Cable System
- 63 - CTER Power Distribution System
- 64 - Provision of FTNS Fixed Telecom Network Services in MTR Network
  
- 70 - Signalling
- 80 - AFC
  
- 90 - Station Box
- 91 - Current Projects in-progress
- 99 - Combined Services for Comms in paper/manual format

## **500 Building Design/Civil Works Standards**

- 00 - Standard Drawing
- 01 - Permanent Way Symbols
- 02 - Civil Symbols
- 03 - Architectural Symbols
- 06 - Landscape/surveys Symbols
- 08 - Drainage Symbols

## **501 Permanent Way**

- 00 - General/Typical
- 01 - Track Components
- 02 - Track Support System
- 03 - Switch & Crossing Layout Diagrams
- 04 - Curve and gradient diagrams
- 05 - Miscellaneous
- 06 - Tools and equipment

## **502 Civil**

- 00 - General/Typical
- 01 - General Arrangement
- 02 - R.C. Details
- 03 - Metal Works
- 04 - Drainage
- 05 - Escalator
  
- 90 - Station Box
- 91 - Current Projects in-progress

## **503 Architectural**

- 01 - General Layout, General Notes, Hoarding, Finish Schedule & Entrance
- 02 - Kiosks
- 03 - Advertising Panel
- 04 - Signs & Queuing System
- 05 - Pay Phones
- 06 - Banks (ATM)
- 07 - Exhibition Areas
- 08 - Display Cases
- 09 - Painting & Repainting
- 10 - Facilities - Toilet, Locker Room, Changing Room, Kitchen & Cleaner
- 11 - Office for Passenger - Ticket Office (EFO/BKO), Combined Office, TSI Office & Lost Properties Office
- 12 - Plant Room & Equipment Room
- 13 - Stores - Dangerous Goods Store, Chemical Waste & Industrial Waste Skip Yard.
- 14 - Office for Non-Public - Mess Room, Conference Room, Office, Station Control Room, Station Master Room, Club House, Train Staff Office, Backup Encoding Area, Combined Office, Assembly Hall & Clean Laboratory
- 15 - V.E. Panel
- 16 - Door, Window, Fire Roller Shutter, Roller Shutter, Collapsible Gate, Floodboard & Steel Gate
- 17 - Metal Work - Barrier, Catladder, Catwalk, Platforms, Support Brackets, Plinth, Shelter, Staircase, Chain Link Fence & Rubbish Trap
- 18 - Floor - AFC Trunking & Floor Finishes
- 19 - Wall - V.E. panel & Wall Finishes
- 20 - Ceiling - Bulkhead & Ceiling Finishes
- 21 - Furniture & Fixture
- 22 - Plumbing and Drainage - Water Spray, Washing Pit, Sprinkler Inlet
- 23 - Noise Mitigation & Water-proofing
- 24 - Asbestos
- 25 - Fire Service Arrangement & Equipment
- 26 - Carpark, Pavement, Planter, Landscaping, Walkway, Flagpole
- 27 - E&M Services - A/C Filter Cleaning Tank, Air Handling Unit, Electric Cable Tray, Trunking
- 28 - Disabled Facilities
- 29 - Wall Tiles Layout
  
- 90 - Station Box
- 91 - Current Projects in-progress

#### **504 Structures (CWS)**

- 01 - General Layout
- 02 - IRS
- 03 - Contract Drawing
- 04 - General Layout - DEPOT (DEP)
- 05 - General Layout - ENTRANCE (ENT)
- 06 - General Layout - GROUND LEVEL (GRD)

- 07 - General Layout - IMMERSED TUBE (IMT)
- 08 - General Layout - INTAKE CELL (INC)
- 09 - General Layout - LIFT SHAFT (LIS)
- 10 - General Layout - OVERHEAD VENTDUCT (OVD)
- 11 - General Layout - PASSENGER ADIT (PAA)
- 12 - General Layout - PLATFORM (PFM)
- 13 - General Layout - PLANT ROOM (PLR)
- 14 - General Layout - PODIUM (POD)
- 15 - General Layout - Roof (ROF)
- 16 - General Layout - SERVICE DUCT (SED)
- 17 - General Layout - STATION WALL (STW)
- 18 - General Layout - TICKETING HALL (TIH)
- 19 - General Layout - TUNNEL (TUN)
- 20 - General Layout - UNDER PLATFORM VOID (UPV)
- 21 - General Layout - VENT SHAFT (VES)
- 22 - General Layout - VIADUCT (VIA)
- 23 - General Layout - CENTRAL REFRIGERATION PLANT (CRP)
- 24 - General Layout - VENTILATION BUILDING (VEB)
- 25 - General Layout - TUNNEL PORTAL (PTL)
- 26 - General Layout - Sub-Station (SUB)
  
- 50 - IRS - BASEMENT (BAS)
- 51 - IRS - KEY PLAN (KEP)
- 52 - IRS - COLUMN (COL)
- 53 - IRS - CONCOURSE (CON)
- 54 - IRS - DEPOT (DEP)
- 55 - IRS - ENTRANCE (ENT)
- 56 - IRS - GROUND LEVEL (GRD)
- 57 - IRS - IMMERSED TUBE (IMT)
- 58 - IRS - INTAKE CELL (INC)
- 59 - IRS - LIFT SHAFT (LIS)
- 60 - IRS - OVERHEAD VENT DUCT (OVD)
- 61 - IRS - PASSENGER ADIT (PAA)
- 62 - IRS - PLATFORM (PFM)
- 63 - IRS - PLANT ROOM (PLR)
- 64 - IRS - PODIUM (POD)
- 65 - IRS - ROOF (ROF)
- 66 - IRS - SERVICE DUCT (SED)
- 67 - IRS - STATION WALL (STW)
- 68 - IRS - TICKETING HALL (TIH)
- 69 - IRS - TUNNEL (TUN)
- 70 - IRS - UNDER PLATFORM VOID (UPV)
- 71 - IRS - VENTSHAFT (VES)
- 72 - IRS - VIADUCT (VIA)
- 73 - IRS - CENTRAL REFRIGERATION PLANT (CRP)
- 74 - IRS - VENTILATION BUILDING (VEB)
- 75 - IRS - TUNNEL PORTAL (PTL)
- 76 - IRS - SUB-STATION (SUB)
- 77 - IRS - Intermediate Landing

- 78 - IRS - First Floor
- 79 - IRS - Second Floor
- 80 - IRS - Third Floor
- 81 - IRS - Fourth Floor
- 82 - IRS - Fifth Floor
- 83 - IRS - Sixth Floor
- 85 - IRS - Track Canopy Level
- 86 - IRS - Arrival Platform
- 87 - IRS - Departure Platform
- 88 - Overrun Deck
- 89 - Cleaning Platform
- 90 - Footbridge Level (+12.6)
- 91 - +17.6 Level
- 92 - +22.6 Level
- 93 - +27.6 Level
- 94 - Viaduct - Pier

## **505 Building ( Estate )**

- 01 - Site Layout/Block Plan/General Notes
- 02 - Submission Calculation
- 03 - Typical Roof Plan/Roof Plan
- 04 - Typical Floor Plan/Floor Plan
- 05 - Elevations
- 06 - Sections
- 07 - Details
- 08 - Finishes Schedules

## **506 Structure ( Estate )**

- 01 - General Notes
- 04 - Framing Plan
- 06 - Sections
- 07 - Details

## **507 Road ( Estate )**

- 01 - General Notes/Site Layout
- 02 - Traffic Routes
- 03 - Emergency Vehicles on Regular Traffic Routes/on Emergency Traffic Routes
- 04 - Details

## **508 Landscaping ( Estate )**

- 01 - General Notes/Site Layout
- 02 - Part Plans
- 03 - Irrigation Pipes Layout

- 04 - Electricity Conduits Layout
- 05 - Details
- 06 - Facilities/Equipment/Finishes Schedule
- 07 - Construction Joint Layout

## 512 Civil (BDS)

- 01 - General Arrangement
- 02 - R.C. Details
- 03 - Metal Works
- 04 - Drainage
- 05 - Escalator
  
- 90 - Station Box
- 91 - Current Projects in-progress

## 513 Architectural (BDS)

- 01 - General Layout, General Notes, Hoarding, Finish Schedule & Entrance
- 02 - Kiosks
- 03 - Advertising Panel
- 04 - Signs & Queuing System
- 05 - Pay Phones
- 06 - Banks (ATM)
- 07 - Exhibition Areas
- 08 - Display Cases
- 09 - Painting & Repainting
- 10 - Facilities - Toilet, Locker Room, Changing Room, Kitchen & Cleaner
  
- 11 - Office for Passenger - Ticket Office (EFO/BKO), Combined Office, TSI Office & Lost Properties Office
- 12 - Plant Room & Equipment Room
- 13 - Stores - Dangerous Goods Store, Chemical Waste & Industrial Waste Skip Yard.
- 14 - Office for Non-Public - Mess Room, Conference Room, Office, Station Control Room, Station Master Room, Club House, Train Staff Office, Backup Encoding Area, Combined Office, Assembly Hall & Clean Laboratory
- 15 - V.E. Panel
- 16 - Door, Window, Fire Roller Shutter, Roller Shutter, Collapsible Gate, Floodboard & Steel Gate
- 17 - Metal Work - Barrier, Catladder, Catwalk, Platforms, Support Brackets, Plinth, Shelter, Staircase, Chain Link Fence & Rubbish Trap
- 18 - Floor - AFC Trunking & Floor Finishes
- 19 - Wall - V.E. panel & Wall Finishes
- 20 - Ceiling - Bulkhead & Ceiling Finishes
- 21 - Furniture & Fixture
- 22 - Plumbing and Drainage - Water Spray, Washing Pit, Sprinkler Inlet
- 23 - Noise Mitigation & Water-proofing

- 24 - Asbestos
- 25 - Fire Service Arrangement & Equipment
- 26 - Carpark, Pavement, Planter, Landscaping, Walkway, Flagpole
- 27 - E&M Services - A/C Filter Cleaning Tank, Air Handling Unit, Electric Cable Tray, Trunking
- 28 - Disabled Facilities
- 29 - Wall Tiles Layout
  
- 90 - Station Box
- 91 - Current Projects in-progress

## **600 Depot Maintenance Facilities**

- 00 - General/Typical
- 01 - Underfloor Wheel Lathe
- 02 - Wash Plants
- 03 - Traverser
- 04 - Bogie Turntable
- 05 - Cranes
- 06 - Compressor/Plant & System
- 07 - Lifting Jacks
- 08 - Miscellaneous Maintenance Equipment
- 09 - General Cleaning Equipment
- 10 - Bogie Maintenance Equipment
- 11 - BR Clamp Lock Test Rig
- 12 - MJ80 Point Machine Test Rig
- 13 - MJ11 Point Machine Test Rig
- 14 - S700KM Test Rig
- 15 - RS Vehicle Air Reservoir Hydraulic Test Rig

## **700 Co-ordination Drawings Standards**

- 00 - Standard Drawing
- 01 - Combined Services
- 02 - Structural E & M
- 03 - Cable/ Pipe Bracket
- 04 - Cast-in-Conduit

## **701 Combined Services Drawing**

- 00 - General
  
- 90 - Station Box
- 91 - Current Projects in-progress

## **702 - 00 - Structural E&M Drawing**

## **703 - 00 - Cable/Pipe Bracket Drawing**

**704 - 00 - Cast-In-Conduit Drawing**

**705 - 00 - Railway Inspection Drawing**

**706 - Projects In-Progress Information System**

-91 - Current Projects In-Progress

**801 - 00 - BOO Approval Plans**

**811 - 00 - FSD Compartmentation Drawings**

**812 - 00 - FSD Ventilation Drawings**

**813 - 00 - Fire Services Equipment Approval Drawings**

**814 - 00 - Land Terrier Plans**

-01 - Key Plan

**815 Master Layout Plans**

01 - Site Plan/General Notes  
02 - Submission Calculation  
03 - Roof Plan/Typical Roof Plan  
04 - Floor Plan/Typical Floor Plan  
05 - Elevations  
06 - Sections  
07 - Pedestrian Flow  
08 - Traffic Routes  
09 - Emergency Traffic Routes

**900 Miscellaneous**

01 - Furniture/Office Equipment  
02 - Operations Safety Equipment  
03 - General Plan Layout (Blank Layout)  
04 - Programme Chart  
05 - Operations Manuals - Layout/diagram  
06 - Track Diagram for Metal Plate

**901 Operating**

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01 - General Layout Plan (Kiosk Operation)  
02 - General Layout Plan (RHKP)  
03 - Safety signage  
04 - General Layout Plan  
05 - General Layout Plan (Fire Services Installation)

- 06 - Station Interchange Installation
- 90 - Statopm Box

#### **902 Digitalised Survey Map**

- 00 - General/Typical
- 01 - General Layout Plan
- 02 - Station Key Plan

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- 01 - Entrance/Layout Plan
- 02 - Kiosks
- 04 - Graphics/Sign
- 10 - Back of House
- 18 - Flooring/Paving
- 19 - Walls
- 20 - Ceiling
- 21 - Disable facilities
- 22 - Platform Screen Door
- 23 - Station Security System
- 24 - Front of House
- 25 - Combine Services
- 26 - Elevation & Section

#### **904 Marketing**

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- 01 - Signage & Facility Information System (SFIS)
- 02 - Advertising Panel (AP)
- 10 - Contractor Submission
  
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#### **905 Platform Screen Doors**

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- 01 - Electrical System Schematic
- 02 - Equipment Location Plan Layout and Elevation
- 03 - Cable Supports and Containment Layout
- 04 - Earthing and Bonding
- 05 - Power Distribution Schedule
- 06 - Wire Interconnection, Control and Schedule
- 07 - Block Diagram
- 08 - Logic Flow Diagram
- 09 - Interface Wiring Diagram
- 10 - Lighting and Signage

- 11 - General PSD Layout
- 12 - Detailed PSD Layout
- 13 - General PSD Elevation
- 14 - Detailed PSD Elevation
- 15 - PSD Threshold Details
- 16 - PSD Section Details
- 17 - PSD Header Details
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- 19 - PSD Equipment Room and Fire Service Room

## **906 Station Modification Projects (E&M Services)**

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- 10 - Low Voltage (LV)
- 15 - Environmental Control System (ECS)
- 20 - Fire Services (FS)
- 25 - Lifts
- 30 - Escalators
- 35 - Plumbing & Drainage
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## **908 Station Facilities**

- 01 - Signage & Facility Information System (SFIS)

## **909 Signage & Facility Information System (SFIS) Master Drawing**

- 01 - Signage & Facility Information System (SFIS)

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## **DRAWING & CADD MANUAL UPDATES**

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This document will become uncontrolled when printed.



# **DRAWING & CADD MANUAL UPDATES**

## **(Control List)**

**Current Official version of D&CM : Rev. A4 (dated 11 Jul 2011)**

| **Last Updated of this Control List : 17 Oct 2014**

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- 1. Purpose**
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- 3. Unconfirmed Changes (requests received and recorded)**
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## **1. PURPOSE**

The Corporation may from time to time revise parts of the Drawing & CADD Manual as necessary. Such changes will be controlled by M-CADD, then issued in accordance with Corporation's quality system procedures and will be kept in this document.

Section 2 – Confirmed Changes (to be incorporated in the next D&CM revision).  
Section 3 – Unconfirmed Changes (requests received and recorded).

FAQ (frequently asked questions) also provided at the end of the document for reference.

## **2. CONFIRMED CHANGES**

### **(TO BE INCORPORATED IN THE NEXT D&CM REVISION)**

Drawing & CADD Manual Reference	Description	Recorded Date
Section 5 Table 5.1 Location Code Table	Abbreviation of location – Fo Tan Railway House changed from "FRH" to "FTH"	10 Nov 2011
Section 5.2.3 Table K – Main Control System	Subject code "K70" - added for a new system "Universal Integrated Training System"	16 Nov 2011
Section 5.2.3 Table K – Main Control System	Subject code "K00" updated. Subject codes K07, K08, K80-K89 added for a new system "Station Based Control System (SCBS)".	17 Jan 2012
Section 5.2.3 Table U – Rolling Stock	Subject code "U00" added.	19 Apr 2012
Section 3.1.2.7	Delete "(up to 2 characters)" at the section heading	04 Sep 2012
Section 5 Table 5.1 Location Code Table	General revision of Location Code Table in accordance with Operations Engineering Standard – Name and Location Code for Railway Lines and Associated Infrastructures (S/NT-mgt/CS/07(00) rev. C	25 Sep 2012
Supplement B – Building Information Modeling (BIM)	General revision of 7.2.2.6 Naming Convention. New sections added including 7.2.2.7 Colours, 7.2.2.8 MTR Project Parameters, 7.2.3 Modeling Definition and Level of Detail.	25 Sep 2012
Supplement B – Building Information Modeling (BIM)	New section added 7.2.4 Schedule of works (Sample).	28 Sep 2012
Section 5 Table 5.1 Location Code Table	Description of abbreviation "295" updated from "TKS" to "LHP".	21 Jan 2013
Section 3.1.2.2	With reference to the email dialog dated 10 Sep 2013, it was confirmed that the statutory drawings are considered "live" and will be used for later amendments, the Stage Code "B" should remain (i.e. don't use "Z" for statutory record drawings).	10 Sep 2013
Supplement B – Building Information Modeling (BIM)	Section 7.2.3 Modeling Definition and Level of Detail, New Category ID "CAP" added.	27 Nov 2013

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## DRAWING & CADD MANUAL UPDATES

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Last Updated: 17 Oct 2014

Section 5.2.3 Table Q – Overhead Line	Subject code “Q16” updated. Subject codes Q17, Q24, Q26, Q27, Q34, Q36, Q46 added.	16 Jun 2014
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## REFER D&CM: SECTION 7.2.2.6 NAMING CONVENTION

### Model file naming

#### DISCIPLINE –

ARC	Architectural
CIV	Civil (including external Drainage optional)
STR	Structural (Building)
STV	Structural (Trackside e.g. tunnel, viaduct, at-grade etc.)
GEO	Geotechnical
PWY	Permanent Way
DRN	Drainage Services (internal)
ELE	Electrical
FPS	Fire Protection Services
ECS	Environmental Control System
PLM	Plumbing Services
TVS	Tunnel Ventilation System
TAS	Trackside Auxiliaries System
PSS	Power Supply System
OLS	Overhead Line System
LIS	Lifts System
EMS	Escalators and Moving Walkways Systems
PAS	Platform Screen Door and Automatic Platform Gate Systems
COM	Communications System
RDS	Radio System
AFC	AFC System
SAM	SAMS System
COS	Control System
SIS	Signalling System

#### AREA (It shall not be less than 3 or more than 10-alphanumeric characters) –

For sub-divided models, this will indicate tunnel/viaduct/at-grade segment, zone or level of the project in the model file. Use “ALL” if build on one model file.

e.g. “A1-TAW-HIK” for at-grade segment 1 from TAW to HIK

“V1-TAW-HIK” for viaduct segment 1 from TAW to HIK

“T1-HIK-DIH” for tunnel segment 1 from HIK to DIH

“T2-HIK-DIH” for tunnel segment 2 from HIK to DIH etc.

### Family naming

In general, the name of the SUBCATEGORY, DESCRIPTION1 and DESCRIPTION2 provide the BIM Originator with a means of further breaking down of the modeling components and gives a degree of flexibility within the Family naming system. The BIM Originator shall ensure the consistency of such naming be documented and maintained in the project.

## REFER D&CM: SECTION 7.2.2.7 COLOURS

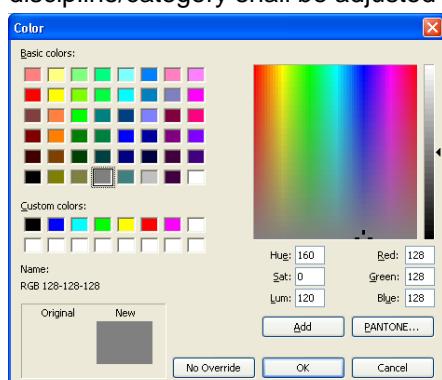
The colour coding shall have specific requirements to tie-in with MTR activities:

1. BD submission - make reference to BD Specification
2. SSCC/STIC/ACABUS/... submission - make reference to MTR Requirement
3. Utility Comparison/Clash Checking
4. Presentation - design specific
5. Others - to be defined and task oriented

The Corporation has established a common colour coding as illustrated in the following table. Any use of other colour coding for various activities, the BIM Originator shall specify the proposed colour coding and the related activity in the BIM Specification for approval.

Discipline / Category	RGB Colour (red-green-blue)	Colour palette
Architectural wall	145-145-143	
Structural foundation, wall, column, stair	101-101-91	
Structural slab, roof	73-68-65	
Structural framing	77-73-68	
Mechanical elements	0-255-0	Green
Electrical elements	0-128-255	Blue
Plumbing elements	128-0-255	Purple
Drainage elements	255-0-255	Magenta
Fire protection elements	255-0-0	Red

Note: In general, the colour assignment of sub-category elements within the same discipline/category shall be adjusted with the "Lum" value.



## REFER D&CM: SECTION 7.2.2.8 MTR PROJECT PARAMETERS

The BIM Originator shall create the following Project Parameters in every BIM model file:

Parameter Type	Parameter Data					Categories	Remarks
	Name:	Discipline:	Type of Parameter:	Group parameter under:	Type or Instance		
Project parameter	<b>BIM Originator</b>	Common	Text	Identity Data	Instance	Project Information	Refer MTR D&CM Section 3.1.2.4 for the code definition
Project parameter	<b>Model Revision</b>	Common	Text	Identity Data	Instance	Project Information	Refer MTR D&CM Section 3.1.3 for the code definition
Project parameter	<b>Structure ID</b>	Common	Text	Identity Data	Instance	Project Information	For MTR IRS system
Project parameter	<b>Structure Name</b>	Common	Text	Identity Data	Instance	Project Information	For MTR IRS system
Project parameter	<b>Second Structure ID</b>	Common	Text	Identity Data	Instance	Project Information	For MTR IRS system
Project parameter	<b>Second Structure Name</b>	Common	Text	Identity Data	Instance	Project Information	For MTR IRS system
Project parameter	<b>IRS Display Selection</b>	Common	Yes/No	Identity Data	Instance	Levels	For MTR IRS system
Project parameter	<b>IRS Level</b>	Common	Text	Identity Data	Instance	Check all except "Grids", "Levels" & "Project Information"	For MTR IRS system
Project parameter	<b>Trackside Grid</b>	Common	Yes/No	Identity Data	Instance	Grids	For MTR IRS system

The parameters “BIM Originator” and “Model Revision” are mandatory fields and shall be filled in by the BIM Originator when submit the BIM database to MTR in accordance with the Contract.

**REFER D&CM: SECTION 7.2.3 MODELING DEFINITION AND LEVEL OF DETAIL****Modeling Definition**

1. The BIM Standard is defined in the Employer's Drawing and CADD Manual and shall be followed by the BIM Originator in building the BIM Database. Any deviation to the aforesaid standard shall in the first instance notify and seek appropriate direction from M-CADD with the proposed changes including the BIM data structures, naming conventions, families, file exchange protocols, symbols and annotations, and etc. The BIM Specification shall be prepared and submitted for agreement with M-CADD prior to any modeling works. The specification shall include, but not limited to the following areas:
  - Definitions and Abbreviations
  - BIM Authoring Application Version
  - Model Geometry (co-ordinates, setting out, levels & units)
  - Model Division (model demarcation, central/local file setting & workset setting)
  - Model Project Browser Set-up
  - Model View Templates and Filters Set-up
  - Model File and Revit Family Naming Convention
  - Model Maintenance and Quality Control Procedures
  - Revit Family Library Descriptions
  - Clash Analysis System
  - BIM Deliverables Descriptions (native files, review files, clash analysis reports structure & file/folder structure)
2. BIM model shall be fully co-ordinated between disciplines. The naming convention of files, views, legends, schedules, sheets, families, groups and links shall contain a common reference to the corresponding 2D drawings where appropriate. Requirements from designated and interfacing contracts shall be incorporated and co-ordinated as required with reference to the corresponding input information shown on the 2D drawings.
3. BIM Models shall be progressively developed throughout the contract and accurately align with the 2D drawings. The BIM Database deliverables shall comply with the requirements of the Employer's Drawing and CADD Manual unless otherwise approved by M-CADD. The BIM Originator shall propose any exceptions or waivers to M-CADD for approval in advance of BIM model production if required.
4. The BIM Database shall contain sufficient information to suit the intended purpose for the activities of services as follows:
  - The BIM Specification shall be submitted with every BIM Database deliverable which fully describes the contents of the deliverables.

- The BIM Model shall define all elements of the works in sufficient details in order to illustrate that they have been properly sized, co-ordinated and specified to a degree where the design can proceed without affecting other disciplines and interfacing parties. Clash analysis shall be performed between disciplines/systems/services to prove the design. It shall accurately align with the 2D drawings including general arrangement and layout plans, sections, elevations, schematics and schedules.
- A detailed clash analysis report as required in the deliverable is to support and prove the design that is well coordinated. The report shall give location and details in both 2D/3D views, saved close-up views in the BIM model and the corresponding references to the 2D drawings, and the remedial measure shall also be proposed.
- The Final As-built BIM Database deliverable shall be developed by the BIM Originator to accurately align with final approved as-built drawings to reflect the actual works built on site.

**Level of Detail****1. Architectural Components to be Modelled**

The level of details of the architectural components shall include, but not limited to the following elements:

- (a) BIM database shall locate the Works in relation to the local area. They shall show the stations, entrances and surrounding land use; road layouts, existing and proposed buildings.
- (b) All rooms, corridors and other spaces (including labelling and cross reference keys to schedules) as defined in the Corporation Data.
- (c) Major openings and equipment routes proposed to enable a check on compliance with the relevant Corporation Data. The BIM model shall includes openings and penetrations for Building Services, Systemwide E&M services and Builder's Works
- (d) Exterior and interior walls.
- (e) Curtain wall and facades.
- (f) Doors and windows.
- (g) Access ladders and catwalks.
- (h) Housing for light fixtures.
- (i) Vertical circulation elements including lifts, escalators and moving walkways and stairs with railings.
- (j) Access and parking arrangements.
- (k) Plant and equipment rooms (including designated use).
- (l) Duct, pipe or plant space.
- (m) Location of common components and station furniture including tactile paths and other information used to define the disabled guide path.
- (n) All elevation views of the BIM model shall include canopies, projections and the like with sufficient detail to illustrate grid application in the elevational detail, material choices and extent of Specialist's and System-wide E&M Works. Sizes and locations of louvres required by Station ECS shall also be indicated.
- (o) Roof, ceiling and various ceiling void components including FS items,

lighting, signage, air grilles and louvres, cable containment and any other E&M and C&C elements. It shall include module arrangement, material choices and finishes.

- (p) Signage and advertising panels to fully describe the types both internal and external.
- (q) Other Architectural components.

## 2. Structural Components to be Modelled

The level of details of the structural components shall include, but not limited to the following elements:

- (a) BIM model shall include all structural elements as shown in 2D design drawings.
- (b) BIM model shall be fully co-ordinated with architectural plans and SEM and to model openings, voids, pits and recesses (includes openings and penetrations for Building Services, Systemwide E&M services and Builder's Works).
- (c) Foundations including piles, pile caps, diaphragm wall and all permanent elements.
- (d) Details are required in congested areas, change in level, junctions/connections between structural elements.
- (e) BIM model shall include all internal and non-structural walls. The model shall show all penetrations for Building Services, Systemwide E&M services and Builder's Works. The Engineer will collate the Phase 2 SEM information produced by the Building Services Contractor and Systemwide E&M contractors and will issue this information to the BIM Originator. The BIM Originator shall check the SEM opening requirements and make necessary amendments to the BIM model.
- (f) Other Structural components.

## 3. Building Services Components (ECS, Electrical Services, Fire Services, P&D Systems, Station Based Control System & Condition Based Maintenance System) to be Modelled

The level of details of the building services components shall include, but not limited to the following elements:

- (a) The BIM model shall include all functional components and equipment which make up the system such as pumps, fans, valves, terminals, electrical switchgear and components to its overall height, width and depth where appropriate.

- (b) The BIM model shall be modelled to the actual outside face and size of pipes, ducts and conduits of 50mm or greater, associated with BS components, cable trays, trunking, cable containment, access zones and electrical equipment.
- (c) Banks of smaller pipes, ducts and conduits shall be modelled where appropriate in a generic form to indicate their location.
- (d) HVAC components shall include FCU, EF, AHU, Chillers, fans, VRV and HVAC switchboards, diffuser and registers, and etc.
- (e) Electrical components shall include power feeds to equipment & switchgear, light fittings, cable trays, trunking, cable containment, access zones, riser rooms, switch boards, generators, diesel tanks, fuel pipes and exhausts, and etc.
- (f) Plumbing and Drainage (P&D) components shall include grease and sand traps, underground drainage, sump and sewage pits and water holding tanks, and etc.
- (g) Fire services components shall include tanks, hydrants and hose reels, and etc.
- (h) The BIM model shall be spatially co-ordinated i.e. there should be no physical clashes between the system components to meet the design intent.
- (i) Spaces between pipes, duct-runs and cable routes modelled shall make allowance for the service at its widest point. Insulation, standard fitting dimensions, joint widths and supports shall therefore have been allowed for in the model.
- (j) The BIM model shall make allowance for installation working space and space to facilitate commissioning and maintenance.
- (k) The BIM model shall detail the provisions required in the structure to accommodate all BS/E&M/C&C services. The model shall include all penetrations, cast-in items, plinths, trenches, pump pits in all structural elements. The model shall be coordinated among all the disciplines (C&S, architectural, BS). The model shall also detail other provisions required to accommodate the building services which significantly affect the design of the structure, fabric and external works.
- (l) Other Building Services components.

#### 4. MTR Systemwide Components to be Modelled

The level of details of the MTR Systemwide components shall include, but not limited to the following elements:

- (a) The BIM model shall include all functional components and equipment which make up the Tunnel Ventilation System such as fans, dampers, ducts, silencers, nozzles, AHUs, air compressors and receivers, motor control centres, etc. and having components to its overall height, width and depth where appropriate.
- (b) The BIM model shall include all functional components and equipment which make up the Trackside Auxiliaries System such as fire mains, fire hydrants, trackside lighting and power, cable/pipe supporting system, tunnel cleansing water system, sump pump system, earthing, etc. and having components to its overall height, width and depth where appropriate.
- (c) The BIM model shall include all functional components and equipment which make up the Power Supply System such as transformers, HV switchboards, HV isolators, DC switchboards, rectifiers, batteries and chargers, PLC cubicles, OVPDs, drainage diode cubicles, negative busbar cubicles, etc. and having components to its overall height, width and depth where appropriate.
- (d) The BIM model shall include all functional components and equipment which make up the Overhead Line System such as OHL wires, rigid conductor rails, OHL supports, OHL masts, portals, headspans, balance weight assemblies, OHL isolators, etc. and having components to its overall height, width and depth where appropriate.
- (e) The BIM model shall include all functional components and equipment which make up the Lifts System such as lift car, lift landing door and architrave, lift landing fixtures, lift control panel, driving machine, control cubicles, guide rails, buffers, etc. and having components to its overall height, width and depth where appropriate.
- (f) The BIM model shall include all functional components and equipment which make up the Escalators and Moving Walkways Systems such as landing floor plates, truss, balustrade, decking and claddings, control cubicles, etc. and having components to its overall height, width and depth where appropriate.
- (g) The BIM model shall include all functional components and equipment which make up the Platform Screen Door (PSD) and Automatic Platform Gate (APG) Systems such as automated sliding doors, emergency escape doors, fixed screens, manual secondary doors, HW/TW local control panels, power supply and control cubicles, etc. and having components to its overall height, width and depth where appropriate.

- (h) The BIM model shall include all functional components and equipment which make up the Communications System such as CCTV cameras, speakers, noise sensors, passenger information display boards, digital advertising panels, helplines and telephones, intercom units, clock units, block wirings, etc. and having components to its overall height, width and depth where appropriate.
- (i) The BIM model shall include all functional components and equipment which make up the Radio System such as antennas, wireless access points, radio amplifiers, leaky coaxial cables, etc. and having components to its overall height, width and depth where appropriate.
- (j) The BIM model shall include all functional components and equipment which make up the AFC System such as AFC gates (includes wide gates), ticket machines, self service points, card enquiry machines, first class processors, office CSC processors, station computers, workstations, printers, network devices, etc. and having components to its overall height, width, depth and required clearance where appropriate.
- (k) The BIM model shall include all functional components and equipment which make up the SAMS System such as group control units, local control units, SAMS station computers, workstations, printers, network devices, etc. and having components to its overall height, width and depth where appropriate.
- (l) The BIM model shall include all functional components and equipment which make up the Control System such as station operator consoles, digital IBP, etc. and having components to its overall height, width and depth where appropriate.
- (m) The BIM model shall include all functional components and equipment which make up the Signalling System such as power supply cubicles, electronic cubicles, cable termination rack, relay rack, workstations, etc. and having components to its overall height, width and depth where appropriate.

## 5. MTR Permanent Way Components to be Modelled

The level of details of the MTR Permanent Way components shall include, but not limited to the following elements:

- (a) The BIM model shall include all Rail type and grade- eg BS90A, UIC54, UIC60 or 60E1 etc. Rail grade R260 or R350HT etc. and the location of all rail joints such as insulated rail joint (IRJ), fishplated rail joint, flash butt welded rail joint and alumino-thermic welded rail joint.
- (b) The BIM model shall include all locations and types of special trackwork such as turnouts and rail expansion joints etc. Type of

turnout such as BV8, CV10, 1in7, 1in8.4, 1in10.5 etc.

- (c) The BIM model shall include all functional components which make up the types of trackforms FST, IST, BCT, PCBT, ballasted track etc.
  - (d) The BIM model shall include all horizontal and vertical alignment information with applied cant, cant deficiency and maximum design speed values.
  - (e) The BIM model shall include the locations of buffer stops and type. e.g fixed steel buffer, concrete buffer and sliding buffer etc. and having components to its overall height, width and depth where appropriate.
6. The Category ID shall be used for the modeling component database, family naming and the clash analysis matrices:

No.	Definition	Category
<b>MTR Systems &amp; Components</b>		
MTR01	Platform Supervisor Box	PSB
MTR02	Customer Services Centre	CUC
MTR03	Advertising Panel	ADP
MTR04	Security equipment	SEC
MTR05	Fixed station furniture	FUR
MTR06	All room spaces, corridors and other spaces (incl labelling and cross reference keys to schedules) as defined in the MTR Data. All plant and equipment rooms (incl designated use) will be identified.	SPA
MTR07	PID, Information, Identity, Operational and Directional Signs	SIG
MTR08	All major openings and equipment routes proposed to enable a check on compliance with the relevant Corporation Data. The required operational headrooms will be modelled as solids.	CLR
MTR09	Tunnel Ventilation System	TVS
MTR10	Trackside Auxiliaries System	TAS
MTR11	Power Supply System	PSS
MTR12	Overhead Line System	OLS
MTR13	Lifts System	LIS
MTR14	Escalators and Moving Walkways Systems	EMS
MTR15	Platform Screen Door (PSD) and Automatic Platform Gate (APG) System	PAS
MTR16	Communications System	COM
MTR17	Radio System	RDS

No.	Definition	Category
MTR18	AFC System	AFC
MTR19	SAMS System	SAM
MTR20	Control System	COS
MTR21	Signalling System	SIS
MTR22	Permanent Way	PWY
<b>Structural Elements</b>		
S01	Foundations including piles, pile caps, tie/ground beams & footings	SFO
S02	Diaphragm walls & retaining walls	DWL
S03	Beams	SBS
S04	Columns	SCL
S05	Slabs, including slab on grade	SLA
S06	Stairs (steps, risers, threads)	STA
S07	Walls	SWL
S08	Water tanks	WAT
S09	Steel frame structures including bracing systems	STS
S10	Precast & Prestressed concrete systems	PST
S11	Tunnel	TUN
S12	Viaduct	VIA
S13	At-grade	ATG
<b>Architectural Elements</b>		
A01	Interior / Exterior walls / Non-structural walls including finishes to identify if tiled/painted and if any wall base or carpentry.	WLL
A02	Interior / Exterior doors	DOR
A03	Platform Screen Door	PSD
A04	Automatic Platform Gate	APG
A05	Interior / Exterior windows	WDW
A06	Curtain wall with mullions and transoms with true profile and window glazing units including shading devices	CTM
A07	Louvres (Sizes and locations of louvres required by Station ECS shall be indicated)	LOU
A08	Stone cladding façades (as mass elements of overall thickness)	CLD
A09	Roofs with overall thickness (including finishes & insulation)	ROF

No.	Definition	Category
A10	Sloped floors and ramps	RMP
A11	Floor finishes details including tiling, carpet, screed only	FLR
A12	Tactile paths and other information used to define the disabled guide paths.	TAG
A13	Ceilings (without support sub-frames) will be modelled as mass elements according to their overall thickness including allowance for light fittings. The underside of the ceiling will match the RCP levels on the architectural drawings. The ceilings should include module arrangement, material choices and finishes.	CLG
A14	Steps & Stairs including risers, threads and railings and MTR headroom clearance requirements.	STE
A15	Lift shafts (without fit-out installations by lift contractor)	LIF
A16	Escalators & moving walkways, with clearance requirements as per DSM will be modelled according to standard supplier requirements (without motorized equipments inside). <i>Escalator pits will be included in the structure slab &amp; beam models.</i>	ESC
A17	Access ladders and catwalks	LAD
A18	Site Infrastructure within site boundary (roads, pavements, car park spaces, access and parking arrangements, the stations, entrances and surrounding land use)	SIT
A19	Hard landscaped areas within site boundary	LDS
A20	Immediate surrounding buildings, modelled as solid mass elements. The BIM models will locate the works in relation to the local area.	SUR
<b>Mechanical Elements</b>		
M01	The following sheet metal ductwork systems will be identified;  Exhaust air ducts, Fresh air ducts, Supply air ducts, Return air ducts, Transfer air ducts	DCT  EAD FAD SAD RAD TAD
M02	The UPS & OTE ducts will be modelled separately and will be integrated with the station structures and slabs.	UPS OTE
M03	Exhaust or extract air fans	EAF
M04	Fresh air fans	FAF
M05	Other fans such as jet fans	FAN

No.	Definition	Category
M06	Diffusers, air-boots, air grilles, air filters, registers	AIR
M07	Fire dampers, motorized dampers, volume control dampers	DAM
M08	Fan Coil unit	FCU
M09	Air Handling unit	AHU
M10	Chiller unit	CHL
M11	Variable refrigerant unit	VRV
M12	Cooling Tower	COT
M13	Split-type indoor & outdoor air conditioning units	ACU
M14	Chilled water supply pipes incl connections, fittings & valves	CWS
M15	Chilled water return pipes incl connections, fittings & valves	CWR
M16	Condensate drain pipes incl connections, fittings & valves	CDP
M17	Pumps	PMP
M18	Switch boards, control panels, BMS panels, DDC panels, BMS control & monitoring modules	PAN
M19	Compressed air pipes incl connections, fittings & valves	CAP
<b>Electrical Elements</b>		
E01	Cable trays, trunking, & cable containment, Electrical risers, conduit, Busduct, power feeds,	CAB
E02	HV & LV switch boards, switchgear, MCCB boards, MCB boards	BRD
E03	Transformers	TRN
E04	Light fittings & fixtures & housings for light fixtures	LGD/LG F
E05	Conduit associated with access, data communication, security systems and electrical equipment	ELV
E06	Equipment and associated installations maintained by public utility companies	CLP
<b>Plumbing and Drainage Elements</b>		
PD01	Fresh water piping, fittings, valves incl hot & cold water pipework with all plumbing equipment, sinks, toilet fixtures, plumbing faucets	FWP
PD02	Rainwater & stormwater pipework including outlets, surface channels, slot channels and manholes	RWP
PD03	Foul drainage, kitchen waste pipework including floor drains, open trapped gullies, sealed trapped gullies	SWP

No.	Definition	Category
	and clean outs, vents and manholes	
PD04	Grease and Sand traps	TRP
PD05	Pumps	PMP
PD06	Sump and sewage pits,	PIT
PD07	Storage, water holding tanks, pressure vessels	TNK
PD08	External drainage & underground drainage	UGR
PD09	Underground Public Utilities for water supply	WSD
PD10	Underground Public Utilities for drainage	DSD
<b>Fire Protection Elements</b>		
F01	System piping, droppers, fittings, valves and sprinkler heads, sprinkler inlets, sprinkler control valve set, subsidiary valves, flow switches	SPR
F02	Fire sprinkler pumps	PMP
F03	Sprinkler tanks	TNK
F04	Hydrants and hose reels, incl street fire hydrant system	HYD
F05	Gas piping for suppression systems	GAS
F06	Heat or smoke detectors, control panels, monitoring and control sensors, pump panels, check meter positions	PAN
F07	Fire extinguishers	EXT
F08	Fire shutters & hoods above	SHT

The components shall be modelled to the actual outside face and size of pipes, ducts and conduits of 50mm or greater. Any elements smaller than 50mm in size or diameter will not be modelled unless they are specifically required to resolve a particular co-ordination issue or future operation and maintenance needs.

Banks of smaller pipes, ducts and conduits shall be modelled where appropriate in a generic form to indicate their location.

If the exact specification is not available, equipment will be modelled to its overall height, width and depth only.

In addition to the basic properties of equipment name/description, dimensions, and location, not more than 10 pieces of equipment attribute data fields (e.g. hp, tonnage, wattage) shall be incorporated for each element. And the basic parameters such as brand name, model number shall be included where appropriate.

The BIM model shall make allowance for installation working space and space to facilitate commissioning and maintenance. It will base on the information during the Design, Construction or As-built stage.

## REFER D&CM: SECTION 7.2.4 SCHEDULE OF WORKS (SAMPLE)

### Schedule of Works

As the requirement of BIM is project specific, the schedule of works in this section provides a sample guideline which may vary with the contract strategy of a project.

The matrix listed below defines the BIM Originator in relation to the schedule of works throughout various stages of the Project. The BIM Originator shall solely be responsible for building the model with reference to the information provided by the Corporation.

Model File	Discipline	BIM Originator		
		Design	Construction (upon the award of the BS Contract)	As-built
ARC	Architectural	①	②	②
CIV	Civil (including external Drainage optional)	①	②	②
STR	Structural (Building)	①	②	②
STV	Structural (Trackside e.g. tunnel, viaduct, at-grade etc.)	①	②	②
GEO	Geotechnical	①	②	②
PWY	Permanent Way	-	②	②
DRN	Drainage Services (internal)	①	③	③
ELE	Electrical	①	③	③
FPS	Fire Protection Services	①	③	③
ECS	Environmental Control System	①	③	③
PLM	Plumbing Services	①	③	③
TVS	Tunnel Ventilation System	-	③	③
TAS	Trackside Auxiliaries System	-	③	③
PSS	Power Supply System	-	③	③
OLS	Overhead Line System	-	③	③
LIS	Lifts System	-	③	③
EMS	Escalators and Moving Walkways Systems	-	③	③
PAS	Platform Screen Door and Automatic Platform Gate Systems	-	③	③
COM	Communications System	-	③	③

<b>Model File</b>	<b>Discipline</b>	<b>BIM Originator</b>		
		<b>Design</b>	<b>Construction (upon the award of the BS Contract)</b>	<b>As-built</b>
RDS	Radio System	-	③	③
AFC	AFC System	-	③	③
SAM	SAMS System	-	③	③
COS	Control System	-	③	③
SIS	Signalling System	-	③	③

**Legend:**

- ① Detailed Design Consultant**
- ② Civil Contractor**
- ③ Building Services Contractor**

### **3. UNCONFIRMED CHANGES** **(REQUESTS RECEIVED AND RECORDED)**

Drawing & CADD Manual Reference	
Section 5 Coding Reference Tables	Section 5.1 – Location Code Table
	Section 5.2 – Subject Code Tables

**REFER D&CM: SECTION 5: CODING REFERENCE TABLES****Originator Code**

- Latest coding shall refer Electronic Project Management System (ePMS) - SharePoint

**Location Code**

- Legends

	<b>Interface Stations</b>
	<b>West Island Line (WIL)</b>
	<b>South Island Line East (SIL(E))</b>
	<b>Express Rail Link (XRL)</b>
	<b>Kwun Tong Line Extension (KTE)</b>
	<b>Shatin to Central Link (SCL)</b>
	<b>Recorded in Section 2 that changes confirmed to be incorporated in the next D&amp;CM revision</b>
	<b><i>Proposed by Project</i></b>

**Subject Code**

- Legends

	<b>Recorded in Section 2 that changes confirmed to be incorporated in the next D&amp;CM revision</b>
	<b><i>Proposed and to be implemented</i></b>

## LOCATION CODE TABLE

Abbrev. Code	Station / Building Name	Station / Building Name (Chinese)	Line (Abbrev.)	Station Line (Chinese)
000	System-wide Location			
201	QUB Overrun		KTL	
202	QVB to QUB Both		KTL	
203	CVB to QVB Both		KTL	
204	LAT to CVB Both		KTL	
205	KWT to LAT Both and all		KTL	
206	NTK to KWT Both and all		KTL	
207	KOB to NTK Both		KTL	
208	KBD Arrival, Departure & Reception Tracks,		KTL	
209	CHH to KOB Both and all		KTL	
210	DIH to CHH Both and all		KTL	
211	WTS to DIH Both		KTL	
212	LOF to WTS Both		KTL	
213	KOT to LOF Both		KTL	
214	SKM to KOT Both		KTL	
215	PRE to SKM Both and all		KTL	
216	MOK to PRE Both KWT Line		KTL	
217	YMT to MOK Both and all KWT Line		KTL	
218	YMT Overrun		KTL	
219	TSW Headshunts Both and all		TWL	
220	TWD Reception Tracks Both		TWL	
221	TWH to TSW Both		TWL	
222	KWH to TWH Both and all		TWL	
223	KWF to KWH Both		TWL	
224	LAK to KWF Both		TWL	
225	MEF to LAK Both and all		TWL	
226	LCK to MEF Both		TWL	
227	CSW to LCK Both		TWL	
228	SSP to CSW Both		TWL	
229	PRE to SSP Both		TWL	
230	MOK to PRE Both TSW Line		TWL	
231	MOK Upper Level Interlocking Area		TWL	
232	MOK Lower Level Interlocking Area		TWL	
233	YMT to MOK Both TSW Line		TWL	
234	JOR to YMT Both		TWL	
235	TST to JOR Both and all		TWL	
236	NVB to TST Both		TWL	
237	SVB to NVB Both (Immersed Tube)		TWL	
238	ADM to SVB Both		TWL	
239	ADM to CEN Sidings Both and all		TWL	
240	CEN to ADM Both and all TSW Line		TWL	
241	CEN Overrun		TWL	
242	CHW Overrun		ISL	
243	HFC to CHW Both and all		ISL	
244	CWD Reception Tracks		ISL	
245	SKW to HFC Both		ISL	
246	SWH to SKW Both		ISL	
247	TAK to SWH Both and all		ISL	
248	QUB to TAK Both and all		ISL	
249	NOP to QUB Both		ISL	

## DRAWING & CADD MANUAL UPDATES

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Abbrev. Code	Station / Building Name	Station / Building Name (Chinese)	Line (Abbrev.)	Station Line (Chinese)
250	FOH to NOP Both		ISL	
251	TIH to FOH Both		ISL	
252	CAB to TIH Both		ISL	
253	WAC to CAB Both and all		ISL	
254	ADM to WAC Both		ISL	
255	CEN to ADM Both Island Lind		ISL	
256	ADM Upper and Lower Level Interlocking Area		ISL	
257	SHW to CEN Both		ISL	
258	SHW Overrun		ISL	
261	AIR to AWE and both		LAL	
262	AIR to TUC and both		LAL	
263	TUC Overrun		LAL	
264	TUC to TSY and both (Rambler Channel Bridge)		LAL	
266	SUN to TSY and both		LAL	
267	TUC to SUN and both		LAL	
268	TSY to LAK and both		LAL	
269	LAK to OLY and both		LAL	
272	OLY to KOW and both		LAL	
273	KOW to HOK and both (Western Immersed		LAL	
274	HOK overrun		LAL	
287	POA Overrun		TKL	
288	POA to HAH and both		TKL	
289	HAH to TKO and both		TKL	
290	TKO to TIK and both		TKL	
291	TIK to YAT and both		TKL	
292	YAT to QVB and both		TKL	
293	YAT to LAT and both		TKL	
294	QVB to QUB and both (obsolete)			
295	TKO to LHP/TKD and both		TKL	
296	NOP Overrun		TKL	
*300~399	Reserved for Railway Extension Projects use			
501	Telford Gardens		KTL	
502	Telford Centre		KTL	
503	Luk Yeung Sun Chuen		TWL	
504	Luk Yeung Sun Chuen - Shopping Arcade		TWL	
505	New Kwai Fong Gardens		TWL	
506	Admiralty Centre		ISL	
507	World Wide House		KTL	
508	Fairmont House		ISL	
509	Hongway Garden		ISL	
510	Southorn Garden		ISL	
511	Kornhill		ISL	
512	Kornhill Gardens (PSPS)		ISL	
513	Fortress Metro Tower		ISL	
514	Felicity Garden		ISL	
515	Heng Fa Chuen		ISL	
516	Heng Fa Chuen - Shopping Centre		ISL	
517	Heng Fa Chuen - Club		ISL	
518	Perfect Mount Gardens		ISL	
519	Service Duct (Luk Yeung Sun Chuen)		ISL	
ADD	Admiralty Distribution Substation	金鐘配電站	ISL	

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Abbrev. Code	Station / Building Name	Station / Building Name (Chinese)	Line (Abbrev.)	Station Line (Chinese)
<b>ADM</b>	Admiralty Station	金鐘	ISL/TWL /SCL/SI L(E)	港島/荃灣綫
<b>AEL</b>	Airport Express Line	機場快綫	AEL	機場快綫
<b>AFF</b>	Affluence	澤豐	LRL	輕鐵
<b>AIR</b>	Airport Station	機場	AEL	機場快綫
<b>AMC</b>	NTSAMC & STPOS		SCL	
<b>AUS</b>	Austin Station	柯士甸	WRL/SCL	西鐵綫
<b>AWE</b>	Asia World-Expo Station	博覽館	AEL	機場快綫
<b>BAL</b>	BaiShiLong	白石龍	SZ4	深圳4綫
<b>BUT</b>	Butterfly	蝴蝶	LRL	輕鐵
<b>CAB</b>	Causeway Bay Station	銅鑼灣	ISL	港島綫
<b>CEN</b>	Central Station	中環	ISL/TWL	港島/荃灣綫
<b>CES</b>	Central South Station		SCL	
<b>CHC</b>	Ching Chung	青松	LRL	輕鐵
<b>CHE</b>	Chestwood	翠湖	LRL	輕鐵
<b>CHF</b>	Chung Fu	頌富	LRL	輕鐵
<b>CHH</b>	Choi Hung Station	彩虹	KTL	觀塘綫
<b>CHT</b>	Chek Lap Kok Traction Substation	赤鱲角牽引配電站	LAL	
<b>CHW</b>	Chai Wan Station	柴灣	ISL	港島綫
<b>CIO</b>	City One Station	第一城	MOL	馬鞍山綫
<b>CKP</b>	Cha Kwo Ling Portal	茶果嶺隧道口	KTL	
<b>CKT</b>	Che Kung Temple Station	車公廟	MOL	馬鞍山綫
<b>CKV</b>	Chai Wan Kok Ventilation Building	柴灣角通風樓	WRL	
<b>CLP</b>	Citylink Plaza	連城廣場	EAL	
<b>CRP</b>	Cheung Sha Wan Central Refrigeration Plant	長沙灣中央製冷廠	TWL	
<b>CRV</b>	Chatham Road Ventilation Building		SCL	
<b>CSP</b>	Choi Shek Portal	彩石隧道口	KTL	
<b>CST</b>	Cheung Sha Wan Traction Substation	長沙灣牽引配電站	TWL	
<b>CSW</b>	Cheung Sha Wan Station	長沙灣	TWL	荃灣綫
<b>CTV</b>	Chau Tau Ventilation Building	洲頭通風樓	EAL	
<b>CUT</b>	Chung Uk Tsuen	鍾屋村	LRL	輕鐵
<b>CVB</b>	Cha Kwo Ling Portal Ventilation Building	茶果嶺隧道口通風樓	KTL	
<b>CWD</b>	Chai Wan Depot	柴灣車廠	ISL	
<b>CWV</b>	Chai Wan Portal Ventilation Building	柴灣隧道口通風樓	ISL	
<b>CYB</b>	Choy Yee Bridge	蔡意橋	LRL	輕鐵
<b>DHD</b>	Diamond Hill Depot (Obsolete code in Detailed Design Stage and replaced by DHS in C1103)			
<b>DHS</b>	Diamond Hill Stabling Sidings		SCL	
<b>DIH</b>	Diamond Hill Station	鑽石山	KTL/SCL	觀塘綫
<b>DIS</b>	Disneyland Resort Station	迪士尼	DRL	迪士尼綫
<b>DRL</b>	Disneyland Resort Line	迪士尼綫	DRL	迪士尼綫
<b>E01</b>	Ho Man Tin Feeder Station (Obsolete code and replaced by HMF)			
<b>E02</b>	Tai Wai Feeder Station (Obsolete code and replaced by TWF)			
<b>E03</b>	Tai Po Kau Track Section Cabin		EAL	
<b>E04</b>	Fanling Track Section Cabin		EAL	
<b>E05</b>	City One Track Section Cabin		MOL	
<b>E06</b>	Wu Kai Sha Track Section Cabin		MOL	
<b>E07</b>	Hung Hom Feeder Station (C1106)		SCL	
<b>E08</b>	Lok Ma Chau Track Section Cabin			

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Abbrev. Code	Station / Building Name	Station / Building Name (Chinese)	Line (Abbrev.)	Station Line (Chinese)
<b>EA1</b>	LMC Emergency Access Point 1		EAL	
<b>EA2</b>	LMC Emergency Access Point 2		EAL	
<b>EA3</b>	LMC Emergency Access Point 3		EAL	
<b>EA4</b>	LMC Emergency Access Point 4		EAL	
<b>EA5</b>	LMC Emergency Access Point 5		EAL	
<b>EA6</b>	LMC Emergency Access Point 6		EAL	
<b>EA7</b>	LMC Emergency Access Point 7		EAL	
<b>EAL</b>	East Rail Line	東鐵綫	EAL	東鐵綫
<b>ELP</b>	East Lantau Tunnel Portal	東大嶼山隧道口		
<b>ELT</b>	East Lantau Tunnel (East) Ventilation Building (Former description: East Lantau Tunnel (East) Traction Substation)	東大嶼山隧道通風樓	LAL	
<b>ELV</b>	East Lantau Tunnel (West) Ventilation Building	東大嶼山隧道通風樓	LAL	
<b>EPB</b>	Quarry Bay East Plant Building	鰲魚涌東機樓	ISL	
<b>EPV</b>	East Portal Ventilation Building	東隧道口通風樓	TWL	
<b>ERL</b>	East Rail Lines (EAL + MOL)	東鐵	ERL	東鐵
<b>ERS</b>	Emergency Rescue Station		XRL	
<b>ETS</b>	East Tsim Sha Tsui Station	尖東	WRL	西鐵綫
<b>EXH</b>	Exhibition Station and Western Ventilation Building	會展	SCL/NIL	
<b>F01</b>	Kwai Fong Feeder Station (Obsolete code and replaced by KFF)			
<b>F02</b>	Tin Shui Wai Feeder Station (Obsolete code and replaced by TSF)			
<b>F03</b>	Ho Pui Track Section Cabin		WRL	
<b>F04</b>	Pat Heung Maint. Cen. Track Sect. Cabin		WRL	
<b>F05</b>	Tuen Mun Track Section Cabin		WRL	
<b>FAF</b>	Fanling Feeder Station	粉嶺饋電站		
<b>FAN</b>	Fanling Station	粉嶺	EAL	東鐵綫
<b>FBD</b>	MTR Fo Tan Bus Depot	港鐵火炭巴士廠	ERL	
<b>FEP</b>	Tuen Mun Ferry Pier	屯門碼頭	LRL	輕鐵
<b>FHO</b>	MTR Freight Head Office	港鐵貨運總辦事處	EAL	
<b>FNR</b>	Fung Nin Road	豐年路	LRL	輕鐵
<b>FOB</b>	MTR Freight Operations Building	港鐵貨運調度大樓	EAL	
<b>FOH</b>	Fortress Hill Station	炮台山	ISL	港島綫
<b>FOT</b>	Fo Tan Station	火炭	EAL	東鐵綫
<b>FPD</b>	MTR Fo Tan P'Way Subdepot	港鐵火炭軌道維修支廠		
<b>FPP</b>	Fenwick Pier Emergency Egress Point		SCL	
<b>FRH</b>	Fo Tan Railway House (Obsolete code and replaced by FTH)			
<b>FTA</b>	Fung Tak Building EEP/EAP		SCL	
<b>FTF</b>	MTR Fo Tan Freight Terminal	港鐵火炭貨場	EAL	
<b>FTH</b>	Fo Tan Railway House (formerly KCRC House)	火炭鐵路大樓	EAL	
<b>FUM</b>	FuMin	福民	SZ4	深圳4綫
<b>FUT</b>	Fung Tei	鳳地	LRL	輕鐵
<b>FUT</b>	Futian Station		XRL	
<b>GAR</b>	Gascoigne Road Traction Substation	加士居道牽引配電站	TWL	
<b>GIN</b>	Ginza	銀座	LRL	輕鐵
<b>GOG</b>	Goodview Garden	豐景園	LRL	輕鐵
<b>HAH</b>	Hang Hau Station	坑口	TKL	將軍澳綫
<b>HAV</b>	Happy Valley Station (Obsolete code in Detailed Design Stage)			

Abbrev. Code	Station / Building Name	Station / Building Name (Chinese)	Line (Abbrev.)	Station Line (Chinese)
HBD	MTR Hung Shui Kiu Bus Depot	港鐵洪水橋巴士廠	LRL	
HCB	HKU Chiller Plant Building		WIL	
HEO	Heng On Station	恒安	MOL	馬鞍山綫
HFC	Heng Fa Chuen Station	杏花邨	ISL	港島綫
HFT	Hoh Fuk Tong	何福堂	LRL	輕鐵
HHB	MTR Hung Hom Building	港鐵紅磡大樓	EAL	
HHF	MTR Hung Hom Freight Terminal	港鐵紅磡貨場	EAL	
HHI	Hang Hau Passenger Transport Interchange	坑口運輸交匯處	TKL	
HHR	Hammer Hill Road Ventilation Building	斧山道通風樓	KTL	
HHS	Hung Hom Stabling Sidings		SCL	
HIC	Hong Kong Intake Cell	香港海水泵房	LAL	
HID	Hong Kong Cooling Water Intake for	香港海水泵房	LAL	
HIK	Hin Keng Station		SCL	
HKB	Hong Kong Park Ventilation Building		SIL(E)	
HKP	Hong Kong Park (Obsolete code in Detailed Design Stage and replaced by HKB in C902)			
HKU	Reserved for WIL (also refer UNV in Detailed Design stage)		WIL	
HLR	Hong Lok Road	康樂路	LRL	輕鐵
HMD	Ho Man Tin Power Distribution Depot	何文田配電維修廠		
HMF	Ho Man Tin Feeder Station	何文田饋電站		
HMT	Hang Mei Tsuen	坑尾村	LRL	輕鐵
HOM	Ho Man Tin Station	何文田	KTE / SCL	
HMS	Ho Man Tin Maintenance Sidings		SCL	
HMT	(Obsolete code in Detailed Design Stage and replaced by HOM)			
HOK	Hong Kong Station	香港	AEL / TCL	機場/東涌綫
HOK2	Hong Kong Station Phase 2 (Project)			
HOS	HongShan	紅山	SZ4	深圳4綫
HOT	Ho Tin	河田	LRL	輕鐵
HPB	Hong Kong Power Supply Building	香港供電大樓	LAL	
HPE	Ho Pui Electric Substation		WRL	
HPV	Ho Pui Ventilation Building	河背通風樓	WRL	
HPV	Huanggang Park Ventilation Building		XRL	
HSC	Hung Hom Station Car Park	紅磡站停車場	EAL	
HSK	Hung Shui Kiu	洪水橋	LRL	輕鐵
HTD	MTR Ho Tung Lau Depot	港鐵何東樓車廠	EAL	
HTR	Hung Tin Road Emergency Platform	洪天路應急月台	LRL	
HTT	Tunnel (Hung Hom to East Tsim Sha Tsui)		EAL	
HUG	HuangGang	皇崗	SZ4	深圳4綫
HUH	Hung Hom Station	紅磡	EAL / WRL / SCL	東鐵綫 東鐵綫
HUV	Hung Hom Ventilation Building	紅磡通風樓	EAL / SCL	
HVB	Hong Kong Ventilation Building	香港通風樓	LAL	
HZZ	HuiZhanZhongXin	會展中心	SZ4	深圳4綫
ISL	Island Line	港島綫	ISL	港島綫
JOR	Jordan Station	佐敦	TWL	荃灣綫
KAF	Kwai Fong Ancillary Building		WRL	
KAT	Kai Tak Station		SCL	
KBD	Kowloon Bay Depot	九龍灣車廠	KTL	
KCV	Kwai Chung Ventilation Building and Adit (VB6)		XRL	
KDC	Kwai Fong Distribution Centre	葵芳配電站	TWL	

Abbrev. Code	Station / Building Name	Station / Building Name (Chinese)	Line (Abbrev.)	Station Line (Chinese)
<b>KEL</b>	Kei Lun	麒麟	LRL	輕鐵
<b>KET</b>	Kennedy Town Station		WIL	
<b>KEV</b>	Kennedy Town Overrun Tunnel Ventilation		WIL	
<b>KFF</b>	Kwai Fong Feeder Station	葵芳饋電站		
<b>KFV</b>	Kwai Fong Ventilation Building	葵芳通風樓		
<b>KIC</b>	Kowloon Intake Cell	九龍海水泵房	LAL	
<b>KIO</b>	Kin On	建安	LRL	輕鐵
<b>KIS</b>	Kin Sang	建生	LRL	輕鐵
<b>KOB</b>	Kowloon Bay Station	九龍灣	KTL	觀塘綫
<b>KOT</b>	Kowloon Tong Station	九龍塘	KTL/EAL	觀塘/東鐵綫
<b>KOV</b>	Kowloon Tong Ventilation Building	九龍塘通風機樓	EAL	東鐵綫
<b>KOW</b>	Kowloon Station	九龍	AEL/TCL	機場/東涌綫
<b>KSL</b>	Kowloon Southern Link (Project)	九龍南綫	EAL	東鐵綫
<b>KSR</b>	Kam Sheung Road Station	錦上路	WRL	西鐵綫
<b>KST</b>	Kwai Tsing Tunnel	葵青隧道	WRL	
<b>KTA</b>	Kai Tak Station (Obsolete code in Detailed Design Stage and replaced by KAT)			
<b>KTB</b>	MTR Kam Tin Building (formerly West Rail Building)	港鐵錦田大樓	WRL	
<b>KTE</b>	Kwun Tong Line Extension (Project)			
<b>KTL</b>	Kwun Tong Line	觀塘綫	KTL	觀塘綫
<b>KTP</b>	Kai Tin Portal	啟田隧道口		
<b>KTR</b>	Kwun Tong Road Ventilation Building	觀塘道通風樓		
<b>KT</b>	Kai Tin Traction Substation	啟田牽引配電站	KTL	
<b>KVB</b>	Kowloon Ventilation Building	九龍通風樓	LAL	
<b>KWF</b>	Kwai Fong Station	葵芳	TWL	荃灣綫
<b>KWV</b>	Kwai Fong Ventilation Building (Obsolete code and replaced by KFV)			
<b>KWH</b>	Kwai Hing Station	葵興	TWL	荃灣綫
<b>KWR</b>	Kwun Tong Road Ventilation Building (Obsolete code and replaced by KTR)			
<b>KWT</b>	Kwun Tong Station	觀塘	KTL	觀塘綫
<b>LAK</b>	Lai King Station	荔景	TWL/TCL	荃灣/東涌綫
<b>LAR</b>	Lantau Airport Railway (AEL + DRL + TCL)	機場鐵路	LAR	機場鐵路
<b>LAR2</b>	Lantau Airport Extension (Project – AEL / TCL)			
<b>LAT</b>	Lam Tin Station	藍田	KTL	觀塘綫
<b>LCK</b>	Lai Chi Kok Station	荔枝角	TWL	荃灣綫
<b>LCT</b>	Lai Chi Kok Traction Substation	荔枝角牽引配電站	LAL	
<b>LEK</b>	Leung King	良景	LRL	輕鐵
<b>LET</b>	Lei Tung Station		SIL(E)	
<b>LHB</b>	LianHuaBei	蓮花北	SZ4	深圳4綫
<b>LHD</b>	LongHua Depot	龍華車輛段	SZ4	深圳4綫
<b>LHR</b>	LongHua Railway Station	龍華火車站	SZ4	深圳4綫
<b>LHP</b>	LOHAS Park Station,	康城	TKL	將軍澳綫
<b>LHZ</b>	LongHuaZhongXin	龍華中心	SZ4	深圳4綫
<b>LKT</b>	Lai King Traction Substation	荔景牽引配電站	TWL	
<b>LKV</b>	Lai King Viaduct	荔景高架行車道		
<b>LMC</b>	Lok Ma Chau Station	落馬洲	EAL	東鐵綫
<b>LMT</b>	Chau Tau Tunnel (Lok Ma Chau)	洲頭隧道(落馬洲)		
<b>LOC</b>	Locwood	樂湖	LRL	輕鐵
<b>LOF</b>	Lok Fu Station	樂富	KTL	觀塘綫
<b>LOM</b>	Lok Man Station (Obsolete code and replaced by MTW)		SCL	

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Abbrev. Code	Station / Building Name	Station / Building Name (Chinese)	Line (Abbrev.)	Station Line (Chinese)
LOP	Long Ping Station	朗平	WRL	西鐵線
LOS	LongSheng	龍勝	SZ4	深圳4綫
LOT	LongTang	龍塘	SZ4	深圳4綫
LOW	Lo Wu Station	羅湖	EAL	東鐵線
LRD	Light Rail Depot	輕鐵車廠	LRL	輕鐵
LRL	Light Rail	輕鐵	LRL	輕鐵
LTE	Lam Tei	藍地	LRL	輕鐵
LUM	Lung Mun	龍門	LRL	輕鐵
LVB	Lai King Ventilation Building	荔景通風樓	TWL	
LWB	Lee Wing Street Ventilation Building		SIL(E)	
LWC	Lai Wan Chiller Plant Building	荔灣冷凍機機樓	WRL	
LWL	Lo Wu Locomotive Shed	羅湖機車庫		
LWM	MTR Lo Wu Marshalling Yard	港鐵羅湖編組站	EAL	東鐵線
MBD	MTR Tuen Mun Bus Depot	港鐵屯門巴士廠	LRL	
MCV	Ma Chai Hang Ventilation Building		SCL	
MEF	Mei Foo Station	美孚	TWL/WRL	荃灣/西鐵線
MEG	Melody Garden	美樂	LRL	輕鐵
MHQ	MTR Headquarters Building (Currently MTR Tower)	港鐵總部大樓	KTL	
MIK	Ming Kum	鳴琴	LRL	輕鐵
MIL	MinLe	民樂	SZ4	深圳4綫
MKF	MTR Mong Kok Freight Terminal	港鐵旺角貨場	EAL	
MKK	Mong Kok East Station	旺角東	EAL	東鐵線
MKV	Mongkok West Ventilation Building (VB8)		XRL	
MOK	Mong Kok Station	旺角	KTL/TWL	觀塘/荃灣線
MOL	Ma On Shan Line	馬鞍山綫	MOL	馬鞍山綫
MOS	Ma On Shan Station	馬鞍山	MOL	馬鞍山綫
MPV	Mai Po Ventilation Building (VB1)		XRL	
MTR	MTR (MTR network)	港鐵	MTR	
MTV	Mid-Tunnel Ventilation Building	隧道中段通風樓	TWL	
MTW	Ma Tau Wai Station	馬頭圍	SCL	
MWV	Ma Wan Viaduct	馬灣高架行車道		
NAC	Nam Cheong Station	南昌	TCL/WRL	東涌/西鐵線
NAF	Nam Fung Portal (Obsolete code in Detailed Design Stage and replaced by NFP in C902)			
NAW	Nai Wai	泥圍	LRL	輕鐵
NCB	New Cha Kwo Ling Ventilation Building	新茶果嶺通風樓	TKL	
NCV	Nam Cheong Ventilation Building and Shaft(VB7)		XRL	
NFG	North Flood Gate Building (C1106)		SCL	
NFP	Nam Fung Portal Ventilation Building		SIL(E)	
NGW	Ngan Wai	銀圍	LRL	輕鐵
NIC	North Intake Cell	北海水泵房	TWL	
NIL	North Island Line (Project)			
NOL	Northern Link (Project)			
NOP	North Point Station	北角	ISL/TKL	港島/將軍澳綫
NOV	North Ventilation Building		SCL	
NPB	North Point Plant Building	北角機樓	ISL	
NTK	Ngau Tau Kok Station	牛頭角	KTL	觀塘綫
NTV	Ngau Tam Mei Ventilation Building (VB2)		XRL	
NVB	North Ventilation Building	北通風樓	TWL	
OCC	Operations Control Centre	車務控制中心	LAL	
OCP	Ocean Park Station		SIL(E)	
OLY	Olympic Station	奧運	TCL	東涌綫

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Abbrev. Code	Station / Building Name	Station / Building Name (Chinese)	Line (Abbrev.)	Station Line (Chinese)
ONT	On Ting	安定	LRL	輕鐵
OP1	Fire Protection Works for Entrance Building Roof Structure – Option No. 1 (Contract 810A only)		XRL	
OP2	Footbridge 6 – Option No. 2 (Contract 810A only)			
OPR	Operating Railway	營運鐵路	OPR	營運鐵路
PAF	Pak Fuk Distribution Substation	百福配電站	ISL	
PAS	Pak Shek Kok Section	白石角段	EAL	東鐵綫
PEV	Prince Edward Ventilation Building	太子通風樓	WRL	
PFD	Pak Fuk Distribution Substation (Obsolete code and replaced by PAF)			
PHD	MTR Pat Heung Depot	港鐵八鄉車廠	WRL	
PHV	Pat Heung Ventilation Building (VB4)		XRL	
PIS	Ping Shan	屏山	LRL	輕鐵
POA	Po Lam Station	寶琳	TKL	將軍澳綫
PRE	Prince Edward Station	太子	KTL/TWL	觀塘/荃灣綫
PRV	Prime View	景峰	LRL	輕鐵
PSK	Ping Shek Ventilation Building	坪石通風樓	KTL	
PUT	Pui To	杯渡	LRL	輕鐵
PVB	Pak Shing Kok Ventilation Building	百勝角通風樓	TKL	
QEX	Quarry Bay East Plant Building (Obsolete code and replaced by EPB)			
QIH	QingHu	清湖	SZ4	深圳4綫
QIS	Quarry Bay Infeed Substation	鯉魚涌饋電支站	ISL	
QUB	Quarry Bay Station	鯉魚涌	ISL/TKL	港島/將軍澳
QVB	Quarry Bay Ventilation Building	鯉魚涌通風樓	ISL	
R01	R01 Rectifier Station (Former description: Ferry Pier Terminus Rectifier Station)	R01 號整流電站	LRL	
R02	R02 Rectifier Station (Former description: Tsing Wun Rectifier Station)	R02 號整流電站	LRL	
R03	R03 Rectifier Station (Former description: Oi Lin Loop Rectifier Station)	R03 號整流電站	LRL	
R04	R04 Rectifier Station (Former description: Ho Tin Rectifier Station)	R04 號整流電站	LRL	
R05	R05 Rectifier Station (Former description: Ming Kum Rectifier Station)	R05 號整流電站	LRL	
R06	R06 Rectifier Station (Former description: Siu Hong Rectifier Station)	R06 號整流電站	LRL	
R07	R07 Rectifier Station (Former description: Nai Wai Rectifier Station)	R07 號整流電站	LRL	
R08	R08 Rectifier Station (Former description: Ping Shan Rectifier Station)	R08 號整流電站	LRL	
R09	R09 Rectifier Station (Former description: Shui Pin Wai Rectifier Station)	R09 號整流電站	LRL	
R10	R10 Rectifier Station (Former description: Yuen Long Terminus Rectifier Station)	R10 號整流電站	LRL	
R11	R11 Rectifier Station (Former description: Tuen Mun Maint. Centre Rectifier Station)	R11 號整流電站	LRL	
R12	R12 Rectifier Station (Former description: Hoh Fuk Tong Rectifier Station)	R12 號整流電站	LRL	
R13	R13 Rectifier Station (Former description: Tin Shui Rectifier Station)	R13 號整流電站	LRL	
R14	R14 Rectifier Station (Former description: Tin Tsz Rectifier Station)	R14 號整流電站	LRL	

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Abbrev. Code	Station / Building Name	Station / Building Name (Chinese)	Line (Abbrev.)	Station Line (Chinese)
R15	R15 Rectifier Station (Former description: Tin Wing Rectifier Station)	R15 號整流電站	LRL	
R16	R16 Rectifier Station (Former description: Tin Yat Rectifier Station)	R16 號整流電站	LRL	
RAC	Racecourse Station	馬場	EAL	東鐵綫
RCN	Racecourse North Section	馬場北段	EAL	東鐵綫
RCS	Racecourse South Section	馬場南段	EAL	東鐵綫
S01	Ho Tin CL&P Primary Sub-Station		LRL	
S02	Shui Pin Wai CL&P Primary Sub-Station		LRL	
S03	Tin Yat CL&P Primary Sub-Station		LRL	
SAH	San Hui	新墟	LRL	輕鐵
SAS	Sam Shing	三聖	LRL	輕鐵
SAW	San Wai	新圍	LRL	輕鐵
SCL	Shatin Central Link (Project)			
SDT	Siu Ho Wan Traction Substation	小濠灣牽引配電站	LAL	
SHD	Siu Ho Wan Depot	小濠灣車廠	AEL/TCL	機場/東涌綫
SHD2	Siu Ho Wan Depot Extension (Project)			
SHE	Siu Hei	兆禧	LRL	輕鐵
SHL	Siu Hong	兆康	LRL	輕鐵
SHM	Shek Mun Station	石門	MOL	馬鞍山綫
SHO	Siu Ho Wan	小濠灣	LAL	
SHP	Shek Pai	石排	LRL	輕鐵
SHS	Sheung Shui Station	上水	EAL	東鐵綫
SHT	Sha Tin Station	沙田	EAL	東鐵綫
SHW	Sheung Wan Station	上環	ISL/WIL	港島綫
SIC	South Intake Cell	南海水泵房	ISL	
SIE	South Island Line East (Project)			
SIH	Siu Hong Station	兆康	WRL	西鐵綫
SIL	Siu Lun	兆麟	LRL	輕鐵
SIW	South Island Line West (Project)			
SKM	Shek Kip Mei Station	石硶尾	KTL	觀塘綫
SKN	Shan King (North)	山景(北)	LRL	輕鐵
SKS	Shan King (South)	山景(南)	LRL	輕鐵
SKW	Shau Kei Wan Station	筲箕灣	ISL	港島綫
SML	ShangMeiLin	上梅林	SZ4	深圳4綫
SMV	Shing Mun Ventilation Building, Shaft and Adit (VB5)		XRL	
SMZ	ShiMinZhongXin	市民中心	SZ4	深圳4綫
SNN	Sha Tin North Section	沙田北段	EAL	
SNS	Sha Tin South Section	沙田南段	EAL	
SNG	ShaoNianGong	少年宮	SZ4	深圳4綫
SOV	South Ventilation Building and associated C&C Tunnel		SCL	
SOH	South Horizons Station		SIL(E)	
SPW	Shui Pin Wai	水邊圍	LRL	輕鐵
SSG	MTR Sheung Shui Slaughter Siding	港鐵上水屠房支線		
SSP	Sham Shui Po Station	深水埗	TWL	荃灣綫
SSS	Shek Kong Stabling Siding		XRL	
SST	Sham Shui Kok Traction Substation	深水角牽引配電站	LAL	
SSV	Sheung Shui Ventilation Building	上水通風樓	EAL	
STF	MTR Sha Tin Freight Terminal	港鐵沙田貨場	EAL	
STS	Sai Wan Ho Traction Substation	西灣河牽引配電站	ISL	
STW	Sha Tin Wai Station	沙田圍	MOL	馬鞍山綫
SUN	Sunny Bay Station	欣澳	TCL/DRL	東涌/迪士尼綫

Abbrev. Code	Station / Building Name	Station / Building Name (Chinese)	Line (Abbrev.)	Station Line (Chinese)
SUW	Sung Wong Toi Station (Obsolete code and replaced by TKW)		SCL	
SVB	South Ventilation Building	南通風樓	ISL	
SWH	Sai Wan Ho Station	西灣河	ISL	港島綫
SWT	Sheung Wan Traction Substation	上環牽引配電站	ISL	
SWT	Sung Wong Toi Station (Obsolete code in Detailed Design Stage and replaced by SUW in C1105)			
SYP	Sai Ying Pun Station		WIL	
T01	Tunnel No.1		EAL	
T02	Beacon Hill Tunnel	畢架山隧道	EAL	
T05	Tunnel 5	5 號隧道	EAL	
T1A	Tunnel 1 A	1A 號隧道	EAL	
T5A	Tunnel 5 A	5A 號隧道	EAL	
TAD	MTR Tai Wai Depot	港鐵大圍車廠	MOL	
TAK	Tai Koo Station	太古	ISL	港島綫
TAP	Tai Po Market Station	大埔墟	EAL	東鐵綫
TAW	Tai Wai Station	大圍	EAL / MOL / SCL	東鐵 / 馬鞍山綫
TCC	Tung Chung Cable Car	東涌纜車	TCC	
TCL	Tung Chung Line	東涌綫	TCL	東涌綫
TCP	Tung Chung Tunnel Portal	東涌隧道口	LAL	
TFU	Tin Fu	天富	RL	輕鐵
THE	Tin Heng	天恒	RL	輕鐵
THN	Tai Hing (North)	大興(北)	RL	輕鐵
THS	Tai Hing (South)	大興(南)	RL	輕鐵
THT	Tin Hau Substation	天后配電站	ISL	
THW	Tai Ho Wan	大濠灣	LAL	
TIC	Tai Kok Tsui Intake Cell	大角咀海水泵房	TWL	
TIH	Tin Hau Station	天后	ISL	港島綫
TIK	Tiu Keng Leng Station	調景嶺	KTL / TKL	觀塘 / 將軍澳綫
TIS	Tin Shui Wai Station	天水圍	WRL	西鐵綫
TIT	Tin Tsz	天慈	RL	輕鐵
TIY	Tin Yiu	天耀	RL	輕鐵
TKD	Tseung Kwan O Depot	將軍澳車廠	TKL	
TKI	Tiu Keng Leng Passenger Transport	調景嶺運輸交匯處	TKL	
TKL	Tseung Kwan O Line	將軍澳綫	TKL	將軍澳綫
TKO	Tseung Kwan O Station	將軍澳	TKL	將軍澳綫
TKP	Tai Kong Po Plant Building (searching Tai Kong Ventilation Building under previous code "TPV")		XRL	
TKS	Tseung Kwan O South Station	將軍澳南	TKL	
TKV	Tai Kok Tsui Ventilation Building	大角咀通風樓	LAL	
TKW	To Kwa Wan Station	土瓜灣	SCL	
TLT	Tai Lam Tunnel	大欖隧道	WRL	
TBD	MTR Tuen Mun Bus Depot (Obsolete code and replaced by MBD)		RL	
TMB	MTR Tuen Mun Building	港鐵屯門大樓	RL	
TMD	MTR Tuen Mun Depot	港鐵屯門車廠	RL	
TMH	Tuen Mun Hospital	屯門醫院	RL	輕鐵
TML	Tuen Mun	屯門	RL	輕鐵
TNK	Tin King	田景	RL	輕鐵
TOC	Town Centre	市中心	RL	輕鐵
TOF	Tong Fong Tsuen	塘坊村	RL	輕鐵
TOI	Tseung Kwan O Passenger Transport	將軍澳運輸交匯處	TKL	

Abbrev. Code	Station / Building Name	Station / Building Name (Chinese)	Line (Abbrev.)	Station Line (Chinese)
<b>TPC</b>	MTR Tai Po Kau Staff Club House	港鐵大埔滘員工會所	EAL	
<b>TPK</b>	Tai Po Kau Staff Quarter	大埔滘員工宿舍	EAL	
<b>TPV</b>	Tai Kong Po Ventilation Building (VB3) (Obsolete code in Detailed Design Stage)			
<b>TRV</b>	Trackside Villas (Tai Po Kau Staff Quarter)	策誠軒 (大埔滘員工宿舍)	EAL	
<b>TSA</b>	Tin Sau	天秀	LRL	輕鐵
<b>TSF</b>	Tin Shui Wai Feeder Station	天水圍饋電站		
<b>TSH</b>	Tai Shui Hang Station	大水坑	MOL	馬鞍山綫
<b>TSL</b>	Tin Shui Wai	天水圍	LRL	輕鐵
<b>TSP</b>	Tuen Mun Swimming Pool	屯門泳池	LRL	輕鐵
<b>TSS</b>	Tsing Shan Tsuen	青山村	LRL	輕鐵
<b>TST</b>	Tsim Sha Tsui Station	尖沙咀	TWL	荃灣綫
<b>TSU</b>	Tin Shui	天瑞	LRL	輕鐵
<b>TSV</b>	Tsim Sha Tsui Ventilation Building	尖沙咀通風樓	EAL	東鐵綫
<b>TSW</b>	Tsuen Wan Station	荃灣	TWL	荃灣綫
<b>TSY</b>	Tsing Yi Station	青衣	AEL/TCL	機場/東涌綫
<b>TTI</b>	Tseung Kwan O Infeed Substation	將軍澳饋電支站 大棠路	TKL	
<b>TTR</b>	Tai Tong Road		LRL	輕鐵
<b>TTS</b>	Tai Kok Tsui Traction Substation	大角咀牽引配電站	LAL	
<b>TUC</b>	Tung Chung Station	東涌	TCL	東涌綫
<b>TUM</b>	Tuen Mun Station	屯門	WRL	西鐵綫
<b>TUT</b>	Tung Chung Traction Substation	東涌牽引配電站	LAL	
<b>TVB</b>	Tsing Yi Ventilation Building	青衣通風樓	LAL	
<b>TWD</b>	Tsuen Wan Depot	荃灣車廠	TWL	
<b>TWF</b>	Tai Wai Feeder Station	大圍饋電站		
<b>TWH</b>	Tai Wo Hau Station	大窩口	TWL	荃灣綫
<b>TWI</b>	Tin Wing	天榮	LRL	輕鐵
<b>TWL</b>	Tsuen Wan Line	荃灣綫	TWL	荃灣綫
<b>TWN</b>	Tsing Wun	青雲	LRL	輕鐵
<b>TWO</b>	Tai Wo Station	太和	EAL	東鐵綫
<b>TWU</b>	Tin Wu	天湖	LRL	輕鐵
<b>TWV</b>	Tai Wai Ventilation Building	大圍通風樓		
<b>TWW</b>	Tsuen Wan West Station	荃灣西	WRL	西鐵綫
<b>TYA</b>	Tin Yat	天逸	LRL	輕鐵
<b>TYI</b>	Tsing Yi Cooling Water Intake for Station	青衣海水泵房	LAL	
<b>TYP</b>	Tsing Yi Portal	青衣隧道口		
<b>TYT</b>	Tsing Yi Traction Substation	青衣牽引配電站	LAL	
<b>TYU</b>	Tin Yuet	天悅	LRL	輕鐵
<b>UNI</b>	University Station	大學	EAL	東鐵綫
<b>UNV</b>	Hong Kong University Station (valid until as-built stage wrt email dated 7/9/09)		WIL	
<b>URL</b>	Urban Lines (KTL + TWL + ISL + TKL)	市區綫	URL	市區綫
<b>WAB</b>	Wylie Road Ancillary Building		KTE	
<b>WAC</b>	Wan Chai Station	灣仔	ISL	港島綫
<b>WCD</b>	Wong Chuk Hang Depot		SIL(E)	
<b>WCH</b>	Wong Chuk Hang Station		SIL(E)	
<b>WCV</b>	Woh Chai Street Ventilation Building	窩仔街通風樓		
<b>WEP</b>	Wetland Park	濕地公園	LRL	輕鐵
<b>WHA</b>	Whampoa Station	黃埔	KTE	
<b>WIL</b>	West Island Line (Project)			
<b>WKF</b>	Wu Kai Sha Feeder Station	烏溪沙饋電站		
<b>WKP</b>	West Kowloon Plant Building (VB9)		XRL	
<b>WKS</b>	Wu Kai Sha Station	烏溪沙	MOL	馬鞍山綫
<b>WKT</b>	West Kowloon Terminus		XRL	

Abbrev. Code	Station / Building Name	Station / Building Name (Chinese)	Line (Abbrev.)	Station Line (Chinese)
WPV	West Portal Ventilation Building	西隧道口通風樓	TWL	
WRL	West Rail Line	西鐵綫	WRL	西鐵綫
WSV	Winslow Street Ventilation Building		SCL	
WTS	Wong Tai Sin Station	黃大仙	KTL	觀塘綫
XRL	Express Rail Link (Project)	區域快綫		
YAO	Yau Oi	友愛	LRL	輕鐵
YAT	Yau Tong Station	油塘	KTL / TKL	觀塘/將軍澳綫
YLL	Yuen Long	元朗	LRL	輕鐵
YMT	Yau Ma Tei Station	油麻地	KTL / TWL / KTE	觀塘/荃灣綫
YMV	Yau Ma Tei Ventilation Building	油麻地通風樓		
YOT	Yam O Traction Substation	陰澳牽引配電站	LAL	
YUL	Yuen Long Station	元朗	WRL	西鐵綫
YVB	Yau Tong Ventilation Building	油塘通風樓	TKL	

\* Location codes 300~399 are reserved for Railway Extension Projects use. Originators shall define the location reference and assign a set of unique location codes to be used solely for the specific project/contract. Originators shall submit the designation to M-CADD for record.

#### Note

This Location Code Table is to be updated regularly; Originators can contact M-CADD or designated representative to obtain the most up-to-date version where necessary.

## SUBJECT CODE TABLES

### SUBJECT CODE

For the purposes of planning drawing production and assigning drawing numbers, drawings shall be classified in terms of the type of works or installation represented in accordance with the table of Subject codes below. The Originator can propose new Subject codes using alpha-numeric characters not yet been assigned in the tables below, subject to submission to M-CADD for review and endorsement.

### SUBJECT CODE TABLE (1<sup>ST</sup> CHARACTER)

The first character of the Subject Code is to differentiate the Subject / System grouping.

<b>Code (1<sup>st</sup> digit)</b>	<b>Subject / System Group Description</b>
<b>A</b>	Architectural, STIC / SSCC Submission
<b>B</b>	Aerial Ropeway
<b>C</b>	Civil & Structural, Permanent Way, Geotechnical, Survey
<b>D</b>	Drainage
<b>E</b>	Electrical - Low Voltage
<b>F</b>	Fire Services
<b>G</b>	Power Supply System
<b>H</b>	Automatic Fare Collection System
<b>I</b>	Sea Water Intake
<b>J</b>	Communication System
<b>K</b>	Main Control System
<b>L</b>	Combined Services Drawings
<b>M</b>	Environmental Control System
<b>N</b>	Lift, Escalator and Moving Walkway
<b>O</b>	(NOT USE)
<b>P</b>	Civil Planning
<b>Q</b>	Overhead Line
<b>R</b>	Signalling
<b>S</b>	Structural E&M
<b>T</b>	Temporary Works
<b>U</b>	Rolling Stock
<b>V</b>	Platform Screen Door
<b>W</b>	Plumbing
<b>X</b>	Property Development
<b>Y</b>	(NOT USE)
<b>Z</b>	Coordination

**SUBJECT CODE TABLES (2<sup>ND</sup> AND 3<sup>RD</sup> CHARACTERS)**

The 2nd and the 3rd characters denote the Sub-Subject / System and shall be in sequence with the 1st character to form the full definition of the Subject Code. The Originator can propose new Sub-Subject / System codes using those alphanumeric characters not yet been assigned in the tables below, subject to submission to M-CADD for review and endorsement.

**A Architectural, STIC / SSCC Submission**

<b>Code</b>	<b>Description</b>
A00	General (Works contract 901 & 902 only)
A01 Series	Scheme Design Drawings
A10 Series	Architectural General Arrangement
A11	Location & site plan
A12	GA plan
A13	Section
A14	Elevation
A15	Reflected ceiling plan
A16	Topside Development - Plan (Works contract under C801 only) or Metal Cladding (Contract 1002 only)
A17	Topside Development – Section (Contract specific proposed for XRL-C801 only)
A18	Topside Development – Elevation (Contract specific proposed for XRL-C801 only)
A19	Scope of Works of JSSC/DC/SO (JSSC- Jointly Selected Subcontracts, DC- Designated Contracts, SO- Supply Only Contracts) (Contract specific proposed for XRL-C801 only)
A20 Series	Statutory & other submissions, TSSC Submission
A21	STIC Submission
A22	SSCC Submission
A23	Dedicated Routes for the Disabled
A24	BD Submission (only if Property included) or Day 1 Arrangement BD Submission (Contract C801)
A25	Section 16 Submission (if applicable)
A26	SSCC Stage 2A (Works contract under XRL C801, SIL(E) C901 & SCL C1108 only)
A27	SSCC Stage 2B (Works contract under XRL C801 & SIL(E) C901 only)
A28	SSCC Stage 3 (Works contract under XRL C801, SIL(E) C901 & SCL C1108 only)
A29	Full Set GBP Submission (Contract C801)
A30 Series	Detailed plan & special room layout
A31	Lift
A32	Escalator
A33	Moving walkways
A34	Stairs
A35	Operation Rooms (SCR, Audit Revenue Room, Fire Control Room)
A36	Staff Rooms (Staff lockers, toilets, Mess Room)
A37	Plant Rooms (Power Equipment Room)
A38	VIP waiting Hall (Works contract under C801 only) or Waterproofing (Contract 823B only)
A39	Ingress/egress points (Contract specific proposed for XRL-C801 only) or Public Room (Toilet, Trolley Cubicle, Baby Changing Room) (Works contract under C801 only) or Detail Sections (Contract 823B only)
A40 Series	Schedules
A41	Finishes
A42	Doors,

A43	Roller shutter
A44	Access panel
A45	Louvres
A46	Sanitary ware
A47	Signs & advertising panel
A48	Catladder
A49	Ironmongery
A50 Series	General Builders Work
A51	Blockwork
A5x	Internal wall elevation drawing where "x"=[A,C,D,E,F,G,H,J,K,L,S,V] (Works contract under C801 only)
A52	Internal finishes
A53	Doors & Fenestration (doors, access panels, roller shutters, louvers and windows)
A54	Ladders & platforms
A55	Balustrade & railings
A56	Fixtures & fittings (Flood board, bumper rail, pantry)
A57	External finishes
A58	External works & soft landscape
A59	Miscellaneous (hoarding)
A60 Series	Special works packages
A61	Floors (stonework, access floor)
A62	Walls (VE panels, compact laminate, stonework)
A63	Ceilings
A64	Common components (CuC PSB, CIS, Help Line, Tel Stand, Litter bin)
A65	External cladding
A66	Glazing
A67	Special roofing
A68	Signage
A69	Advertising Panels
A70 Series	Standard Architectural Components (Entrance Portal, Headwall / tailwall units, concession shopfront)
A71	Entrance Signage Bulkhead
A72	Head and Tailwall Unit
A73	Concession Shop Front
A80 Series	Systemwide components/E&M Interface (PSD, PEP)
A81	Platform Screen Door / Automatic Platform Gate
A90 Series	Special Elements & Details
A91	Reinstatement Works for Existing Facilities (Contract 1001 & 1004 only) or Acrylic Safeguard (1102)
A92	Recycled Timber Trellis Details (Works Contract 1113 only)
A93	Canopy and Covered Walkway (Works Contract 1113 only)
A94	Water Tank Details (Works Contract 1113 only)
A99	Passenger Movements (Contract C903 Only)

## B Aerial Ropeway

Code	Description
B00	General information
B01	Item belonging to track rope station equipment (eg, anchoring, tensioning, & deviation of track rope)
B02	Item belonging to haul rope station equipment (without drive) (eg, tensioning, and deviation of haul rope)
B03	Item belonging to drive equipment for moving the installation (eg, bull wheel, counter wheel, gearbox, motor & brake)
B04	Item belonging to line equipment(eg, saddles for track rope and pulleys for haul rope)

B05	Item belonging to carrier (eg, cabin, carriage, hanger and grip)
B06	Item belonging to tower structure
B07	Item belonging to rescue equipment used if the installation is not moving (eg, winch, rescue carrier)
B08	Item belonging to station equipment (eg, security device, guiding, synchronisation, magazine, rails)
B09	Item belonging to station structure

**C Civil & Structural, Permanent Way, Geotechnical, Survey**

<b>Code</b>	<b>Description</b>
C01	General information
C02	Line location & setting out
C03	Tunnel layout
C04	Surveys (topographical & hydrographical)
C05	Geotechnical interpretative detail
C06	Geotechnical detail
C07	Geotechnical 'as-found' detail
C08	Precast Unit Structure GA & Section (Works contract under C801 only)
C09	Precast Unit RC Details (Works contract under C801 only) or BD Submission of A&A Works (1112 only)
C10	Civil general arrangement
C11	Civil detail
C12	R C Drawing
C13	Prestressing
C14	Drainage
C15	Bearing
C16	Joint
C17	Perimeter wall – layout
C18	Perimeter wall – detail
C19	Piling – layout
C20	Piling – detail
C21	Construction sequence & traffic management
C22	Site formation
C23	Structural steelwork
C24	External works
C25	WKT station roof (Contract specific proposed for XRL-C801 only)
C26	Non-structural R.C. wall (Contract specific proposed for XRL-C801 and SCL-1107 only)
C27	Cast-in item (Contract specific proposed for XRL-C801 only)
C28	WKT station roof R.C. slab plan and details (Contract specific proposed for XRL-C801)
<b>Permanent Way</b>	
C30 Series	Alignment
C31	Schematics
C32	Standard Details
C33	Junction Layout
C35	Track Component – Plain Line
C36	Work Areas
C39	Operation Facility
C50	E&M Services
C60	Fencing and Noise Barriers
C90	Track Component – Special Trackwork
<b>Survey</b>	
C80	As-built survey
C81	Wriggle survey

C82	E&M survey of existing E&M services (Contract specific proposed for SCL-C1103 only)
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**D Drainage**

<b>Code</b>	<b>Description</b>
D00	Drainage schematic & general info. (notes, symbols, legends & abbreviations)
D01	Drainage - sump pumping system
D02	Drainage - foul drainage system
D03	Drainage - storm water drainage
D04	Drainage - track drainage
D05	Drainage installation detail
D06	Drainage layout
D07	Sewage treatment
D08	Waste water treatment
D18	Drainage Diversion Drawings (Works contract under C1106 only)
D19	Drainage Diversion Drawings (Stage 2) (Works contract under C1106 only)
D80	DR Foul and Waste Water Schematic - 10 Cars (Works contract under C1106 only)
D86	DR Layout - 10 Cars (Works contract under C1106 only)
D91	Typical drainage sump pumping equipment room layout
D92	Typical drainage foul drainage equipment room layout
D94	Drainage Details (Contracts 1125 & 1126 only)
D95	Drainage Details (contract 965C only)

**E Electrical - Low Voltage**

<b>Code</b>	<b>Description</b>
E00	Electrical Schematic & general info. (notes, symbols, legends & abbreviations)
E01	Electrical lighting & small power
E02	Electrical emergency power, UPS, generator
E03	Electrical earthing & lightning protection system
E04	Electrical lighting protection
E05	Electrical advertising panel, station sign
E06	Electrical security & burglar alarm
E07	Electrical L.V. distribution system & switchboard general arrangement
E08	Electrical containment system
E09	Electrical Fire Alarm & Detection system
E10	Electrical Traffic Management system
E11	Electrical Services layout – Miscellaneous
E12	Electrical distribution board schedule
E13	Electrical installation detail
E14	Electrical Power (Contract 816C only)
E15	Cast-in Conduit (Contract 816C only)
E16	Underfloor Trunking System (Contract 816C only)
E18	Electrical Services Diversion Drawings (Works contract under C1106 only)
E19	Electrical Diversion Drawings - Phase 2 (Works contract under C1106 only)
E50	Electrical Diversion Drawings - Phase 3 (Works contract under C1106 only)
E51	Electrical Lighting & Small Power - Phase 2 (Works contract under C1106 only)
E58	Electrical Containment System - Phase 2 (Works contract under C1106 only)
E61	Electrical Layout (Miscellaneous) - Phase 2 (Works contract under C1106 only)
E62	Electrical Distribution Board Schedule - Phase 2 (Works contract under C1106 only)
E68	Electrical Diversion Drawings (Stage 1) - Phase 2 (Works contract under C1106 only)
E80	Electrical Schematic & General Info - 10 Cars (Works contract under C1106 only)
E81	Lighting Layout Plan – 10 Cars (Works contract under C1106 only)
E88	Cable Containment Layout Plan – 10 Cars (Works contract under C1106 only)

E91	Small Power & Miscellaneous Layout Plan – 10 Cars (Works contract under C1106 only)
E92	Typical emergency power equipment room layout
E93	Distribution Board Details – 10 Cars (Works contract under C1106 only)
E97	Typical LV distribution equipment room layout
E99	EL Modification Works Layout Plan – 10 Cars (Works contract under C1106 only)

**F Fire Services**

<b>Code</b>	<b>Description</b>
F00	Fire Services schematic & general info. (notes, symbols, legends & abbreviations)
F01	Fire Services fire hydrant, hose reel
F02	Fire Services sprinkler
F03	Fire Services Drencher system
F04	Fire Services water spray
F05	Fire Services total gas flooding
F06	Fire Services layout – combined
F07	Fire Services installation detail
F08	Fire alarm and detection system, power supply and interface
F09	Fire extinguisher
F10	Long Throw Sprinkler System Layout Plans (Contract specific proposed for XRL-C801 only)
F11	Dry System Layout Plans (Works contract under C801 only)
F12	Wet System Layout Plans (Works contract under C801 only)
F13	Emergency Signage Control System Layout Plans (Works contract under C801 only)
F18	Fire Services Diversion Drawings (Works contract under C1106 only)
F19	Fire Services Sprinkler Diversion Layout (Works contract under C1106 only)
F20	Fire Services Drencher Diversion Layout (Works contract under C1106 only)
F21	Fire Alarm and Detection System Diversion Layout (Works contract under C1106 only)
F81	FS Fire Hydrant / Hose Reel System - 10 Cars (Works contract under C1106 only)
F82	FS Sprinkler System - 10 Cars (Works contract under C1106 only)
F86	FS Layout - 10 Cars (Works contract under C1106 only)
F91	Typical fire hydrant, hose reel equipment room layout
F92	Typical FS sprinkler equipment room layout
F95	Typical FS total gas flooding equipment room layout
F96	Typical combined FS equipment room layout

**G Power Supply System**

<b>Code</b>	<b>Description</b>
G00	General
G01	Standards
G02	System design – a.c. transmission and distribution
G03	System design – d.c. traction
G04	Traction Substation layout
G05	Services substation layout
G06	Trackside cable route
G07	Track Bonding
G09	Miscellaneous
G10	Trackside/tunnel lighting
G11	Portal lighting
G12	Signage
G13	Earthing
G14	Trackside/ tunnel power socket system

G15	Lightning protection
G16	Environmental control system
G17	MCS control & PRC control
G18	System design – a.c. traction
G20	Switchgear – 33kV
G21	Switchgear – 11kV
G22	Switchgear – 11kV RMU
G23	Switchgear – d.c. Traction
G24	Switchgear – LV
G25	Switchgear – 25kV
G26	Switchgear - 25kV (Drawing Schedule & Hardware List) (for contract 845 only)
G30	Transformer – Infeed
G31	Transformer – 33/11 kV
G32	Transformer – Rectifier
G33	Transformer – Services
G40	Cable – 33kV
G41	Cable – 11kV
G42	Cable – d.c. Traction positive
G43	Cable – Track bonding
G44	Cable – LV
G45	Cable – Pilot and control
G46	Cable – Installation
G47	Cable – 25kV
G50	Rectifier
G52	Tunnel drainage plumbing system
G54	Tunnel fire protection system
G56	Cable & pipe support system
G57	Cable bracket disposition
G60	Battery and charger
G63	Uninteruptable Power Supply
G65	Standby generator set
G70	Protection and Control
G75	Alarm and Telemetry
G80	Stray current corrosion control
G91	Typical equipment room
G92	Elevation view drawing (for contract 845 only)
G93	Section view drawing (for contract 845 only)
G98	Combined Services Drawings
G99	Structural E&M Drawings

## H Automatic Fare Collection System

Code	Description
H01	General
H02	Few fare machine
H03	Multi fare machine
H04	Ticket office machine
H05	Station computer
H06	Station control unit
H07	Gate manual
H08	Gate automatic
H09	Gate interchange
H10	Luggage chute
H11	Wiring and interfaces
H12	Overhead beam
H13	G.L.A.P.

H14	Route information system
H15	Software system
H16	Installation
H17	Access control
H91	Typical equipment room
H99	Builders work

**I Sea Water Intake**

<b>Code</b>	<b>Description</b>
I01	Sea Water Intake schematic
I02	Sea Water Intake layout
I03	Sea Water Intake schedule

**J Communication System**

<b>Code</b>	<b>Description</b>
J00	General
	<b>MTR Related System (Group 1)</b>
J01	General
J02	Radio system
J03	CCTV system
J04	Transmission system
J05	PABX telephone system
J06	Direct line telephone system
J07	Public address system
J08	Passenger information system
J09	General
	<b>Commercial Systems</b>
J11	General
J12	Cable way provision
J13	CT-2 system
J14	Paging system
J15	Mobile telephone network
J16	Mobile payphone
J17	Public payphone
J18	Commercial information system
	<b>Security System</b>
J31	General
J32	CCTV system
J33	Telephone system
J34	Security Access Management System
	<b>Traffic Interchange</b>
J41	General
J42	Radio system
J43	CCTV system
J44	Telephone system
J45	Public address system
J46	Passenger information system
	<b>MTR Related Systems (Group 2)</b>
J61	Network
J62	Clock system
J63	Teleprinter
J70	SAMS - Equipment Location (XRL) (Contract 854 only)
J71	SAMS - Equipment Location (IMMD) (Contract 854 only)
J72	SAMS - Equipment Location (C&ED) (Contract 854 only)

J73	SAMS - Equipment Location (BCA) (Contract 854 only)
J74	SAMS - CIC Layout (Contract 854 only)
J75	Small Electrical Power Layout (Contract 854 only)
J76	Typical Installation Details for WKT and VBs(Contract 854 only)
J77	SAMS - Equipment Rack/Room & Rack Face Layout, Cable Termination Schedule, Equipment Mounting Details (Contract 854 only)
J78	SAMS - Cable Route Drawing (XRL) (Contract 854 only)
J79	SAMS - Cable Route Drawing (IMMD) (Contract 854 only)
J80	SAMS - Cable Route Drawing (C&ED) Contract 854 only)
J81	SAMS - Cable Route Drawing (BCA) (Contract 854 only)
J82	SAMS - Cable Containment (Contract 854 only)
J91	Typical equipment room

## K Main Control System

<b>Code</b>	<b>Description</b>
	Central System
K00	General info. (notes, symbols, legends, abbreviations)
K01	Central monitoring & control system (CMCS)
K02	Data communication network
K03	Central control room
K04	Central equipment room
K05	Backup control centre
K06	Expert system
K07	System Architecture (SBCS)
K08	Control Schematic (SBCS)
	Station/Depot Systems
K10	Station Management System (SMS)
K11	Station LAN
K12	Depot Management System (DMS)
K13	Depot LAN
K14	LAK Remodeling
	Data Acquisition System
K20	Power remote control system (PRC)
K21	Environmental control system (ECS)
K22	Automatic train supervision / regulation (ATS/ATR)
K23	Automatic fare collection (AFC)
K24	Communication Systems
K25	Fire protection systems
K26	Station and tunnel services
K27	Access control system
K28	Variable signage system
K29	Patronage monitoring system
K30	Escalator/lift monitoring system
K31	Master clock
K33	Platform screen door
K35	Traffic management control system
	MIS Systems
K50	Management information system
K51	Maintenance support system
K52	Geographic information system
K53	Office automation system
K54	TURS
	Interfaces to External Systems
K60	Interfaces to existing CCR
K61	Interfaces to CLP

K65	Interfaces to HEC
K70	Universal Integrated Training System
	<b>Station Based Control System (SBCS)</b>
K80	SBCS layout
K81	SBCS cable containment, cable route layout
K82	SBCS equipment schedule
K83	SBCS control logic block diagram
K84	SBCS electrical schematic
K85	SBCS mode table
K86	SBCS typical installation detail
K87	SBCS inter-connection detail drawings
K88	SBCS panel assembly drawings
K89	SBCS installation drawing
K91	Typical equipment room

## L Combined Services Drawings

<b>Code</b>	<b>Description</b>
L00	Combined Services Drawings – Symbols, legends, abbreviations
L01	Combined Services Drawings
L02	Combined Services Reflected Ceiling Plans
L03	Plantroom Details (Contract 816A only)
L51	Combined Services Drawings - NSL Platform (Works contract under C1106 only)
L52	Combined Services Drawings - EWL Platform (Works contract under C1106 only)
L53	Combined Services Drawings - MTD Level (Works contract under C1106 only)
L54	Combined Services Drawings - Podium Level (Works contract under C1106 only)
L55	Combined Services Drawings - Podium Mezzanine Level (Works contract under C1106 only)
L56	Combined Services Drawings - Roof Level (Works contract under C1106 only)
L91	Typical Combined Services Drawings
L98	Typical Combined Services Drawings (Works contract under C1105 only)

## M Environmental Control System

<b>Code</b>	<b>Description</b>
M00	ECS general info. (notes, symbols, legends, abbreviations)
M01	ECS Air Side schematic
M02	ECS Air Side layout
M03	ECS Air Side Schedule
M04	ECS Water Side Schematic
M05	ECS Water Side Layout
M06	ECS Water Side Schedule
M07	ECS Controls Schematic
M08	ECS Controls Layout (compressed air system, E/P control system & VAC)
M09	ECS layout – combined
M10	ECS & Smoke Control layout (smoke extraction Layout & smoke zone)
M11	ECS installation detail
M12	ECS equipment schedule
M13	ECS refrigerant system
M14	ECS electrical schematic
M15	ECS electrical layout
M16	ECS pneumatic schematic
M17	ECS mode table
M18	ECS Diversion Drawings (Works contract under C1106 only)
M19	ECS Diversion Drawings – Phase 2 (Works contract under C1106 only)
M20	ECS Diversion Drawings – Phase 3 (Works contract under C1106 only)
M21	ECS Diversion Drawings – Phase 4 (Works contract under C1106 only)

M22	ECS Diversion Drawings – Phase 5 (Works contract under C1106 only)
M51	Compressed Air System (Contract 823B), ECS Air Side Layout Phase 2 (Contract C1106)
M54	ECS Water Side Schematic - Phase 2 (Works contract under C1106 only)
M59	ECS Layout (Combined) - Phase 2 (Works contract under C1106 only)
M60	ECS & Smoke Control Layout (Smoke extraction Layout & Smoke Zone) - Phase 2 (Works under C1106 only)
M62	ECS Equipment Schedule - Phase 2 (Works contract under C1106 only)
M64	ECS Electrical Schematic - Phase 2 (Works contract under C1106 only)
M67	ECS Mode Table - Phase 2 (Works contract under C1106 only)
M81	ECS Airside Schematic - 10 Cars (Works contract under C1106 only)
M84	ECS Waterside Schematic - 10 Cars (Works contract under C1106 only)
M89	ECS Layout - 10 Cars (Works contract under C1106 only)
M90	ECS Smoke Zone - 10 Cars (Works contract under C1106 only)
M92	ECS Equipment Schedule - 10 Cars (Works contract under C1106 only)
M94	ECS Electrical Schematic - 10 Cars (Works contract under C1106 only)
M96	ECS Room Details - 10 Cars (Works contract under C1106 only)
M97	ECS Mode Table - 10 Cars (Works contract under C1106 only)
M98	Typical ECS Control equipment room layout
M99	ECS plant room layout

**N Lift, Escalator and Moving Walkway**

Code	Description
N00	Schedules & Schematics (Contracts 1125 & 1126 only)
	<b>Lift</b>
N80	Fixture (Car and landing)
N81	Car cab
N82	Entrance
N83	Circuit wiring / control logic diagram
N84	Delivery routing/access plan
N91	Typical equipment room
	<b>Escalator &amp; Moving Walkway</b>
N01	Drive machinery
N02	Emergency brake
N03	Motor & gearbox bedplate
N05	Speed detector
N07	Idler machinery
N08	Upper tracks
N09	Incline tracks
N10	Lower tracks
N11	Steps and chains
N12	Upper truss
N13	Lower truss
N14	Incline truss
N15	Civil/Structural Engineering support
N16	Truss fittings
N17	Handrail and support
N18	Upper handrail stand
N19	Lower handrail stand
N20	Countershaft
N21	Combplates and floorplates
N22	Maintenance barriers
N23	Lubrication system
N24	Chain guide
N25	Electricity (wiring & components)

N26	Step safety system
N28	Drip tray
N44	Mechanical products, catalogue
N45	Electrical products, catalogue
N46	Electrical cabinet
N51	Balustrade decking
N52	Newel decking
N53	Glass support beam
N54	Skirting
N55	Dress guard
N56	Skirt moulding
N57	Exterior moulding
N58	Support profile of ext. cladding (balustrade)
N59	Support profile of ext. cladding (truss sides and bottom)
N60	Interior panel (balustrade)
N61	Exterior panel (balustrade)
N62	Exterior panel (truss)
N63	Bottom panel (truss)
N64	Decking between paired escalators
N65	Junction decking with wall
N66	Box cladding under escalator
N67	Fittings on decking
N70	Upper and lower landings
N75	Tools
N91	Typical equipment room
N99	Builder's works

**O (Not Used)**

<b>Code</b>	<b>Description</b>

**P Civil Planning**

<b>Code</b>	<b>Description</b>
P01	Land requirement
P02	Railway area plan, land resumption plan
P03	Location of entrusted works
P04	Utility coordination/agreement
P05	Location of existing utilities
P06	Relocation of utilities
P07	Works area
P08	Access to works area
P09	Site office
P10	Running line lease plan
P11	Maintenance responsibility matrix drawing
P12	Railway Protection Plan
P13	MTR Plan

**Q Overhead Line**

<b>Code</b>	<b>Description</b>
Q01	General
Q02	Schematic

Q03	General Arrangement
Q04	Chart, Calculation, Diagram
Q05	OHL Layout
Q06	SCADA Cable Route
Q07	Assembly Drawing for OHL Equipment
Q08	Assembly Drawing for OHL Mast and Footing
Q09	Assembly Drawing for Tunnel Drop Vertical
Q10	Assembly Drawing for Earthing and Bonding System
Q11	Assembly Drawing for Back Stay
Q12	Assembly Drawing for Miscellaneous Items
Q13	Sub-Assembly Drawing
Q14	Component Drawing For Proprietary Products
Q15	Component Drawing For Non-Proprietary Products
Q16	Cross Section Drawing for Tension Length / OHL Assignment
Q17	Overhead Rigid Conductor Rail (ORCR) Assembly
Q24	Overhead Rigid Conductor Rail (ORCR) Component
Q26	Overhead Rigid Conductor Rail (ORCR) Assignment
Q27	Depot Assembly
Q34	Depot Component
Q36	Depot Assignment
Q46	Isolator Assignment

## R Signalling

<b>Code</b>	<b>Description</b>
R01	Air Conditioning
R02	ATC Trainborne
R03	ATO (Trackside)
R04	ATP (Trackside)
R05	Automatic Train Supervisory System
R06	Auxiliary Electrical Systems
R07	Auxiliary Converter (ACV)
R08	Auxiliary Inverter (AIV)
R09	Axle Counter
R10	Battery Loco
R11	Brake
R12	Camshaft
R13	Carbody & Underframe
R14	Chopper
R15	Central Control Room Equipment
R16	Control & Monitoring System
R17	Control Circuit
R18	Diesel Locomotive
R19	Door System
R20	Vehicle Exterior & Interior Fitting
R21	Couplers & Gangways
R22	Information System
R23	Locomotives (Diesel / Battery)
R24	Solid State Interlocking
R25	Pneumatics & Air Distribution System
R26	Power Supply System
R27	Point
R28	Rail Grinding Vehicle
R29	Railway Task Trainer
R30	SACEM On-Board Equipment SACEM
R31	SACEM Telemetry Equipment SACEM

R32	SACEM Trackside Equipment SACEM
R33	ATC Indicator Circuit
R34	Signalling Test Equipment
R35	Station
R36	Traction Camshaft
R37	Traction Chopper
R38	Track Circuit
R39	Traction & Braking System
R40	Trailer

**S Structural E&M**

<b>Code</b>	<b>Description</b>
S00	Structural E&M Drawing – general notes, legend
S01	Structural E&M Drawing – slab
S02	Equipment access route, Delivery Route Drawing
S03	Structural E&M Drawing - wall
S04	Delivery Route Drawing (Contract 1064 only) or Lighting Layout for Viaduct Box Structure (C1101)
S05	Drainage Installation Details (Works contract under C1101 only)
S07	FS Installation Details (Works contract under C1101 only)
S11	ECS Installation Details (Works contract under C1101 only)
S13	Electrical Installation Details (Works contract under C1101 only)
S91	Structure E&M Details (Works contract under C1106 only)

**T Temporary Works**

<b>Code</b>	<b>Description</b>
T01	Site layout, works area
T02	Geotechnical
T03	Cofferdam
T04	Earthworks, excavation, dewatering
T05	Dredging
T06	Falsework
T07	Formwork
T08	IMT detail
T09	IMT fitting out
T10	Marine operation
T11	Other temporary work
T12	Temporary drainage
T13	Temporary water supply
T22	Segment catalogue
T23	Structural Steel (mainly for shop drawing) (Contract 823A/823B only)
T25	Construction principles/method
T26	Substructure method
T27	Precast method
T28	Erection method
T31	Hoarding (Contract 823A/823B only)
T32	Temporary Power Supply (Contract 823A/823B only)
T33	Temporary Structure (Contract 823A/823B only)

**U Rolling Stock**

<b>Code</b>	<b>Description</b>
U00	General
U01	Air conditioning system

U02	Automatic train control
U03	Auxiliary electrical system
U04	Bogies
U05	CMS & event recorder
U06	Door system
U07	Vehicle exterior & interior fittings
U08	Gangways & couplers
U09	Information systems
U10	Pneumatic & air distribution system
U11	Traction & braking system
U12	Vehicle structure

**V Platform Screen Door**

<b>Code</b>	<b>Description</b>
V00	General
V01	Platform supervisor booth
V02	PSD cabinetry room
V03	PSD equipment room
V04	Platform side system
V40	Automated Platform Gate (APG)

**W Plumbing**

<b>Code</b>	<b>Description</b>
W00	Plumbing schematic & general info. (notes, symbols, legends & abbreviations)
W01	Plumbing main water distribution
W02	Plumbing flushing water
W03	Plumbing irrigation
W04	Plumbing services layout – combined
W05	Plumbing installation detail
W06	Fresh water system
W07	Hot water system
W08	Swimming pool filtration plant
W09	Gas services
W11	Plumbing for noise barrier (Works contract under C1106 only)
W18	Plumbing Diversion Drawings (Works contract under C1106 only)
W80	PL Schematic - 10 Cars (Works contract under C1106 only)
W92	Accommodation Details (Works contract under C1108 only)
W94	Typical combined plumbing services equipment room layout

**X Property Development**

<b>Code</b>	<b>Description</b>
X01	General
X10	Lease Plans – Legal portion boundary
X11	Lease Plans – construction sequence & extent

**Y (NOT USE)**

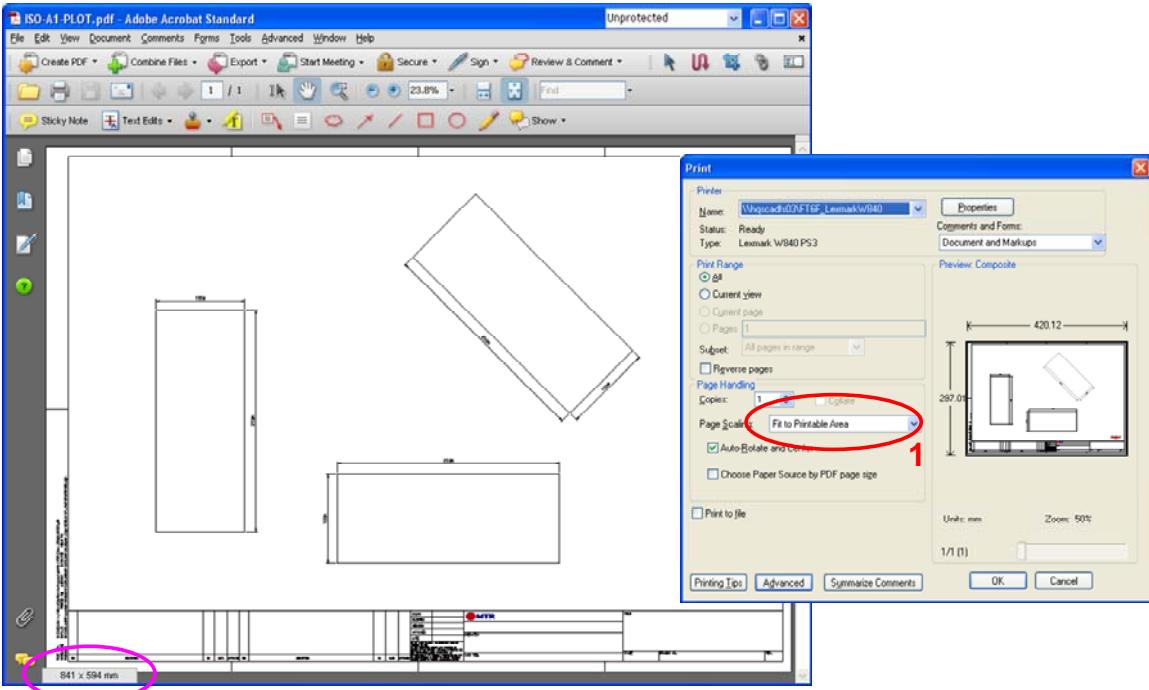
<b>Code</b>	<b>Description</b>
Y00	Drawing list for Ventilation Building E&M services drawings (Works contract under C801 only), Compressed Air System (Works contract under 965B only)
Y01	Drawing list for Government Entrusted Work E&M services drawings (Works contract under C801 only)
Y02	A&A works at Lai Cheung Road CLP Substation (Works contract under C801 only)

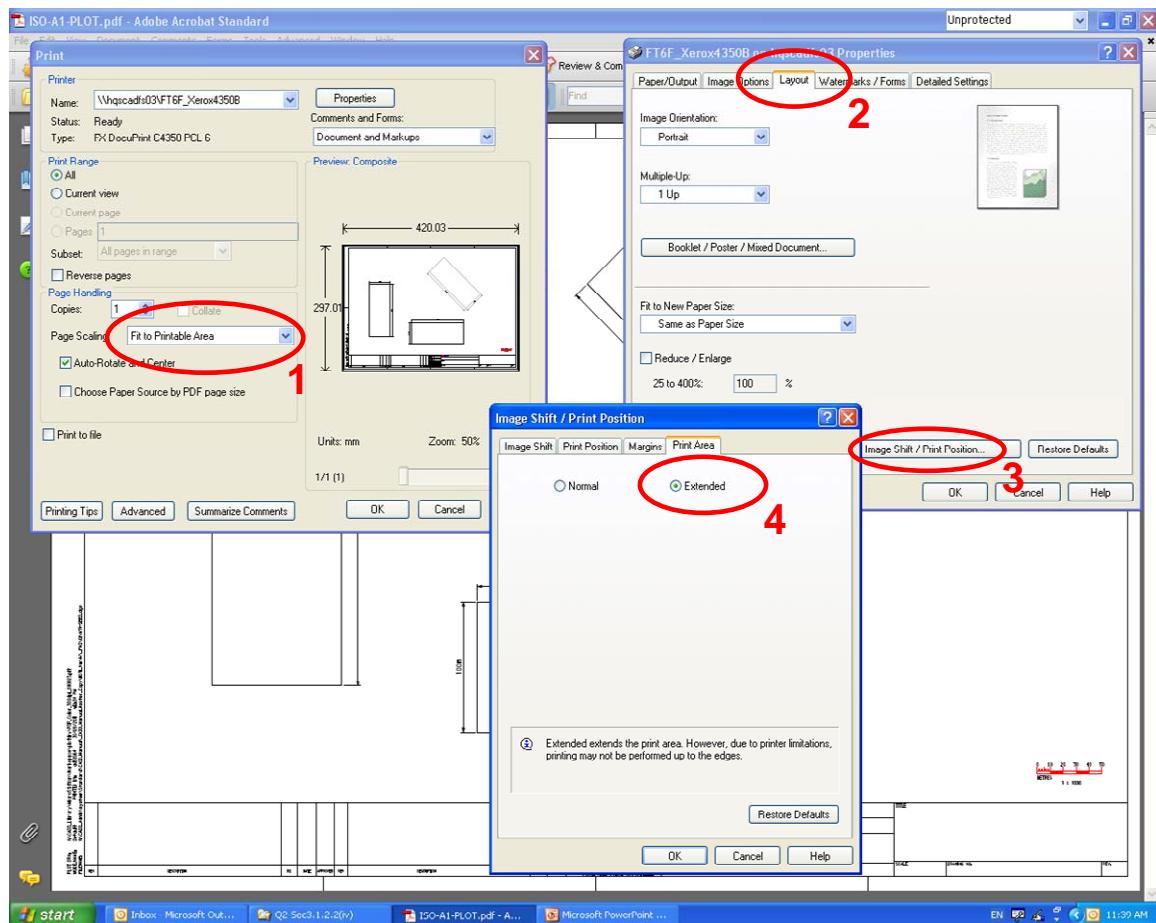
Y07	Interfacing detail for E&M and civil works (Works contract under C801 only)
-----	---

## Z Coordination

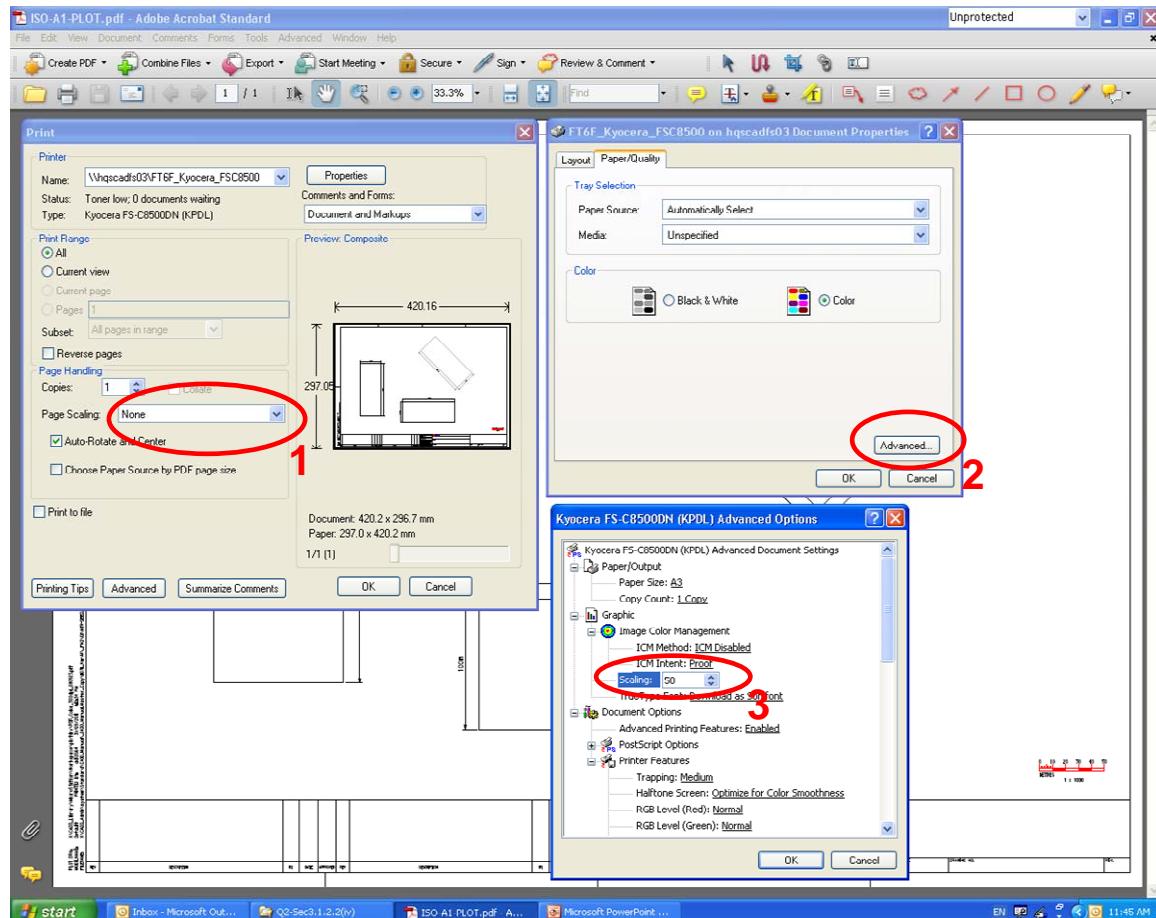
<b>Code</b>	<b>Description</b>
Z01	Coordination drawings (master layout)
Z10	Government
Z20	Utilities
Z30	Contractor
Z40	Consultant
Z50	Third Parties
Z60	Artwork / Graphic

## 4. FAQ

		D&CM Reference
1.	How to print A1size PDF drawing to A3 which is in scale in most of the printer?	Section 2.2.1 & 2.4
<p><u>Sample setting for Lexmark W840 B/W printer:</u></p> 		

Sample setting for Xerox 4350 color printer:

### Sample setting for Kyocera FSC8500 color printer



2. When I have to print an approved drawing, shall I print from the CADD drawing or PDF drawing? Section 1.5.3(6) & 2.4

You should do this with the PDF drawing because the Time Stamp was already recorded in the PDF file by the time it was created from the CADD file.

3.	What is the date should be entered in the drawing titleblock in general?	Section 2.6.1.2																																																			
	The "date" field is related to the completion of the drawing by the originator																																																				
	<table border="1"><tr><td></td><td></td><td></td><td></td><td>DRAWN</td><td></td><td rowspan="5">ORIC</td></tr><tr><td></td><td></td><td></td><td></td><td>DESIGNED</td><td></td></tr><tr><td></td><td></td><td></td><td></td><td>CHECKED</td><td></td></tr><tr><td></td><td></td><td></td><td></td><td>APPROVED</td><td></td></tr><tr><td></td><td></td><td></td><td></td><td>DATE</td><td></td></tr><tr><td></td><td></td><td></td><td></td><td colspan="2">DO NOT SCALE DRAWINGS. ALL DIMENSIONS SHALL BE VERIFIED ON SITE. © MTR CORPORATION LIMITED 2008 COPYRIGHT IN RESPECT OF THIS DRAWING / DOCUMENT IS OWNED BY THE MTR CORPORATION LIMITED OF HONG KONG. NO REPRODUCTION OF THE DRAWING / DOCUMENT OR ANY PART BY WHATEVER MEANS IS PERMITTED WITHOUT THE PRIOR WRITTEN CONSENT OF THE MTR CORPORATION LIMITED.</td></tr><tr><td></td><td>BY</td><td>DATE</td><td>APPROVED</td><td></td><td></td><td>CADI</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table>					DRAWN		ORIC					DESIGNED						CHECKED						APPROVED						DATE						DO NOT SCALE DRAWINGS. ALL DIMENSIONS SHALL BE VERIFIED ON SITE. © MTR CORPORATION LIMITED 2008 COPYRIGHT IN RESPECT OF THIS DRAWING / DOCUMENT IS OWNED BY THE MTR CORPORATION LIMITED OF HONG KONG. NO REPRODUCTION OF THE DRAWING / DOCUMENT OR ANY PART BY WHATEVER MEANS IS PERMITTED WITHOUT THE PRIOR WRITTEN CONSENT OF THE MTR CORPORATION LIMITED.			BY	DATE	APPROVED			CADI								
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	BY	DATE	APPROVED			CADI																																															

4.	About signatures for the drawing	Section 2.6.2
	<p>Example:</p> <p>For ACP : no need for any signature for ACP or interim stage of drawing revisions for individual drawings, both CADD or Hardcopy.</p> <p>For Approved Rev.A drawing : hardcopy - only signature on "checked" &amp; "approved" for title block, no signature for the revision; CADD - no need for any signature.</p> <p>For Approved Rev.B drawing : hardcopy - only signature for "approved" in the revision, no signature for title block; CADD - no need for any signature.</p> <p>Sample hardcopy with signature (Rev.A &amp; Rev.B):</p> <p>The image shows three versions of a door schedule table. Each table includes columns for door number, description, date, and various door types (e.g., DOOR, GATE, K.H.). The top section of each table contains a title block with project information: MTR, SIL (EAST) &amp; KTL EXTENSION, PROJECTS DIVISION, and PROJECT ENGINEERING / ARCHITECT DEPARTMENT. The bottom section contains a detailed description of the door schedule, including door types, sizes, and access levels. The first two tables (Rev. A and Rev. B) include handwritten signatures for 'DESIGNED' (K.W. Cheng), 'CHECKED' (A. Wong), and 'APPROVED' (W. Yeung). The third table (SAMPLE) does not have any handwritten signatures.</p>	

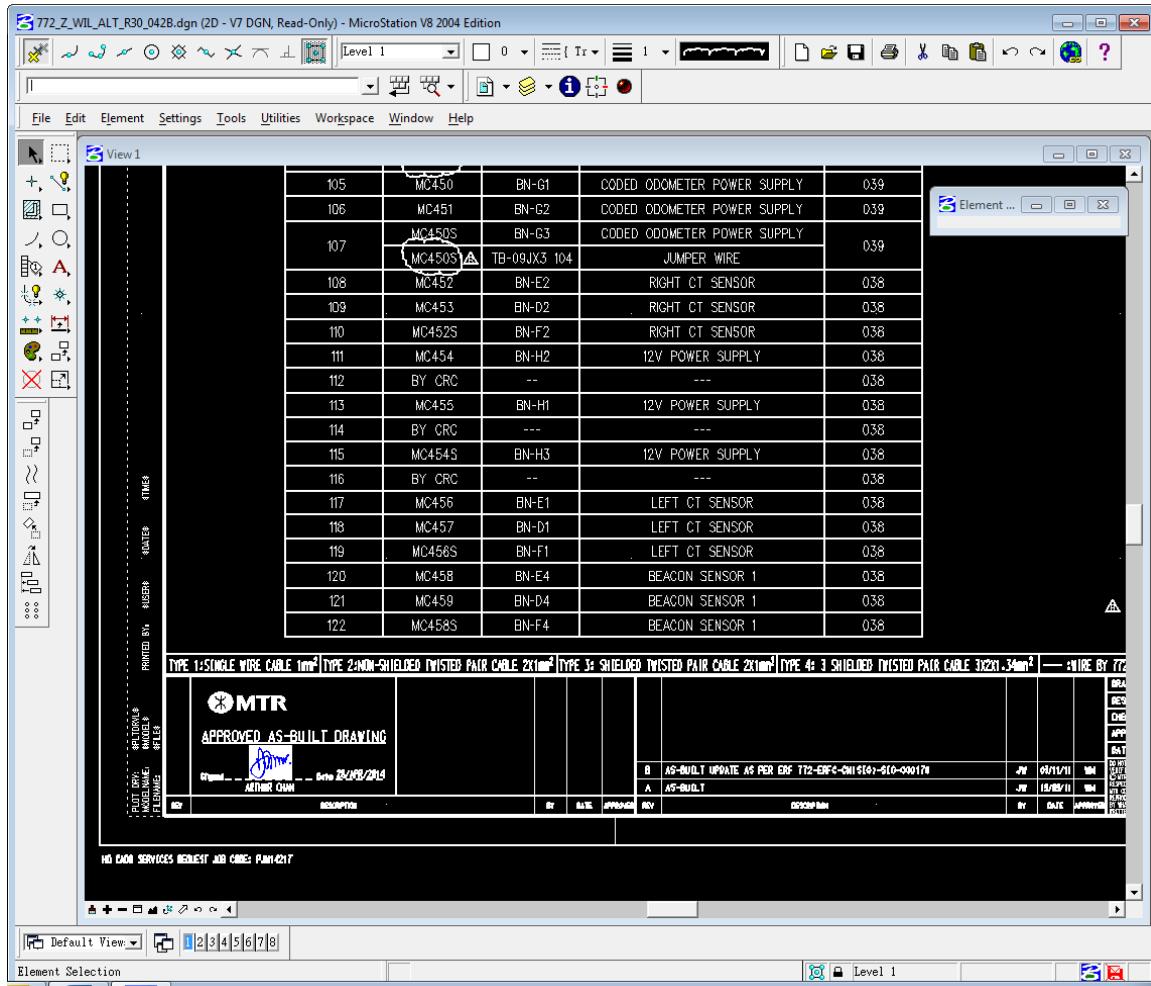
It is recommended that by the time the Originator to submit the individual drawing (in pdf) to ePMIS for approval, then the signature as required (refer the interpretation above) should be appeared in the pdf drawing.

To achieve this, either

1. Sign on the hard copy then scan the signed hard copy before uploading, or
2. Put the scanned signature into the CADD files before plotting.

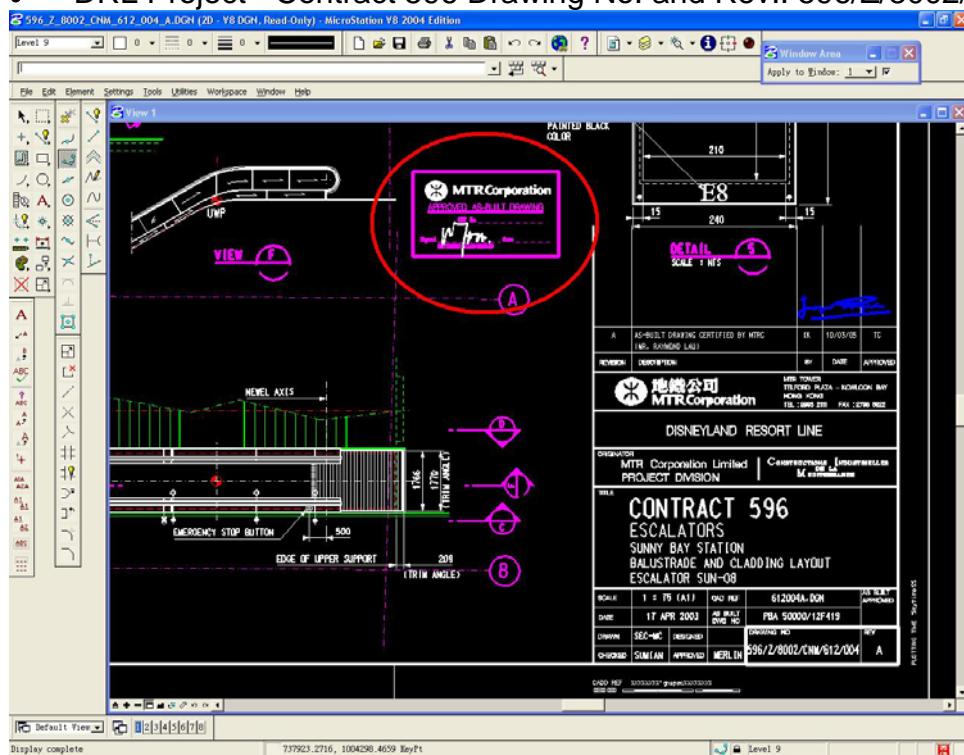
For As-built drawings : similar to above approved drawing revisions. In addition, As-built stamp (embedded in "MTR-A1.DGN") signed by MTR authorized approver shall be attached to the CADD file.

To locate an empty space in the drawing area to hold this stamp, the Originator may consider to put into the titleblock's lower left-hand corner within the rev. description as below:

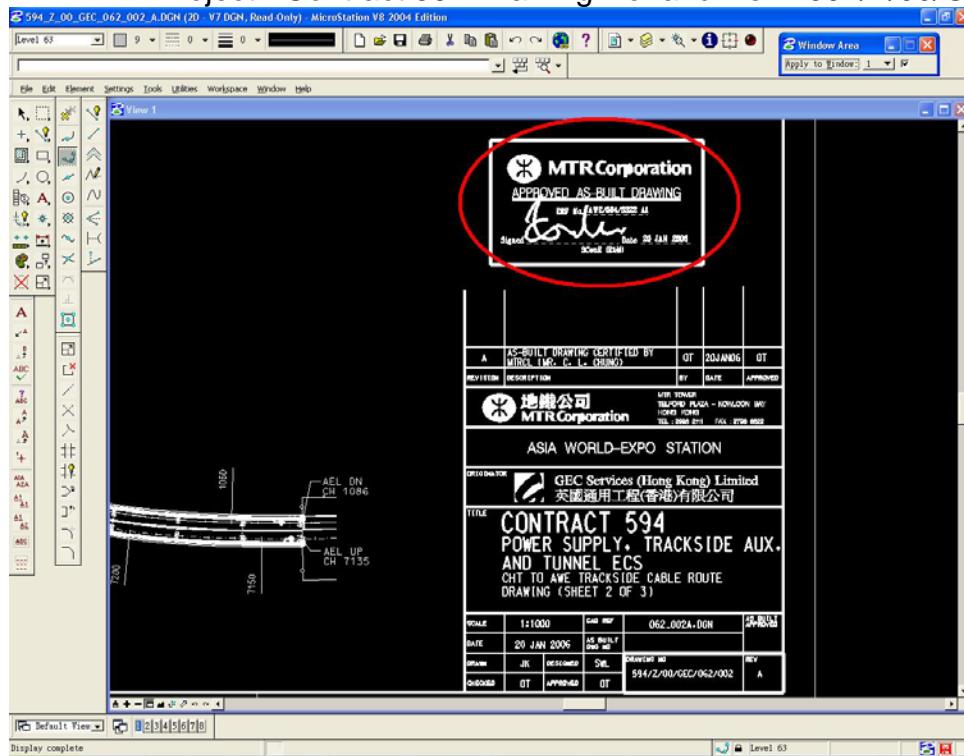


Sample As-built drawing CADD files with MTR authorized approver signature from past MTR projects:

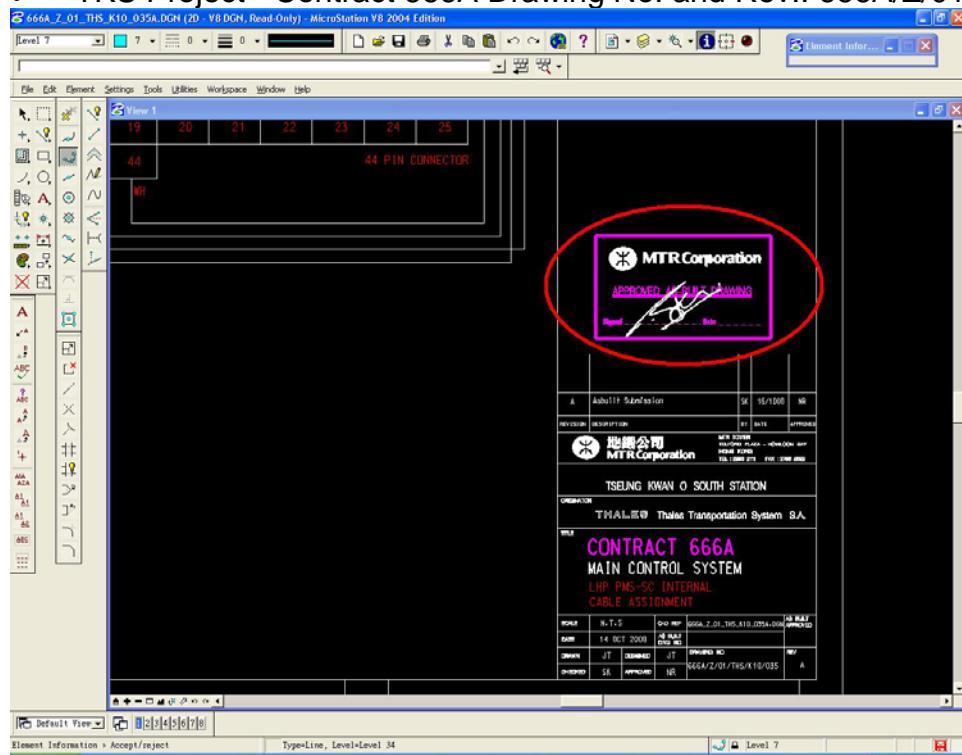
- DRL Project - Contract 596 Drawing No. and Rev.: 596/Z/8002/CNM/612/004/A



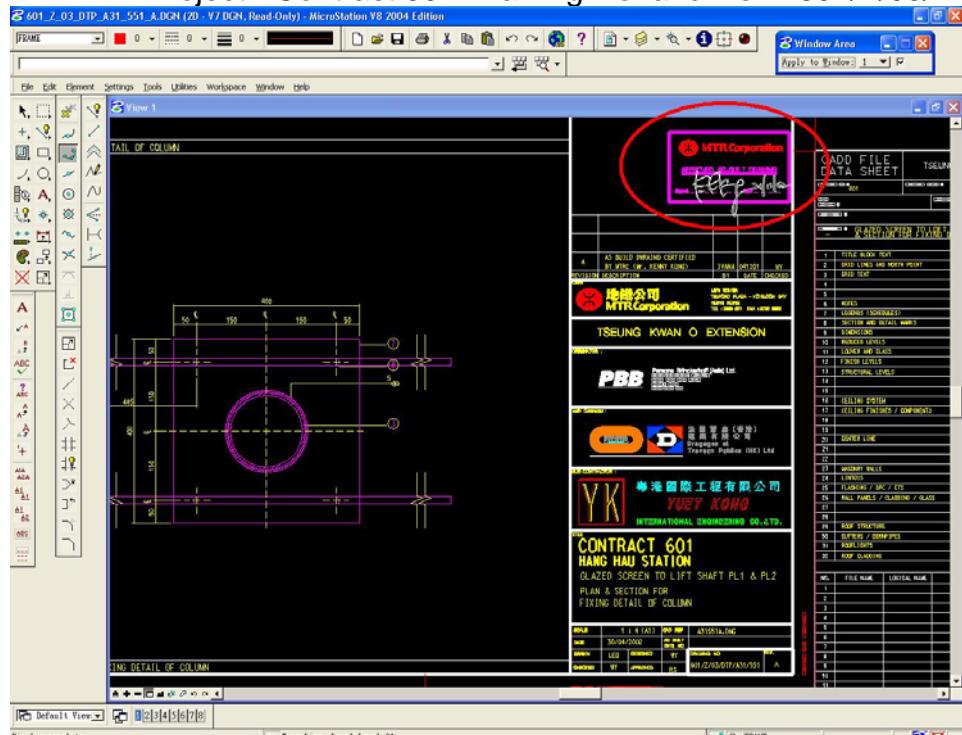
- AWE Project - Contract 594 Drawing No. and Rev.: 594/Z/00/GEC/062/002/A



- TKS Project - Contract 666A Drawing No. and Rev.: 666A/Z/01/THS/K10/035/A



- TKE Project - Contract 601 Drawing No. and Rev.: 601/Z/03/DTP/A31/551/A



5.	For the first field of the Drawing Number, if it is to be produced and applied for various contracts in a project. When the drawing is issued for a particular contract, should the drawings be re-numbered?	Section 3.1.2.1
	Refer D&CM Section 3.1.2.1, field 1 of drawing number shall be the Contract / Project Number / Job Reference Code. The designer / engineer shall decide which coding to be used according to the purpose of the drawing set.	
6.	About MTR Drawing Numbering System	Section 3.1



## Memorandum 備忘錄

To	Distribution	Date	26 Sept 2012
From	Wilfred Yeung - CA	Ref	GEN-COR-CA-CADD-100001
Tel	2688-1206	Location	6/F, FTRH

### Drawing Numbering System

During our review of statutory submission packages, it has come to our attention that some of our consultants or staff may not fully understand the MTR drawing numbering system and we have also received similar complaints from FSD.

Manager-CADD has prepared a simple guideline on the MTR drawing numbering system and I would be grateful if you can disseminate this information to your staff who need to produce or manage drawings. The same information has also been posted on the iShare Forum on 12<sup>th</sup> September.

Regards,

A handwritten signature of Wilfred Yeung.

Wilfred Yeung

WV/zf  
D:\In\GEN-COR-CA-CADD-100001.doc

Encl.

### Distribution :

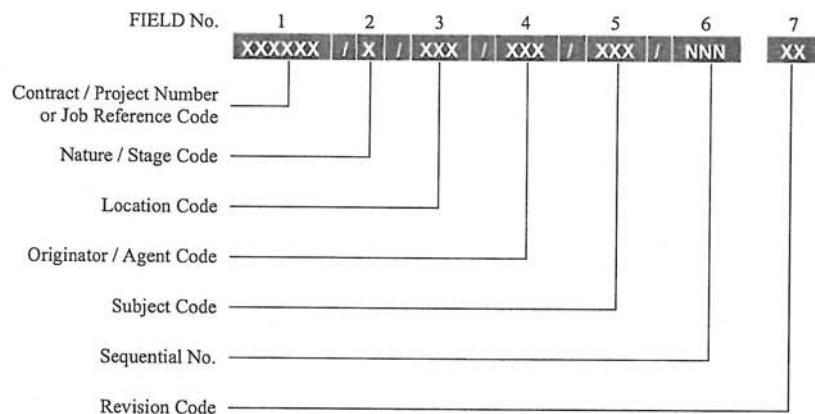
Rod Hockin	}
Antonio Choi	}
David Sorton	}
Paul Lo	}
James Chow	} w/e
Henry Lam	}
Philco Wong	}
Patrick Lun	}
C L Leung	}
Peter Leung	}
c.c. Stephen Chik	- w/e
Harry Wu	- w/e

優質服務 互敬互重、創造價值 勇於進取  
Excellent Service Mutual Respect Value Creation Enterprising Spirit

This is an extract from the MTR Drawing and CADD Manual (D&CM) regarding the drawing numbering system. Please refer to the D&CM for all the requirements on drawing standards.  
(<http://ishare.mtr.com.hk/s/pjeng/pjsec/pjdef/doc/Design%20Documents/08%20-%20Drawing%20and%20CADD%20Manual/GEN-DS-MTR-0002A4.pdf>)

## 1. DRAWING NUMBERING CONVENTION

All drawings and sketches shall each be assigned a unique number, which shall comply with the convention specified below :



Where :      X = Alphanumeric character  
                  N = Numeric value

## 2. DRAWING NUMBER - CODES DEFINITION

### 2.1 PROJECT / CONTRACT NUMBER OR JOB REFERENCE CODE (FIELD 1)

This code is the first field of the drawing number. This shall be assigned from the Originator's own Project / Contract number or Job Reference Code from the In-House Design teams

### 2.2 NATURE / STAGE CODE (FIELD 2)

The definition of stage codes are summarized as follows :

Stage / Nature	Code
Sketch	K
Feasibility study, conceptual design, indicative design, standard design, standard detail drawings	S
Model files	M
Statutory Submission	B
Pre-Tender design stage drawings	P
Tender drawings	T
Consultant or Contractor drawings	C
Construction stage working drawings	W
As-built drawing	Z

## 2.3 LOCATION CODE (FIELD 3)

This 3-alphanumeric characters identifies the geographical location of the works shown on the drawing. It represents the individual station, stop, depot, auxiliary building, or a segment of the railway line within the entire Corporation premises.

## 2.4 ORIGINATOR / AGENT CODE (FIELD 4)

This 3-alphanumeric characters identifies the consultant / contractor who is responsible in the design and production of this drawing. This code is referred to as the "Agent Code", which shall be assigned in accordance with the list of "Agent Responsible Codes (ARC)" published as part of the CAD Standard for Works Projects (CSWP) of HKSAR. Originators can propose new originator codes where the ARC is not applicable.

## 2.5 SUBJECT CODE (FIELD 5)

This code is composed of 3-alphanumeric characters in matrix format, and is used for the identification of the works systems and sub-system hierarchy of the drawing concerned, i.e. the engineering discipline of the drawing. The first character denotes the Subject / System Group. The Originator can propose new Subject codes using those alphanumeric characters that have not yet been assigned in D&CM.

## 2.6 SEQUENTIAL NUMBER (FIELD 6)

This 3-digit code consists of a drawing sequence number to be assigned by the Originator. The sequence numbering shall be planned in a logical manner. In general, the sequential numbering shall start from 001.

## 2.7 REVISION CODE (FIELD 7)

This code identifies the version after each revision of the drawing. See section 3 for detail.

## 3. REVISION CODING DEFINITION

### 3.1 REVISION CODE FOR APPROVED ISSUE

The revision for the first approved issue of a drawing shall be "A"; and its subsequent revisions shall be in alphabetical sequence, i.e. "B", "C", etc.

After the "Z" revision, the coding shall restart by adding a second letter prefix starting from "A"; e.g. "AA", "AB", etc. Accordingly, after the "AZ" revision, a new cycle will start from "BA", "BB", etc..

Revision cloud, triangle and description for the revision since last approved issue shall be clearly identified. For clarity, previous revision cloud and triangle shall be removed from the drawing.

### 3.2 REVISION CODE FOR INTERIM RELEASES

Prior to finalizing a revision for approved issue, a drawing will typically go through several amendment and verification cycles (such as the advance check prints, working drafts, etc). Hence, a numeric suffix will be appended to that revision for version control and release distinction. For example, subsequent amendment to a drawing of revision A, interim releases such as B1, B2 and B3, etc. will be used for version reference during the development period until the drawing has been formalized to revision B.

Revision cloud, triangle and description for each interim release shall be identified. For clarity, previous revision cloud and triangle shall be removed. Once the interim release is finalized and approved, the drawing can be issued as approved issue as described in 3.1.

Example:

A1 → A2 → A3 ... → A → B1 → B2 → B3 ... → B → C1 → C2 ...
Interim Releases      Formal Issue      Interim Releases      Formal Issue      Interim Releases

7.	CADD data delivery to MTR M-CADD for uploading to the Corporate Drawing Management System (DMS)	Section 1.5.1.4
	<p>Here's an example of the flow of as-built drawing approved in MTR ePMS system individually, then send to M-CADD for registration, verification and loading into the DMS:</p> <pre> graph LR     DO[Drawing Originator] -- "Submit drawings in pdf format" --&gt; EPMS[ePMS]     DO -- "Submit drawings in native CADD format through CD/DVD (refer PIMS/PN/09-5 Paras. 5.1.2 &amp; 6.2.2)" --&gt; DC[Drawing Coordinator]     EPMS -- "Sample Check" --&gt; DC     DC -- "Approved Drawings" --&gt; MCADD[M-CADD]     MCADD -- "Verify &amp; Upload" --&gt; DMS[DMS]   </pre> <p><b>PIMS/PN/09-5 Para. 6.2.2</b> Completed version shall be uploaded to the DMS:</p> <ul style="list-style-type: none"> <li>Final Preliminary Design Drawings</li> <li>Final Scheme Design Drawings</li> <li>Tender &amp; Tender Addendum Drawings</li> <li>Working Drawings &amp; Revised Drawings</li> <li>As-built Drawings</li> <li>Approved Statutory Submission Drawings</li> </ul>	

**Step 1: Contract 753 as-built drawing: 753/Z/SHW/ATL/M15/004 rev. A got approved in ePMs under CSF submission: 753-CSF-ATL-ECS-008001 individually**

The screenshot shows the ePMs Document Search interface. On the left, there's a sidebar with 'Notice' and 'System Support' sections. The main area shows a search result for '753\_Z\_SHW\_ATL\_M15\_004A.PDF'. The details pane shows the following information:

- Attached Step:** 753-CSF-ATL-ECS-008001 (Received)
- File:** 753\_Z\_SHW\_ATL\_M15\_004A.PDF (220 58KB)
- Type:** Drawing
- Parent Doc No:** 753-CSF-ATL-ECS-008001
- Drawing No:** 753 / Z / SHW / ATL / M15 / 004 A
- Contract:** EM(WSK) - E&M Project Works for WIL, SLL & KTE
- Nature / Stage:** Z - As-built drawing
- Location:** SHW - Sheung Wan Station
- Originator:** ATL - ATAL Building Services Engineering Ltd. (Originator Ref No: 753/Z/SHW/ATL/M15/004A)
- Subject:** M15 - ECS Electrical Layout
- Title:** Sheung Wan Station West Concourse Tunnel ECS Cable Containment Layout At Intermediate Level & 2nd Basement Level
- Document Date:** 28/03/13
- Project Record:** Approved
- Status:** Approved
- Primary Recipient:** CHENG CoCo HoI Yan (ATAL Building Services Eng) pp
- Remarks:** IN - Drawings
- Document Library:** http://epms.mtr.com.hk/epms/Doc/SingleFileRetrieve.aspx?DocumentDrawingNo=753\_Z\_SHW\_ATL\_M15\_004A.PDF
- URL:** 753\_Z\_SHW\_ATL\_M15\_004A.PDF
- Original File Name:** 753\_Z\_SHW\_ATL\_M15\_004A.PDF
- Registration Date:** 28/03/13
- Registered By:** CHENG CoCo HoI Yan (ATAL Building Services Eng) pp
- Modification Date:** 19/04/13
- Modified By:** YU Zinnia Chi Hang (余翠衡) pp

**Step 2: Drawing record uploaded and archived in DMS**

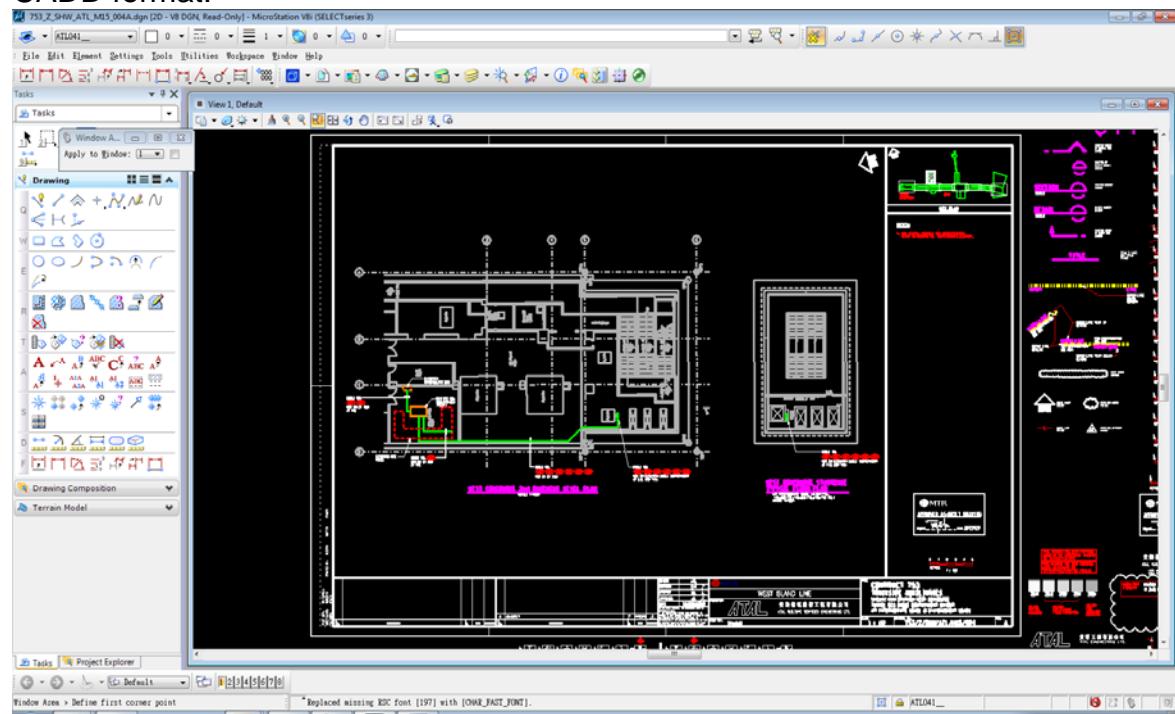
The screenshot shows the MTTC-DMS interface. The Explorer View on the left shows a tree structure of contracts and specific drawing files. The Result Window on the right displays a list of uploaded drawing files, each with a preview thumbnail and file details. Some of the files listed are:

- 753\_Z\_SHW\_ATL\_M14\_002A.dwg
- 753\_Z\_SHW\_ATL\_M14\_002A.dgn
- 753\_Z\_SHW\_ATL\_M15\_001A.dwg
- 753\_Z\_SHW\_ATL\_M15\_001A.dgn
- 753\_Z\_SHW\_ATL\_M15\_002A.dwg
- 753\_Z\_SHW\_ATL\_M15\_002A.dgn
- 753\_Z\_SHW\_ATL\_M15\_003A.dwg
- 753\_Z\_SHW\_ATL\_M15\_003A.dgn
- 753\_Z\_SHW\_ATL\_M15\_004A.dwg
- 753\_Z\_SHW\_ATL\_M15\_004A.dgn
- 753\_Z\_SHW\_ATL\_M15\_101A.dwg
- 753\_Z\_SHW\_ATL\_M15\_101A.dgn
- 753\_Z\_SWT\_ATL\_M02\_001A.dwg
- 753\_Z\_SWT\_ATL\_M02\_001A.dgn
- 753\_Z\_SWT\_ATL\_M03\_001A.dwg
- 753\_Z\_SWT\_ATL\_M03\_001A.dgn
- 753\_Z\_SWT\_ATL\_M04\_001A.dwg
- 753\_Z\_SWT\_ATL\_M04\_001A.dgn
- 753\_Z\_SWT\_ATL\_M05\_001A.dwg
- 753\_Z\_SWT\_ATL\_M05\_001A.dgn
- 753\_Z\_SWT\_ATL\_M06\_001A.dwg
- 753\_Z\_SWT\_ATL\_M06\_001A.dgn
- 753\_Z\_SWT\_ATL\_M07\_001A.dwg
- 753\_Z\_SWT\_ATL\_M07\_001A.dgn
- 753\_Z\_SWT\_ATL\_M08\_001A.dwg
- 753\_Z\_SWT\_ATL\_M08\_001A.dgn
- 753\_Z\_SWT\_ATL\_M09\_001A.dwg
- 753\_Z\_SWT\_ATL\_M09\_001A.dgn
- 753\_Z\_SWT\_ATL\_M10\_001A.dwg
- 753\_Z\_SWT\_ATL\_M10\_001A.dgn
- 753\_Z\_SWT\_ATL\_M11\_001A.dwg
- 753\_Z\_SWT\_ATL\_M11\_001A.dgn
- 753\_Z\_SWT\_ATL\_M12\_001A.dwg
- 753\_Z\_SWT\_ATL\_M12\_001A.dgn
- 753\_Z\_SWT\_ATL\_M13\_001A.dwg
- 753\_Z\_SWT\_ATL\_M13\_001A.dgn
- 753\_Z\_SWT\_ATL\_M14\_001A.dwg
- 753\_Z\_SWT\_ATL\_M14\_001A.dgn
- 753\_Z\_SWT\_ATL\_M15\_001A.dwg
- 753\_Z\_SWT\_ATL\_M15\_001A.dgn
- 753\_Z\_SWT\_ATL\_M16\_001A.dwg
- 753\_Z\_SWT\_ATL\_M16\_001A.dgn
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- 753\_Z\_SWT\_ATL\_M17\_001A.dgn
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- 753\_Z\_SWT\_ATL\_M18\_001A.dgn
- 753\_Z\_SWT\_ATL\_M19\_001A.dwg
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- 753\_Z\_SWT\_ATL\_M20\_001A.dwg
- 753\_Z\_SWT\_ATL\_M20\_001A.dgn
- 753\_Z\_SWT\_ATL\_M21\_001A.dwg
- 753\_Z\_SWT\_ATL\_M21\_001A.dgn
- 753\_Z\_SWT\_ATL\_M22\_001A.dwg
- 753\_Z\_SWT\_ATL\_M22\_001A.dgn
- 753\_Z\_SWT\_ATL\_M23\_001A.dwg
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- 753\_Z\_SWT\_ATL\_M209\_001A.dgn
- 753\_Z\_SWT\_ATL\_M210\_001A.dwg
- 753\_Z\_SW

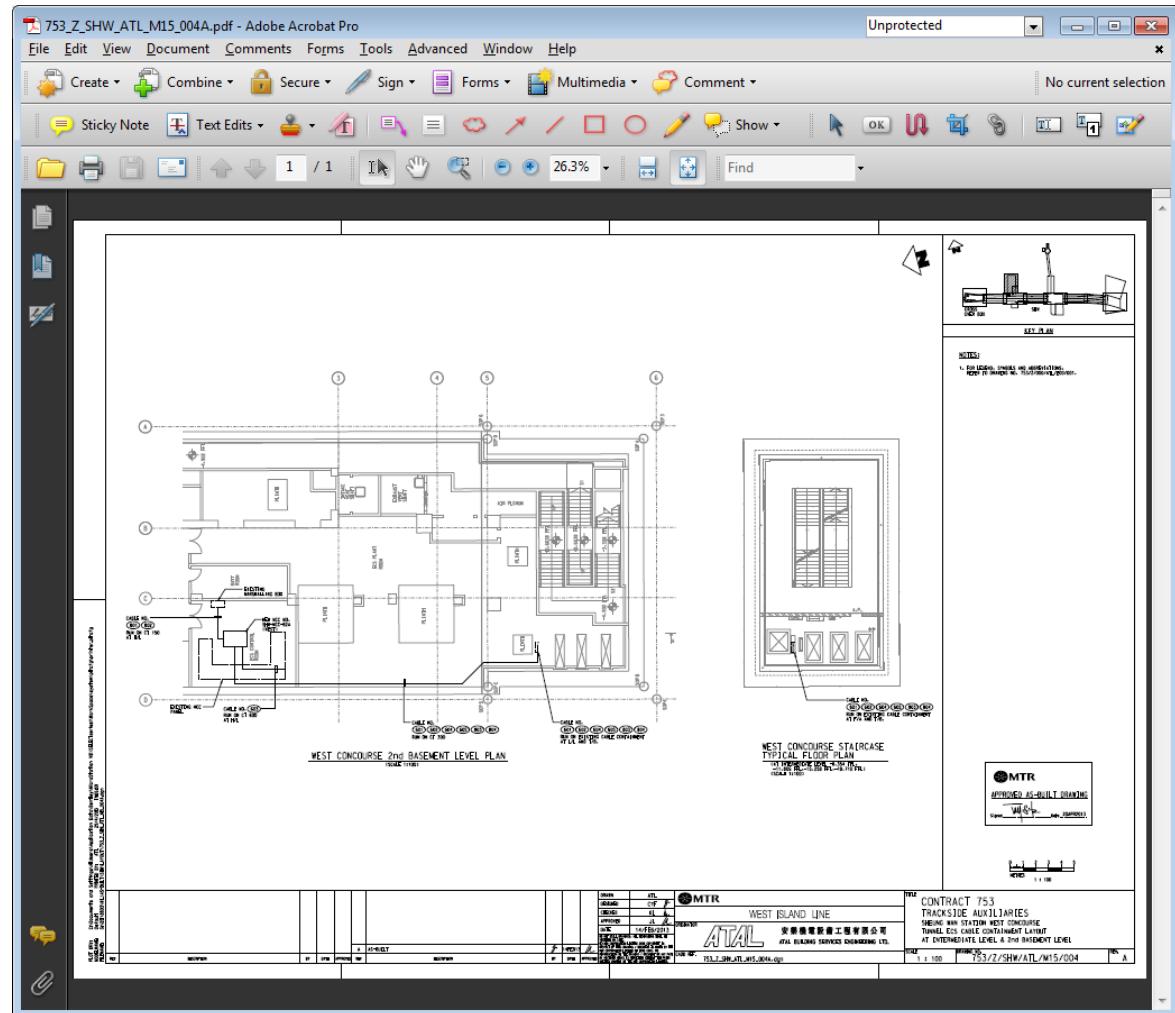
## DRAWING & CADD MANUAL UPDATES

Last Updated: 17 Oct 2014

### CADD format:



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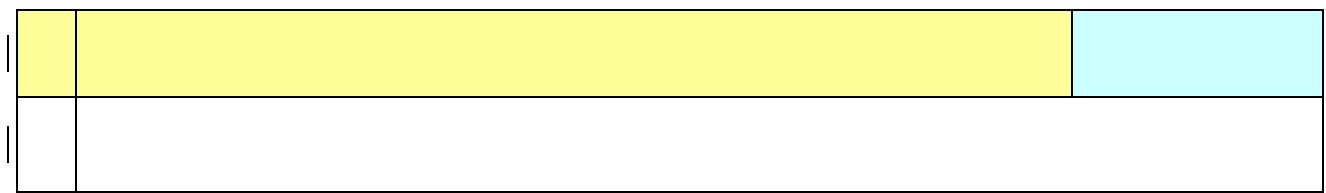


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## DRAWING & CADD MANUAL UPDATES

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Last Updated: 17 Oct 2014





## **DRAWING & CADD MANUAL**

REVISION	DATE	PREPARED BY	CONTROLLED BY	APPROVED BY
A	02 Feb 2005	BEAM	BEAM	CDM
A2	18 Mar 2008	M-CADD	CA	HPE
A3	17 Jun 2009	M-CADD	CA	HPE
A4	11 Jul 2011	M-CADD 	CA 	HPE 

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**Drawing & CADD Manual  
Revision Record Sheet**

Version	Date of Issue	Page No(s)	Brief Description of Change	Approved by
A	2 Feb 05		First issue	CDM
A2	18 Mar 08	All	General revision to update Manual and integrate relevant information in line with CSWP requirements	HPE
A3	17 Jun 09	See Description of Change	General revision to update Manual on sections – 1.2.2, 2.2.5.3, 2.2.6, 2.3.8.3, 3.1, 3.1.2.2(iv), 5.1, 5.2.3(A, D, E, F, G, M, V, W & Z), 7  Section 7.2 Supplementary B – Building Information Modeling (BIM) Standards added	HPE
A4	11 Jul 11	See Description of Change	General revision to update Manual on sections – 1.3.2.1, 1.5.1.1, 1.5.1.2(ii), 1.5.1.4, 1.5.3(1)&(15), 1.5.5, 2.2.1, 2.4, 2.6.2.2, 2.6.2.4, 3.1.2.1, 3.1.2.2, 3.1.2.3, 3.1.2.4, 3.1.2.5, 3.1.2.7, 3.3.2, ,3.3.3.2, 3.3.3.5, 5.2.2, 5.2.3 (G, N, S), 6.2, 6.4  Section 7.2 Supplement B – Building Information Modeling (BIM) Statndards overall reviewed.  Section 7.3 Supplement C – MTR Operation Division Drawing Numbering System added.	HPE

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# 1. GENERAL

## 1.1 PURPOSE AND SCOPE

### 1.1.1 PURPOSE

This Manual sets out the standards to be followed in the production of Computer-Aided Design & Drafting (CADD) drawings for the Corporation. The purpose of these standards is to ensure that all drawings are produced in a consistent and efficient manner, with a high level of clarity, readability, and professionalism.

### 1.1.2 SCOPE

This Drawing & CADD Manual applies to all internal organizations and external originators producing drawings for the Corporation.

All drawings, including those prepared by the Corporation and by external consultants and contractors, shall comply with the standards set out in this Drawing & CADD Manual.

### 1.1.3 MANUAL HIGHLIGHT

This Manual is divided into the following Sections :

**Section 1, General**, introduces the Drawing & CADD Manual and lists out the definitions, abbreviations and corresponding reference standards.

**Section 2, Drawing and CADD Standards**, describes the general drawing standards which shall be adopted for drafting work, and the requirements for electronic drafting work using MicroStation software.

**Section 3, Drawing Identifier Coding**, describes the requirement of the drawing identifier coding such as drawing numbering, file name, project codes, agent codes, location codes, subject codes, etc.

**Section 4, CADD Layer Coding**, describes the layering requirements for drawing and model files.

**Section 5, Coding Reference Tables**, describes the coding reference for users of different disciplines.

**APPENDICES** contains the reference materials for the main Sections.

**SUPPLEMENTARIES** contain the supplemental information as referred to the main Sections.

## **1.2 DEFINITIONS AND ABBREVIATIONS**

### **1.2.1 DEFINITIONS**

The definitions of the main terms used in the CADD Manual are stated below.

<i>CADD System</i>	The computer system used to create CADD drawing files and produce paper plots output. MicroStation is adopted as the standard CADD system for the Corporation.
<i>Control Base Alignment Drawings</i>	The set of railway alignment drawings controlled by the Corporation.
<i>Corporation</i>	The MTR Corporation Limited or its representative appointed to act on its behalf in respect of a Project / Contract.
<i>Drawing File</i>	<p>Drawing file is the electronic file(s) of a drawing with a unique drawing number. The file may comprise either-</p> <ul style="list-style-type: none"><li>• a complete drawing, containing all the details in one file including a standard Title Block file reference;</li><li>• a composite drawing with its major details / contents referenced from other drawings / base maps, such as the Alignment and General Arrangement (GA) Plan; or;</li><li>• a clipped portion of a larger master drawing with multiple references or model files, such as the Architectural layouts and Station-box drawings.</li></ul>
<i>Drawing Issue</i>	A formal issue of a drawing(s) by a Project Consultant/ Contractor in the execution of a Contract.
<i>Drawing Coordinator (DC)</i>	A Project Team staff or CADD office staff delegated by Design Manager, Construction Manager, Heads of Design Departments or Manager-CADD (M-CADD) for supporting and coordinating with the Project Team to manage project drawings, maintain appropriate records of drawing receipt and issue, and ensure that all required drawing information is passed to the M-CADD for maintenance in the Drawing Management System (DMS).
<i>Drawing Issue History (DIH)</i>	A report which shows the history of drawing revision issue.
<i>Drawing Management System (DMS)</i>	CADD drawing management system to control the CADD drawings' integrity, such as format, numbering, revision, security, as well as to provide archive and search functions.

*Drawing Office*

The Corporation's centre of excellence for CADD, DMS and Engineering Information. Provides CADD drawing services and matrixed engineering information support to all departments of the Corporation. Also provides assistance to Detailed Design Consultants (DDC) CADD teams working on Corporation projects.

*Electronic Project Management System (ePMS)*

A computer system with database and project management functions to be used by all the Corporation's staff, consultants, and contractors involved in projects managed by Projects Division for capturing, sharing, storing, controlling, managing and archiving incoming and outgoing project documents throughout and beyond the project period.

*Manager-CADD (M-CADD)*

Manager of the Corporate CADD Section and administrator of the CADD standards, system and the Drawing Management System (DMS) for the Corporation.

*Model Files*

The reference files used to store all common project data (2D or 3D) for effective design processing. Drawing co-ordination of all disciplines working on the same project is carried out by combining the model files through referencing.

*Originator*

A person or an organisation responsible for producing drawings for the Corporation or for a Corporation project.

*Stage*

A stage refers to a part of the drawing production phase, such as tender stage, construction stage, as-built stage, etc.

*Symbol*

A graphic element used in a drawing to indicate the occurrence/location of an item or feature, or as an annotation to indicate one or more of the attributes of an item or feature, but not drawn to scale. For CADD purposes, symbols are graphic elements contained in MicroStation cell format.

**1.2.2 ABBREVIATIONS**

The abbreviations stated below are applicable to the Manual.

CADD	Computer-Aided Design and Drafting
CBAD	Control Base Alignment Drawings
CFSS	CADD File Submission Summary
CM	Construction Manager
CSWP	Computer-Aided-Drafting Standard for Works Projects
DC	Drawing Coordinator
DGN	A MicroStation CADD file format
DIH	Drawing Issue History
DIL	Drawing Issue List
DM	Design Manager
ePMS	Electronic Project Management System
HKSARG	The Government of the Hong Kong Special Administrative Region of the People's Republic of China
IDT	In-house Design Team
M-CADD	Manager of the CADD Section
MU / SU	Master Units / Sub Units
PDF	Portable Document Format (Adobe Systems Inc. file format for viewing various documents on computers)
PU	Position Units
SSCC	Safety and Security Coordinating Committee (a Government committee responsible for agreeing areas usually controlled by Buildings Ordinance)
STIC	Station and Transport Integration Committee (a Government committee responsible for agreeing the layout of stations in relation to their immediate surroundings)
TSSC	Trackside Safety and Security Committee (a Government committee responsible for agreeing the fire safety and security along the trackside area )

## 1.3 APPLICABLE STANDARDS

### 1.3.1 CODES AND STANDARDS

In addition to the requirements of this Manual, drawings shall be prepared in accordance with the requirements of the following principal standards and systems :

- The Computer-Aided-Drafting Standard for Works Projects (Works Branch, Development Bureau of the HKSARG)
- BS 308 - Engineering Drawing Practice (British Standards Institute)
- BS 1192 - Construction Drawing Practice (British Standards Institute)
- 1980 Hong Kong Grid - Gauss Conformal Projection System (Lands Department of the HKSARG)

### 1.3.2 REVISIONS OF STANDARDS

#### 1.3.2.1 Drawing & CADD Manual

The Corporation may from time to time revise parts of this Manual as necessary. Such changes will be controlled by M-CADD, and issued in accordance with Corporation's quality system procedures. Such changes will be kept in manual updates and to be incorporated in the next revision.

#### 1.3.2.2 Codes and Standards

The version of the aforesaid codes and standards shall be the latest version unless otherwise specified. If revised versions of such documents are issued by the relevant agency during the course of the Project or Contract, the Originator shall advise the M-CADD of the potential impacts associated with adopting the newest versions.

### 1.3.3 CONFLICTS OF STANDARDS

In case of any inconsistency, ambiguity or discrepancy found between this Manual and the aforesaid codes and standards, the Originator shall in the first instance notify and seek appropriate direction from M-CADD. In general, the hierarchy of precedence will be as follows.

- i) The Drawing & CADD Manual shall prevail over any other drafting standards.
- ii) The Computer-Aided-Drafting Standard for Works Projects (CSWP) shall prevail over British Standards.

## **1.4 INFORMATION AND DATA PROVIDED BY THE CORPORATION**

### **1.4.1 CADD UTILITIES PACKAGE**

Upon the appointment of the Originator, the Corporation shall in due course provide to the Originator the softcopies of a CADD utilities package, which shall comprise the following :

- Drawing & CADD Manual
- Corporation seedfile in MicroStation format
- The Corporation standard title block MTR-A1.DGN
- Pen table
- Drawing file samples for Project or In-house works
- Templates of DIH and DIL

### **1.4.2 FILES PROVIDED BY OTHERS FOR CADD USE**

The Originator, as part of his drawing production, may use electronic files and data produced by others and supplied by various parties such as the Government, consultants, other Project Contractors, and the Corporation. In such cases, the Originator shall be aware that such files or data may not necessarily conform to the requirements of this Manual. If the Originator incorporates any part of such electronic files or data in to his drawings, the Originator shall undertake any necessary modification or conversion work to ensure that all deliverables under the Contract shall comply with the requirements of this Manual.

Notwithstanding the above, the drawing details shown on Government survey and map files which are reproduced as the base maps in the Originator's drawings shall not be modified.

## **1.5 DRAWING SUBMISSION**

Manager-CADD (M-CADD) or his delegate shall be responsible for accepting and registering receipt of all CADD file deliverables and their accompanying documentation.

### **1.5.1 DRAWING SUBMISSIONS REQUIREMENTS**

The Corporation's acceptance of a drawing issue or a drawing submission shall be dependent on their compliance with the requirements stated.

#### **1.5.1.1 Submission Documentations and Data**

Each Drawing Issue shall consist of the documents and data as described below:

Documentation	Format <sup>4</sup>	Quantity
Drawing Issue Register - comprising the Drawing Issue History (DIH) and Drawing Issue List (DIL)	Soft copy (EXCEL <sup>1</sup> workbook)	1 set
Drawing prints	Sizes as specified in the Contract	As specified in the Contract
Drawing files and model files	DGN <sup>2</sup> (MicroStation) and PDF <sup>3</sup> (Acrobat) converted from the DGN drawing files individually (i.e. one drawing one PDF file with file name same as DGN drawing file except the file extension to be .PDF)	1 set, unless specified otherwise in the Contract

Footnotes:

- <sup>1</sup> Microsoft EXCEL files shall be in version 2003 or above.
- <sup>2</sup> DGN file format shall be in MicroStation Version 8 or above.
- <sup>3</sup> PDF document files shall be viewable in Adobe Acrobat Reader Version 8.0 or above.
- <sup>4</sup> Software version of the submission documentations and data shall be agreed by the Corporation.

### 1.5.1.2 Drawing Records

The drawings submitted as part of each Drawing Issue shall be accompanied by a set of drawing records comprising :

- Drawing Issue History (DIH)
- Drawing Issue List (DIL)

Templates of the record forms shall be provided by the Corporation for the Originator's use (refer Appendix A & B).

#### (i) Drawing Issue History (DIH)

A DIH is a series of drawing lists which provides a concise and continuous record of drawing revisions and issues.

A soft copy of the DIH shall accompany each Drawing Issue. The Originator shall continuously update and maintain the DIH for a "Drawing Stage". A new DIH shall be established upon the commencement of a new "Drawing Stage".

When all revision columns in a sheet have been used up, the same block of drawings shall continue on an additional sheet bearing the same

sequential number but with a letter suffix commencing with “A”, then “B” etc. Sufficient gaps between drawing list entries shall be included to allow room for insertion of additional drawings in sequential order where required. Unused or deleted drawing numbers or pages shall be designated “NOT USED” for reference purpose.

### **(ii) Drawing Issue List (DIL)**

The DIL is a list of drawings contained within a Drawing Issue. A DIL shall be submitted in soft copy format for every Drawing Issue, which shall be referenced with the relevant Issue Reference Number or Submission Number.

#### **1.5.1.3 CADD Data Format for Submission**

MicroStation format is the standard CADD software adopted by the Corporation for the production of all Corporation drawings. The standard drawing file format of MicroStation contains the extension ‘DGN’. All submission softcopies of drawing files, model files, reference files and other necessary files shall be submitted to the Corporation in this MicroStation ‘DGN’ format; and the software version shall be agreed by the Corporation.

#### **1.5.1.4 CADD Data Delivery**

DC shall pass the CADD files, drawings in PDF format and the associated documentation to M-CADD for registration, verification and loading into the DMS.

The CADD files can be submitted in media formats as follows:

***Compact Disc*** (CD) is the preferred delivery media. High-speed (minimum 4x) CD in Mode 1 format shall be used to transfer files. Multiple Drawing Issues shall not be contained within the same disc. All the CADD files’ related reference files and model files shall be contained in the same folder of the same disc, i.e. all the drawings shall be directly opened from the disc without missing any of its linked reference files.

The use of ***Digital Versatile Disc*** (DVD) is subject to the need of large quantity drawings submissions and shall be agreed by M-CADD.

#### **1.5.1.5 Directory Structure of Data Files for CD / DVD**

##### **(i) Files for Drawings**

CADD files for drawings (drawing files, model files, reference files) shall be submitted on electronic delivery media in accordance with the following directory structures :

D: \ DATE \ DGN \ DWN  
D: \ DATE \ PDF \ DWN

Where : ‘D’ is the drive name

‘DATE’ is the date of submission (YYMMDD)

‘DGN’ is for MicroStation format drawings

‘PDF’ is for Adobe Acrobat file format drawings

‘DWN’ is the drawing number

The ‘DGN’ folder may be divided into sub-folders named in accordance with the system/sub-system categories as accepted by the Corporation.

For example, a drawing file with the drawing number DB6800/W/KOT/MTR/A12/001 rev.A, which to be submitted on the 1<sup>st</sup> March 2008 and stored on a CD-ROM drive ‘D’ say, would appear as :

D:\080301\DGN\DB6800\_W\_KOT\_MTR\_A12\_001A.DGN

‘Save Full Path’ option for all reference files attachment is not allowed. All the reference files of its parent drawing files shall be located in the same directory as the parent drawing files.

### **(ii) Other Documents**

The soft copies of the DIL and DIH workbook relevant to the Drawing Issue shall be stored under the directory folder as follows :

D:\ DATE \ DIN

Where : ‘D’ is the drive name

‘DATE’ is the date of submission (YYMMDD)

‘DIN’ is the Drawing Issue number of this Submission

## **1.5.2 ACCEPTANCE OF DELIVERABLES IN DIGITAL FORMAT**

The Corporation’s acceptance of the set of drawing prints contained in a Drawing Issue shall not be interpreted to mean an acceptance of the drawings in digital format. The Acceptance of the Drawing Issue shall only be given following verification of the drawing deliverables in digital format.

Section 1.5.3 specifies the file verification requirements which shall be undertaken by the Originator, to ensure that the Drawing & CADD standards stipulated in this Manual are met prior to the Drawing Issue submission to the Corporation. Any deviations from the requirements of this Manual will result in rejection by the Corporation shall be remedied in accordance with the provisions of the Contract.

## **1.5.3 DRAWING ISSUE VERIFICATION CHECKS**

Verification checks of CADD standards compliance shall be conducted for each of the Drawing Issue submissions for conformity with all the requirements as illustrated below:

- 1) Check for the completeness of the submission package such as the Drawing

Issue History (DIH), Drawing Issue List (DIL), drawing prints; and ensure their softcopies are all contained in the submitted electronic media.

- 2) The submitted electronic media shall be verified for its integrity including readability, correctness of the file structures and file names format. The file name shall be derived from the drawing number, i.e. file name such as PLATFORM\_LIGHTING.DGN is not acceptable.
- 3) CADD files shall be in MicroStation file format, which is originated from the Corporation-provided seed file MTR-SEED.DGN. All drawing files such as master drawings, model and reference files must be in genuine MicroStation design files, in which all data content is manipulatable. It is NOT acceptable for a MicroStation title box with the entire drawing contents to be attached with reference files in raster image format.
- 4) Drawing arrangement shall follow the Corporation's standard format, as shown in reference drawings MTR-A1.DGN and MTR-SEED.DGN. Special entities can be tailor-made by Originator such as the consultant's or contractor's company information and logo; however, prior approval shall be obtained from M-CADD.
- 5) Drawing title block shall be filled in correctly with CADD filename, Drawing Number, Revision Letter(s), and Revision Description.
- 6) Automated Plot Date and Time Stamp shall be properly laid in the lower left hand corner.
- 7) The specified text/letter sizes and font types for title box, notes, descriptions, dimensions, etc. shall be strictly adhered to.
- 8) Co-ordinates and orientation shall be placed correctly.
- 9) The setting for display view shall be "View 1".
- 10) The layer structure and naming codes shall comply with the standards of this manual.
- 11) Elements shall be drawn/placed on their corresponding designated layers.
- 12) The standard symbols are referenced from the Corporation and CSWP; the use of any non-standard symbols shall be endorsed by M-CADD.
- 13) Drawings containing unrelated elements shall not be included in the drawing files.
- 14) All the reference files attachment of parent drawing files shall be located in the same directory as the parent drawing files. The 'Save Full Path' option for all reference files shall not be used; and the file name of all reference files shall not be changed regardless of any revision changes of its parent drawing.
- 15) All the reference file layers shall be displayed in View 1 only. The initial view of a drawing shall be identical to its drawing print.

- 16) Unused reference files shall not be attached to master drawing.

#### **1.5.4     DRAWING ISSUE WITH STANDARDS OTHER THAN THE CORPORATION**

If, on an exceptional basis, a Drawing Issue needs to comply with CADD standards other than those contained within the Corporation's Drawing & CADD Manual, Originators or DCs shall seek prior approval from M-CADD.

M-CADD will arrange special processes to conduct the verification checks for such exceptional drawings.

**1.5.5 DRAWING PRODUCTION LIFE-CYCLE SUBMISSIONS**

<b>Stage</b>	<b>Submission Requirements</b>
Design/Tender	<p>In general, tenderers are required to submit a preliminary Drawing Production Plan containing information such as :</p> <ul style="list-style-type: none"> <li>• The resume / CV of Consultant / Contractor's Drawing Coordinator (DC);</li> <li>• Number of CADD staff and CADD workstations proposed to be employed for the Contract;</li> <li>• Summary of the subject / discipline categories relevant to the Contract; together with an estimation of drawing quantities for each discipline; and</li> <li>• Drawing numbering system.</li> </ul>
Upon Contract award	<ol style="list-style-type: none"> <li>1) M-CADD shall provide the latest version of the Drawing &amp; CADD Manual together with the relevant CADD utilities package to the Project team / Consultant / Contractor.</li> <li>2) Where necessary, the Project Manager shall arrange a briefing session for M-CADD to brief the Consultant / Contractor and their DC on the requirements of the Corporation's Drawing &amp; CADD standards, the drawing submission procedures, verification issues, etc.</li> <li>3) The Consultant / Contractor shall submit the drawing production plan and procedures, which are to be included in the Quality Plan(s) in accordance with the Contract.</li> </ol>
All stages of the Contract / Construction	<ul style="list-style-type: none"> <li>• Originator shall submit the new / revised drawings to DC in accordance with the relevant design, consultancy or contract agreement.</li> <li>• The Consultant / Contractor shall continuous update the Drawing Production Plan, and shall submit to M-CADD via DC.</li> <li>• The DC shall accept and register receipt of the drawing submission issue and pass the CADD files, drawings in PDF format and the associated documentation to M-CADD for registration, verification and loading into the DMS.</li> <li>• M-CADD or his designate shall be responsible for carrying out checks on CADD files for CADD standard compliance.</li> <li>• The DC of the In-house Design team (IDT) shall submit the drawings to M-CADD after preparation / revision, checking and internal approval has been carried out.</li> <li>• For CADD files of approved drawings prepared by M-CADD / CADD Office, these shall be transmitted via the network according to the instruction from the DC of IDT.</li> </ul>

**END OF SECTION 1**

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## **2. DRAWING AND CADD STANDARDS**

### **2.1 GENERAL REQUIREMENTS**

#### **2.1.1 DRAWING FORMAT AND CADD SYSTEM**

All drawings prepared for the Corporation shall be prepared in MicroStation Version 8 or above format, and software version to be agreed by the Corporation.

For exceptional case of using the AutoCAD software, such as for MTR Urban Lines / EMU / LRV drawings, Originator shall seek the written approval from M-CADD.

Model Files and Drawing Files shall be used together with the level / layer features in the CADD system, to determine that data has been structured correctly so as to accommodate the Corporation's Facilities Management System.

All files shall be capable of being implemented, revised and plotted through standard MicroStation production techniques (i.e. not to attach reference files with "CADD drawing contents" in bitmap, jpg or raster format to a MicroStation title frame).

#### **2.1.2 INTEGRITY OF DRAWING CONTENTS**

CADD operators shall ensure the integrity of their drawing contents production; such as:

- placing elements precisely within the drawing file;
- all geometries shall be constructed to-scale;
- dimensions shall be labelled to-scale from elements or line segments;
- lines segments shall be joined / snapped exactly to the end point or intersection point etc.

#### **2.1.3 SEEDFILES**

The Originator shall use the seedfile 'MTR-SEED.DGN' as a basis to set up base-drawing parameters for the production of new drawings. The use of 'byCell' in assigning colours, line styles and line weights is not permitted.

#### **2.1.4 GOVERNMENT TOPOGRAPHICAL MAPS**

Any use of the Government topographical maps, which may be used as controlled date / background maps in the production of Corporation or Projects drawings, shall contain the following acknowledgement:

**Maps reproduced with permission of the Director of Lands, © Hong Kong Government**

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Topographical background maps shall always be displayed and plotted underneath the drawing and other reference files, in general in grey colour with halftone effect where appropriate.

### **2.1.5 CADD REFERENCE FILES (MODEL FILES)**

The use of CADD reference files is to ensure that unity and accuracy of the common CADD data across different disciplines is maintained, such as the use of common background reference. To facilitate this function across systems, the ‘save full path’ option shall not be used when attaching reference files. All project data shall be created in the default model of the CADD files. If attachment of the raster image reference files is required, prior acceptance of the Corporation shall be obtained.

In case the reference clip boundary technique is used, the boundaries defined for the clipping should be placed in Level 081\_ \_, and the reference file should be named logically to facilitate the future reference.

The reference-file capabilities of MicroStation shall be used for the Model File concept of drawing production. The Originator creating the Model Files shall comply with the following principles :

- 1) Keep separate and maintain the design works that are being carried out by different disciplines, and allow different disciplines to share the common background drawings;
- 2) Keep separate texts, grids and construction dimensions from design elements;
- 3) Carry out the design works on a whole model file(s) and use the drawing border to create master drawing files (with proper drawing numbers) for plots;
- 4) Allow one discipline to control the displaying and plotting of the reference-background drawing created by another discipline (by using reference-file-level symbology);
- 5) All layouts that cannot be covered by a single general arrangement drawing (A1 size) shall use the Model File concept to develop the drawings;
- 6) Overall views of sections and elevations shall use the Model File concept to develop the drawings; and
- 7) For Diagrams and Schematics that cannot be covered by a single general arrangement drawing (A1-size), e.g. the signalling diagrams and track schematic diagrams, the Model File concept shall be used to develop the drawings.

## 2.2 DRAWING ARRANGEMENTS

### 2.2.1 DRAWING SIZES

Drawing sizes shall be conformed to the ISO-A series sizes. The standard and maximum plotting size of drawings shall be in A1 (594mm x 841mm) size (including the page size of PDF drawing). Any deviation from these standards is not permitted unless prior concession approval in writing by M-CADD is obtained.

For those drawings that require the use of irregular longer drawing size, such as the P-way drawings, the vertical side of these drawings should be matched with the height of A1 (594mm) or A3 (297mm).

### 2.2.2 DRAWING BORDERS

The Corporation Standard Drawing Arrangement is in A1 drawing border size, landscape orientation, and title block pressed with the Corporation's identities. These details will be supplied to Originator in CADD format in file "MTR-A1.DGN", which is to be used as a standard reference file for all drawings.

### 2.2.3 LANGUAGE

All descriptions shall be in English except for the following drawing types where both English and Chinese descriptions shall be used if required:

- gazettal drawings;
- public consultation drawings;
- presentation drawings to the Executive Council, Legislative Council, District Councils, and authorities in Mainland China; and
- operation and maintenance drawings where specified.

### 2.2.4 COLOURS

Colour is used to identify individual elements or groups with separation. The embedded colour table provided in the Corporation's seedfile is the standard colour setting for all CADD files. The assignment of colour and weight for screened elements (e.g. topographical mapping background) shall be in colour number 250 and the weight shall not be greater than 1.

### 2.2.5 NOTES AND LEGENDS

#### 2.2.5.1 Notes Arrangement

Notes shall generally be included near the top right hand corner of the drawing. Where required, the Legends for symbols shall preferably be positioned below the drawing notes. If Notes and Legends are inevitable, they shall be superimposed onto the drawing details such as the map-base background, and such area shall be clipped with a blank / white background to ensure legibility.

### 2.2.5.2 General Notes

Where notes are extensive and to be repeated for many drawings, “Drawing(s) for General Notes” can be used to contain all the standard and common notes. Any deviation from the General Notes, if required, can be specified clearly in the Notes section of individual drawing.

Where a General Notes Drawing is used, the first note on every applicable drawing shall be written as follow:

#### 1. FOR GENERAL NOTES, REFER TO DRAWING NO. ##### ###### ####

### 2.2.5.3 Standard Legends for Consultative Type Drawings

For those Government statutory related drawings as listed below, the standard legends and symbols from the relevant authorities shall be used instead.

- **Gazettal** drawings for the Project or Contract
- **Station and Transport Integration Committee** (STIC) submission drawings
- **Safety and Security Coordinating Committee** (SSCC) submission drawings
- **Trackside Safety and Security Committee** (TSSC) submission drawings

## 2.2.6 GENERAL ARRANGEMENT DRAWING LAYOUT

All plans shall include a key location plan in the upper right corner of the drawing border; and the portion or section regarding the limits to the drawing contents should be highlighted in the key plan.

If the drawing’s content is a map-base or orientation plan, a north point / arrow should be placed at the upper-right hand corner of the plan.

### 2.2.6.1 Sections and Elevations

In general, **sections through plans** shall be taken as looking **to the left**, and **upward**.

In general, **sections through elevations** shall be taken as looking **to the left**, and **downward**.

The exceptions to this are the Rolling Stock drawings, which shall use the Third Angle Projection where applicable. For architectural drawings, the direction of

view for sections may vary to suit for the details being shown, e.g. reflected ceiling plans.

Sections (and Details) shall be numbered and tagged with the appropriate drawing(s) cross reference where required. Cranked sections should be avoided as far as possible but, where unavoidable, the section lines should not be stepped more than once step. Sections shall not be viewed or drawn at unnatural angles. Refer to Appendix C for examples.

#### **2.2.6.2    Projection**

All drawings shall be drawn in First Angle Projection with proper orientation indicated.

Third Angle Projection shall be permitted for Rolling Stock drawings.

## 2.3 CADD STANDARD FOR DRAWING PRODUCTION

### 2.3.1 FILE SETTING - FILE TYPE 2D / 3D

In general 2D design file type setting shall be used for all drawing production.

3D design file type setting shall only be used in the case of 3D objects, perspective views, 3D topography layouts or layout plans that are required to link with Government 3D map-bases.

### 2.3.2 UNITS

All units shall follow the SI convention and all linear dimensions shall be in millimetres (mm), except for the survey levels and chainages which shall be in metres (m).

#### 2.3.2.1 Working Units (CADD System)

For all MicroStation drawings, Master Units (MU) and Sub Units (SU) shall be used and have already been pre-set in the MTR-SEED.DGN file. All user-created cells should be related to these Working Units to reflect the relative proportional scale.

MU = Metres Label : m  
SU = Millimetres Label : mm

In case there is a need to overlay or match with other drawings, all elements should be drawn in full size (scale 1:1) except for drawings of Rolling Stock components.

The scale of the reference files can be adjusted to suit drawings that are required to present details in different scales. The main scale of a drawing file is used for defining the view for plotting only. In general, the plotting scale of a drawing file is equal to the reference file scale specified in the drawing title block.

#### 2.3.2.2 Decimal Point Accuracy

In dimensioning where the master unit is metres, 3 decimal point accuracy shall be used to indicate the accuracy down to millimetre; and all the 3 digits shall be listed out including all zeros, for example: 9.900m

In normal circumstances where the master unit is millimetres, no decimal point should be required. However for those Rolling Stock components drawings where the highest precision of dimension is required, accuracy to three decimal places with proper mm suffix shall be used as illustrated below:

675.326mm

### 2.3.3 GLOBAL ORIGIN

Global Origin is not required for MicroStation version V8 2004 or later.

Inevitably if drawing production shall be compatible with other parties' MicroStation versions earlier than Version 8, the Global Origin is required and shall conform to the Hong Kong Grid (1980) System by denoting the coordinates in "Northings" and "Eastings" format, which shall be applied to all the master, model, and reference drawing files for consistency. The Corporation has adopted the Global Origin as -

2147483.648, 2147483.648, 2147483.648

The global origin setting can be input in MicroStation design files by keying-in command "GO=?"

In case the Global Origin of the model or reference file is different from the master drawing file, the Coincident – World option shall be selected for the matching of their coordinates during the attach reference process.

### 2.3.4 LINE WORK

#### 2.3.4.1 Line Styles

Line styles shall follow the Corporation standard which has been set in the MTR-SEED.DGN & MTR-A1.DGN. Users can also refer the CSWP standard for more applicable line styles.

Any customized line styles initiated by Originators, such as multi-lines styles, or incorporated with texts/special graphic attributes, shall not be used without prior approval from M-CADD.

Every pair of dashed lines shall be jointed with "snap-able" point or angle.

#### 2.3.4.2 Line Thickness

Lines thicknesses and weights shall comply with the CSWP standard. The use of line style, thickness, weight and colour shall be constant throughout the whole project / contract drawings production.

### 2.3.5 TEXT AND LETTERING

#### 2.3.5.1 Lettering Orientation and Font Face

Lettering orientation shall be aligned from left to right, and from bottom to top; slanting or inclined lettering shall be avoided.

Font face should use the standard upright form. Others such as italic, embossed, or distorted font faces shall not be used.

**2.3.5.2 Placement of Texts in the CADD file**

Texts, text leaders and leader heads should be combined and placed in a separated layer (level) so as to be distinguished from the graphic elements.

**2.3.5.3 Text Sizes**

English and Chinese font faces and their sizes shall be in accordance with the CSWP. English text should be upright, uppercase lettering. All texts should be aligned as top left justified. Centre-justified text shall only be used in title-boxes.

Using of non-standard types of text sizes, fonts, and cases shall only be allowed for particular drawings for statutory, presentation, public consultation, customer related poster, media, or similar purposes.

For drawing in A1-size format, the nominal text height for any drawing notes and annotations should be 3.5mm for English text and 3.75mm for Chinese text.

**2.3.6 DIMENSIONING****2.3.6.1 Linear Dimensions**

Linear dimensions for millimetre units shall be in whole numbers, generally without decimal point except as specified in 2.3.2.2 above; and for metre unit, dimensions shall be shown in three decimal places, illustrated as follows:

millimetres  
27500      or      27500mm  
678            or      678mm

metres  
27.500      or      27.500m  
0.678        or      0.678m

Levels shall be in metre units with three decimal places, with the prefix of the positive (+) or negative (-) in respect to the HK Principal Datum specified as follows:

+27.500    or    +27.500m    or    +27.500 mPD  
+0.678      or      +0.678m      or      +0.678 mPD

**2.3.6.2 Area, Volume and Weight Measurements**

Area, volume and weight measurement shall be specified with the suffix of its unit designation such as:

<u>Square metre (Area)</u> 27500 sqm	<u>Cubic metre (Volume)</u> 27500 cum	<u>Kilogram (Weight)</u> 27500 kg
---	--	--------------------------------------

### 2.3.6.3 Dimensioning Standards

Dimensioning should be applied consistently throughout the whole drawing set. Some guidelines are given below for reference:

- a) **Dimension Orientation** shall be aligned from left to right, and from bottom to top; slanting or inclined lettering shall be avoided. If it is required to place dimension on an angle, that angle shall be aligned on the quadrant and capable of being read from normal upright orientation or looking from the right-hand side.
- b) **Dimension Text** shall be placed above the dimension line and centre-justified.
- c) **Dimension Reading** shall be the exact measured reading with the adjustment in respect of the element's scale. Any self-defined reading that does not reflect the actual element's measured dimension is not allowed.
- d) **Dimension Line** shall be a continuous line across the exact measuring length of the line segment or element to be dimensioned.
- e) **Dimension Leader Line** shall be pointed or closed to the element. Inevitably, where the leader line is required to cross another line, it can be broken at the crossing point for clarity.
- f) **Dimension Line Starting & Ending** termination shall use either arrowheads or 45° slashes throughout a drawing. The inscribed angle of arrowhead should be at 45° maximum and 15° minimum. The Corporation standard solid arrowhead, expressed as a factor of text height, is 1.0 of width and 0.5 of height.

Refer Appendix C for examples illustrating dimensioning.

### 2.3.6.4 Placement of Dimensions in CADD File

**Dimension Components** shall be placed in a separated layer (level) to distinguish them from the graphic elements.

### 2.3.7 DRAWING SCALES

Drawing scales shall be in "Metric Scale Standard", i.e. irregular scales such as 1:333, 1:150, 1:72 should not be used. The Corporation has established a common drawing scales standard as illustrated in Table 2.3.7.1 "Standard Drawing Scales" for the use of railway related industries. Any use of other drawing scales shall require prior approval from M-CADD.

The scale put in the title block shall be the master scale applied for all the elements / portions within the drawing. If the scale of an element / portion is different from the master scale, it should be specified under the title heading of such element / portion.

**2.3.7.1 Standard Drawing Scales****Table 2.3.7.1 : Standard Drawing Scales**

Drawing Type	Scale 1 :													
	5000	2000	1000	500	400	250	200	100	50	20	10	5	2	1
Location Plans	•	•	•	•										
Gazettal Drawings			•											
Site Surveys and Site Plans	•			•			•	•						
Construction Plans / Layout				•	•		•	•						
Utilities plans			•	•	•		•							
General Arrangements				•	•		•	•						
Architectural Sections and Elevations							•	•						
Architectural Detailed Plans, Sections and Elevations					•		•		•	•				
Architectural Details					•		•				•	•		
Structural Sections and Elevations				•	•		•	•						
Detailed Plans, Sections and Elevations							•	•	•					
Details										•	•	•	•	•
Engineering Plan & Profile (Horiz)			•	•										
Engineering Plan & Profile (Vert)				•		•								
Rail. Align. Plan & Profile (Horiz)	•	•												
Rail. Align. Plan & Profile (Vert)		•	•											
Steel Reinforcement Details							•	•	•			•	•	
Steelwork Details										•	•		•	•
E & M Drawings (Plan and Layout)							•	•	•	•			•	•
CSD / SEM Layouts								•	•	•				
E and M Details									•	•			•	•
Geological Maps	•	•												
Geological Cross-Section (Horiz)			•											
Geological Cross-Section (Vert)							•							
Geological Plan & Profile (Horiz)	•	•	•	•										
Geological Plan & Profile (Vert)			•	•	•									

**2.3.7.2 Graphical Scale Bar**

Graphical scale bar shall be placed in the lower right-hand corner of the drawing where applicable.

**2.3.7.3 Scale Specified in the Title Block**

Scale(s) specified in the title block should be concise and representable.

- If the drawing is required to be submitted in reduced or enlarged drawing size, then the scale shall be specified with the suffix “@(original size)”. For example, if an original A1 size drawing is to be submitted in A3 size format, it shall be specified as “1 : 500 @ A1”.
- When the drawing contents are not drawn to any scale, specify Not to Scale “NTS” in the title block.
- Where different scales should be used for horizontal and vertical vertex, such as the alignment profiles, both scales shall be specified clearly with suffix “H” for horizontal and “V” for vertical.
- If many different scales are used in a drawing and cannot be represented by a common master scale, the drawing should be specified as “AS SHOWN”.

**2.3.8 SYMBOLS****2.3.8.1 Standard Symbols**

Standard symbols shall be based on those provided by the Corporation or under the CSWP.

Where a choice of symbols is available, the Originator shall seek clarification from M-CADD on which one shall be adopted.

**2.3.8.2 Common Symbols by the Corporation**

The common symbols are illustrated in Appendix D. Other specialised symbols, such as those used for Permanent Way, Signalling & Control (S&C), Overhead Line , Rolling Stock, etc., can be supplied to the Originator where required.

**2.3.8.3 Symbols for Statutory Drawings**

For gazettal, Building Department submission, STIC, SSCC, TSSC drawings and other Statutory submissions; the use of symbols shall be in accordance with the requirements of their relevant authorities.

### 2.3.8.4 Material Symbols / Patterns

Symbols or patterns for material are used in the sectional area of a cut-section to demonstrate its generic material nature, such as block wall, reinforced concrete wall, etc. The relevant material symbol or pattern may not necessarily be filled throughout the whole sectional area as long as the material nature can be clearly expressed.

### 2.3.8.5 Special Symbols

Some special symbols are tailor-made for the use in particular disciplines / engineering trades, such as the component symbols for electronic circuitries, EMU, S&C, Traction Power and Automatic Train Control, etc. These are not yet covered in the Corporation or CSWP standards. Where use of these symbols is necessary to be compatible with trade-market, Originators can submit the required special symbols to M-CADD for “one-off” endorsement for their use on the project or contract.

All these special symbols for a specific project or contract will be recorded in the CADD Office for reference.

The Symbol (or cell) names shall be limited to six characters in accordance with the MicroStation convention. Nested cells (cells within other cells) and Multiple level cells (cells consisting of more than one level) shall be avoided.

## 2.3.9 CO-ORDINATES AND ORIENTATION

### 2.3.9.1 Co-ordinates and Levels

All co-ordinates and levels stated on drawings shall be based on the Hong Kong Grid (1980) System and Hong Kong Principal Datum respectively.

All “co-ordinate-related” drawings (both Model files and Master drawing files) shall be drawn with true co-ordinate locations based on the Hong Kong Grid (1980) System in a global co-ordinate system.

All sections and elevations in Model files shall be based on Hong Kong Principal Datum, and the 0.0mPD shall generally coincide with ‘0’ of the y-axis for 2D sections, profiles, and elevations where applicable. As far as possible, all the sections and elevations should be aligned with the same datum level for ease of reference.

Detail drawings and drawing files not directly related to the global co-ordinate system may use a local co-ordinate system.

General Arrangements and Site Plans shall incorporate either a 100m or 500m grid system in respect to the drawing scale. Annotation of northing and easting values shall also be marked on the appropriate grids.

### **2.3.9.2 Orientation**

All the key plans, site plans, and drawings containing map-bases shall maintain the map orientation as far as practical, with the “north direction” pointing upward.

For alignment drawings, orientation shall be aligned in accordance with the alignment objects and in its horizontal direction, i.e. the alignment objects such as railway tracks are placed in parallel to the x-axis.

The North point indicator shall be placed on the upper-right hand corner as far as practical.

### **2.3.10 HATCHING AND SHADING**

The use of hatching or shading shall be kept to a minimum. All hatching, shading and their boundary graphics shall be placed in a separated layer (level) so as to be distinguished from the graphic elements.

The hatching or shading shall be set in “View 1”, with the attributes setting “pattern display” and “fill display” turned on. If it is required for plotting, then the view shall be saved as the view name “PLOT”.

## **2.4 PLOTTING**

Whenever a hard copy drawing is required, it shall be plotted from the PDF drawing. Where applicable, plotting date and time shall be printed vertically outside the lower-left corner of the drawing border.

### **2.4.1 MICROSTATION PLOTTING ARRANGEMENT**

Some plotting requirements are listed as follows:

- Always place a “Rectangular FENCE” to the desired plotting portion as the plot-limit.
- Colour plots shall follow the colour setting in the Corporation colour table.
- Display attributes settings should be verified prior the plotting, such as data fields: [off]; constructions: [off]; text-nodes: [off]; fast-font: [off]; etc.
- To enable the retrieval of plotting details and boundary more quickly, these can be saved as view name “PLOT” in View 1 for ease of reference.
- When batch plotting is required, a cell “PLTBA1” can be included in the Corporation title block.

## **2.5 REVISIONS**

### **2.5.1 REVISION CLOUDS AND TRIANGLES**

Any revised / amended portions of a drawing shall be fenced with a cloud for easy recognition of the changes. In addition, the latest sequential revision code shall be put in an equilateral triangle to be placed adjacent to the revision cloud for identification.

Only the latest revision clouds with their corresponding revision code shall be shown in the drawing content area.

## 2.5.2 REVISION DESCRIPTION

A concise description of each approved and issued revision, i.e. Rev. A, Rev. B, etc. shall be entered into the revision-description column to record the development history of the drawing. The revision date, designation of the originator and the responsible person (to approve this revision) shall also be stated.

When there is no space to enter the current revision information, the earliest revision descriptions can be superseded by the latest updated revision.

## 2.6 DRAWING TITLE BLOCKS AND SIGNATURES

### 2.6.1 DRAWING TITLE BLOCK

The Drawing number and title shall be prominently displayed within the appropriate boxes. Revision box is piled up at the bottom left-hand side of the title block. A standard Corporation title block is illustrated as follows:

**Figure 2.6.1 : Example of a Drawing Title Block**

REV	DESCRIPTION			BY	DATE	APPROVED	A -	--- DD/MM/YY ---
REV	DESCRIPTION			BY	DATE	APPROVED		

DRAWN	---	 <b>MTR</b> <small>ORIGINATOR</small> WEST ISLAND LINE PROJECTS DIVISION   PROJECT ENGINEERING DEPARTMENT
DESIGNED	---	
CHECKED	---	
APPROVED	---	
DATE	DD/MM/YYYY	
<small>DO NOT SCALE DRAWINGS. ALL DIMENSIONS SHALL BE  VERIFIED ON SITE.  COPYRIGHT © MTR CORPORATION LIMITED 2008. COPYRIGHT IN  RESPECT OF THIS DRAWING / DOCUMENT IS OWNED BY THE  MTR CORPORATION LIMITED OF HONG KONG. NO  REPRODUCTION OR TRANSFER OF THIS DRAWING / DOCUMENT OR ANY PART  OF IT, WHATEVER THE MEANS IS PERMITTED WITHOUT THE PRIOR  WRITTEN CONSENT OF THE MTR CORPORATION LIMITED.</small>		
CADD REF. XXXXXX_X_XXX_XXX_XXX_NNNA.DGN		

<small>TITLE CONTRACT NO./TITLE TITLE LINE 2 DETAILS DETAILS DETAILS</small>		
		SCALE 1 : ___ (A1)

### 2.6.1.1 Drawing Title

The drawing title consists of five lines of left-justified data fields as follows:

- The first line shall be the project / contract number and its title, or the reference heading of the Standard, Directive drawings, or In-House design modification works.
- The second line shall be the respective area, section, location, portion or subject for this drawing. If none is applicable, this line shall be left blank.
- The third line shall be the type of drawing such as Architectural Layout, Sections & Elevations, HVAC Arrangement, Alignment Profile, etc.
- The fourth and the fifth line shall be the detailed correspondences under the above subjects. Where drawings are required to be grouped in series, the 5<sup>th</sup> line should specify the consecutive sheet number and total sheet number, for example “SHEET 1 OF 5”.

### 2.6.1.2 Other Parts of the Title Block

Other parts of the title block shall be filled up as follows:

- The Scale shall provide the relevant scale of the drawing (refer Section 2.3.7.3 for details).
- The Drawing No. and Rev. refers to the identification of this drawing (refer Section 3 for details).
- The project title or the title of the A&A / C&R Works shall be filled in the box which is located beneath the MTR Logo.
- The Originator box is provided for the users to specify their identity such as Company name and logo or In-House Department / Section, etc. In some cases box may contain the cross-reference drawing no. of the originator (refer Section 3 for details).
- The CADD Ref. is the CADD file name for this drawing (refer Section 3 for details).
- The Designed, Drawn, Checked and Approved box data fields shall be filled in with the initials of the responsible person for the works.
- For entrusted works, Government Submission or Statutory drawings, the title block arrangement shall be altered to meet the requirement of the respective Authority.
- The date shall be in year 2000 compliance format – either DD/MMM/YYYY (02/DEC/2007) or DDMMYY (02DEC08). The abbreviation of months shall be followed as below:

Month	January	February	March	April	May	June	July	August	September	October	November	December
Abbreviation	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC

## 2.6.2 SIGNATURES

### 2.6.2.1 Digital Signatures

For projects that adopt the “Digital Signatures” for drawings authorization:

- **Official Copies** refers to the electronic CADD drawing instead of the hardcopy prints.
- **Checked or Approved** indicates that such drawing has been digitally signed.

### 2.6.2.2 Signatures for Hardcopy Drawings

All the initial and subsequent revisions of a drawing shall bear the hand-written signatures of the checker and approver of such drawings wherever applicable. For interim release of drawings prior to finalizing a revision, no signatures on hardcopies are required but shall be certified according to MTR Project Integrated Management System (PIMS) – Design Management Techniques and Design Checks. The **Checked** and **Approved** boxes of the drawing Title Block, and the **By** and **Approved** boxes of the Drawing Revision columns in CADD files and hard copies shall be completed as follows :

- **CADD Files** shall be filled in with the names or initials of the authorised persons;
- **Hard Copies** for formal drawings deliverables or submissions shall have the hand-written signatures of the authorised persons.

In subsequent revision of the same drawing, the hand-written signatures of the previous revision would then be substituted by the CADD text of their initials, and hand-written signatures shall be signed for the latest revision accordingly. The general requirements are summarised as follows:

**Table 2.6.2.2 : Signature Requirements**

Signing Box	CADD FILE	HARD COPY
<b>TITLE BLOCK</b>		
DESIGNED	CADD Initials	CADD Initials
DRAWN	CADD Initials	CADD Initials
CHECKED	CADD Initials	CADD Initials + Signature (1 <sup>st</sup> issue only)
APPROVED	CADD Initials	CADD Initials + Signature (1 <sup>st</sup> issue only)
<b>REVISION BOX</b>		
BY	Drawer's CADD Initials	Drawer's CADD Initials
APPROVED	Approver's CADD Initials	Approver's CADD Initials + Signature (current issue only)

**2.6.2.3 List of Certified Persons of Project**

The Project Contractor shall provide the Corporation with a list of persons who are authorized to check and approve drawings. The list shall consist of typed name and initials for each certified person together with their specimen signatures as shown in the following example:

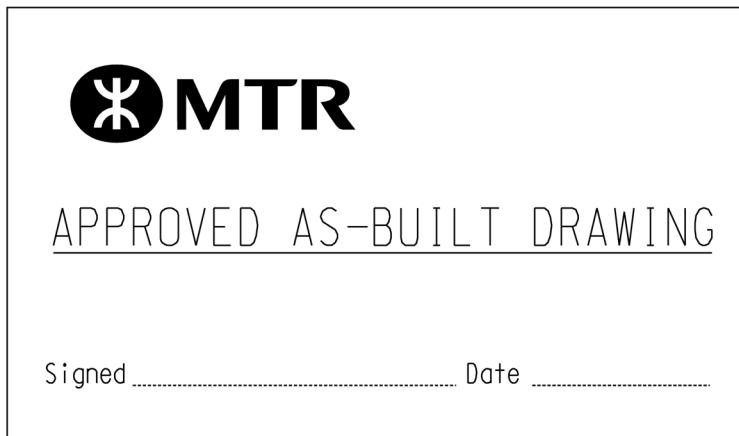
Initials	Name	Signatures
ANA	A.N. Approver	 

In the event that the certified person is not present in Hong Kong, the Hong Kong office shall nominate a representative to sign for the certified person. Such nomination shall be addressed to the Corporation in writing together with the nominated representative's particulars and signatures as specified above.

**2.6.2.4 Additional Signature for As-built Drawing**

As-built drawing shall be labeled with an "APPROVED AS-BUILT DRAWING" stamp signed by MTR authorised approver, preferably at the lower right hand corner of the drawing. The signature shall be scanned and attached to the CADD file.

**Figure 2.6.2.4 : Sample of the stamp (embedded in "MTR-A1.DGN")**



**END OF SECTION 2**

### 3. DRAWING IDENTIFIER CODING

#### 3.1 DRAWING NUMBERING

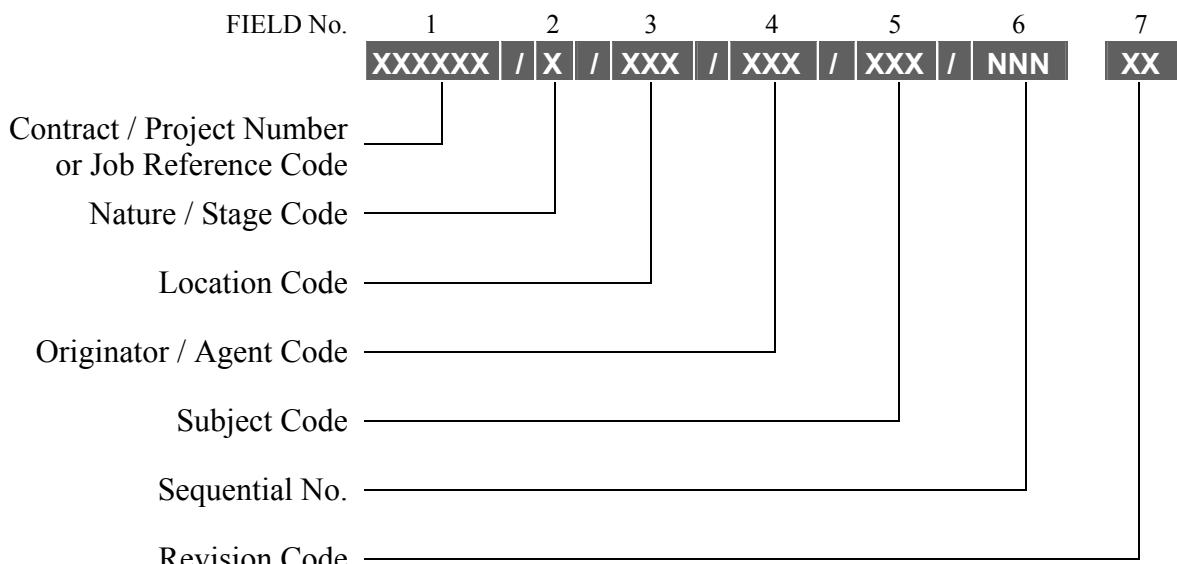
Drawing numbering establishes the unique identity for the production of individual drawings without duplication.

Exceptional cases shall be noted for Government Statutory drawings :

- **Lands, Transport Department and Gazettal Drawing, etc.** – the Originator shall seek the direction from the respective Authorities on the appropriate numbering to be adopted.
- **STIC, SSCC, and TSSC Submissions** – the drawing numbering arrangement shall comply with the requirement from the respective Board Committee. Temporary drawing numbers may be required until the finalised drawings numbering arrangement have been confirmed.

##### 3.1.1 DRAWING NUMBERING CONVENTION

All drawings and sketches shall each be assigned a unique number, which shall comply with the convention specified below :



Where :    X = Alphanumeric character  
                   N = Numeric value

### 3.1.2 DRAWING NUMBER - CODES DEFINITION

#### 3.1.2.1 Project Number / Job Reference Code (*Field 1*)

This code is the first field of the drawing number, which consists of maximum 25-alphanumeric characters. This shall be assigned from the Originator's own Project / Contract number or Job Reference Code from the In-House Design teams; and shall be approved by M-CADD. Any hyphens within the Contract Number / Job Reference shall be omitted from this drawing number field.

#### 3.1.2.2 Nature / Stage Code (*Field 2*)

The Nature code defines the project status of the drawing and shall be incorporated into the "Nature / Stage" code of the drawing number. The definition of stage codes are summarized as follows :

Stage / Nature	Code
Sketch	K
Feasibility study, conceptual design, indicative design, standard design, standard detail drawings	S
Model files	M
Statutory Submission	B
Pre-Tender design stage drawings	P
Tender drawings	T
Consultant or Contractor drawings	C
Construction stage working drawings	W
As-built drawing	Z

##### (i) Sketch (K)

- Conceptual drawings for the use in preliminary design
- General sketches for draft purposes
- Drawings that are produced before the adoption of the drawing requirements, standards or numbering, etc.
- Drawings that are not stated in the Schedule of Design be the Office Drawings

##### (ii) Feasibility Study (S)

- Drawings that are prepared during the feasibility, design and consultation stage
- Preliminary drawings that are produced for consultants and upon which the consultants will base their further designs or development
- General presentation and public consultation drawings

**(iii) Model Files (M)**

- Model or reference files used for drawing production

**(iv) Statutory Submission (B)**

- Gazettal drawings
- STIC, SSCC, TSSC submission drawings
- Transport Department submission
- Building Department submission
- Lands Department submission
- Fire Services submission

**(v) Pre-Tender (P)**

- Drawings that are prepared during the pre-tender design stages prior to issue for tendering

**(vi) Tender (T)**

- Drawings that are prepared for the issues of tendering or quotation.

**(vii) Consultant or Contractor Drawings (C)**

- Drawings prepared by the Project consultants, or design drawings prepared by ‘design and build’ contractors or works contractors

**(viii) Construction / Working (W)**

- Drawings that are issued for the execution (commencement) of the works
- Drawings to be used during the entire construction period
- Drawings that are prepared by ‘design and build’ contractors, which are being issued for the construction, manufacturing or installation

**(ix) As-Built (Z)**

- Drawings representing the as-constructed, as-built, or as-installed project

The revision of the first issue of as-built drawings shall be designated as “A” with the revision description stated as “As-Constructed” or “As-Built”. All the revision clouds and codes shall also be removed.

**3.1.2.3 Location Code (*Field 3*)**

This 3-alphanumeric characters identifies the geographical location of the works shown on the drawing. It represents the individual station, stop, auxiliary building, or a segment of the railway line within the entire Corporation premises.

Where in doubt, the Originator shall consult M-CADD to select the most appropriate codes. Refer to Section 5.1 of the Coding Reference Tables on the selection of coding.

Originators can propose new location codes for the new Railway Line Projects and shall seek the approval from M-CADD. Subsequent to the completion of the Project, such new location codes would be reviewed by M-CADD and respective line managers from Operations and Engineering. If the new coding is deemed to be applicable and beneficial to the Corporation, it will be adopted and appended to this Drawing & CADD Manual.

In some instances, location codes adopted during the Project stages may be totally changed after the Project completion to suit the operational needs.

#### **3.1.2.4 Originator / Agent Code (*Field 4*)**

This 3-alphanumeric characters identifies the liable initiator's company, organization or agency of this drawing. In most cases it represents the consultant / architect / contractor who is responsible in the design and production of this drawing.

This code is referred to as the "Agent Code", which shall be assigned in accordance with the list of "Agent Responsible Codes (ARC)" published as part of the CSWP.

Originators can propose new originator codes where the ARC is not applicable, and shall seek the approval from M-CADD. If the new coding is deemed to be applicable and beneficial to the Corporation, it will be adopted and appended to this Drawing & CADD Manual.

#### **3.1.2.5 Subject Code (*Field 5*)**

This code is composed of 3-alphanumeric characters in matrix format, and is used for the identification of the works systems and sub-system hierarchy of the drawing concerned, i.e. the engineering discipline of the drawing. The first character denotes the Subject / System Group. Refer to Section 5.2 of the Coding Reference Tables Section for the appropriate coding designation.

The Originator can propose new Subject codes using those alphanumeric characters that have not yet been assigned in the tables of Section 5.2, and shall submit the proposal to M-CADD for approval and record.

Subject to the review by M-CADD and corresponding line managers, if the new coding is deemed to be applicable and beneficial to the Corporation, it will be adopted and appended to this Drawing & CADD Manual.

**3.1.2.6 Sequential Number (Field 6)**

This 3-digit code consists of a drawing sequence number to be assigned by the Originator. The sequence numbering shall be planned in a logical manner. In general, the sequential numbering shall start from 001.

**3.1.2.7 Revision Code (up to 2 characters) (Field 7)**

This code identifies the version after each revision of the drawing. In general it is a 1-alphabetic code unless an interim release identifier is required.

**3.1.3 REVISION CODING DEFINITION**

The revision for the first issue of a drawing shall be "A"; and its subsequent revisions shall be in alphabetical sequence, i.e. "B", "C", etc.

After the "Z" revision, the coding shall restart by adding a second letter prefix starting from "A"; e.g. "AA", "AB", etc. Accordingly, after the "AZ" revision, a new cycle will start from "BA", "BB", etc..

(Note: numeric digits shall not be used in revision coding except for interim release revision as described in 3.1.3.1.)

**3.1.3.1 Revision Code for Interim Releases**

Prior to finalizing a revision, a drawing will typically go through several amendment and verification cycles (such as the advance check prints, working drafts, etc). Hence, a numeric suffix will be appended to that revision for version control and release distinction.

For example, interim releases such as B1, B2 and B3, etc. will be used for version reference during the development period until the drawing has been formalized to revision B. After then, all the interim revisions, and their respective descriptions, triangles and clouds shall be removed from the drawing.

**3.2 DRAWING FILE NAME****3.2.1 DRAWING FILE NAME CONVENTION (CADD REF.)**

The file naming convention shall correspond to the drawing number, except that the individual codes shall be separated by an underscore instead of "/", and shall not have an underscore or space in-between the sequential no. and the revision character(s) as illustrated below :-

**XXXXXX\_X\_XXX\_XXX\_XXX\_NNNX.DGN**

If the revision is having 2 characters :-

**XXXXXX\_X\_XXX\_XXX\_XXX\_NNNXX.DGN**

### 3.2.2 DRAWING FILE NAME EXAMPLES

The example below illustrates the relationship between the drawing numbering and file naming convention.

Drawing No.	File Name	Explanation
KSL233/Z/NAC/MTR/A12/005A	KSL233_Z_NAC_MTR_A12_005A.dgn	Project KSL233, as-built, Nam Cheong Station, originated by MTR, Architectural GA Plan, the landscape detail of 005 <sup>th</sup> , revision A

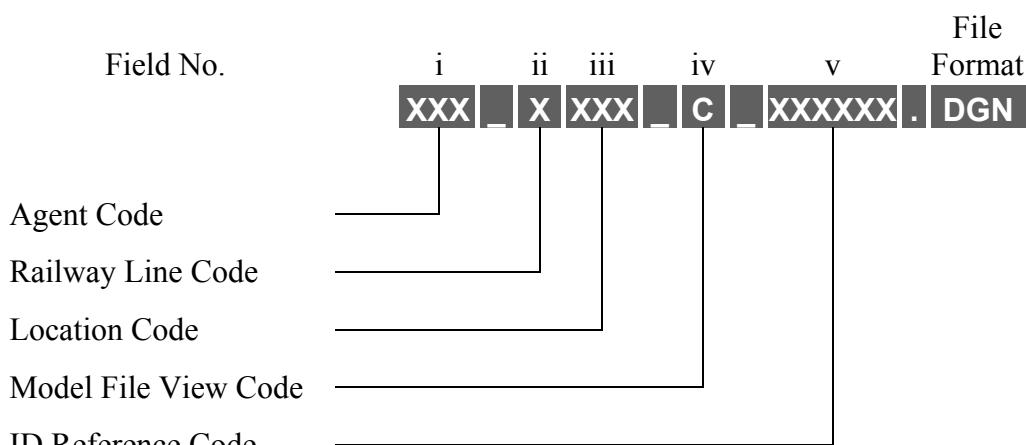
## 3.3 MODEL FILE NAMING

### 3.3.1 MODEL FILES

Model file names have their own file name format that is different from the standard drawing numbering. Version control and revision history shall be recorded inside the model file.

### 3.3.2 MODEL FILE NAMING CONVENTIONS

Model files shall be numbered in accordance with the convention as specified below.



Where :    X = Alphanumeric character  
                  C = Alphabetic character

### 3.3.3 MODEL FILE NAME CODES

#### 3.3.3.1 Agent Code (*Field i*)

This code identifies the initiator's company, organization or agency. The Agent code shall be assigned in accordance with the list of "Agent Responsible Codes (ARC)", which are published as part of the CSWP.

### 3.3.3.2 Railway Line Code (*Field ii*)

This code identifies the railway line of the model file concerned as illustrated below:

<b>Code</b>	<b>View Description</b>
0	General
A	Airport Express Line
B	<i>South Island Line (New railway line under planning)</i>
C	<i>Sha Tin Central Link (New railway line under planning)</i>
D	Disneyland Resort Line
E	East Rail Line
H	<i>North Island Link (New railway line under planning)</i>
I	Island Line
K	Kwun Tong Line
L	Light Rail
M	Ma On Shan Line
N	<i>West Island Line (New railway line under planning)</i>
O	<i>Northern Link (New railway line under planning)</i>
R	<i>Lantau, &amp; Airport Railway 2 (New railway line under planning)</i>
S	Tsuen Wan Line
T	Tseung Kwan O Line
U	Tung Chung Line
W	West Rail Line
X	<i>Express Rail Link (New railway line under planning)</i>
Y	<i>Kwun Tong Line Extension (New railway line under planning)</i>

### 3.3.3.3 Location Code (*Field iii*)

This code identifies the geographical location of the model file concerned. Refer to Section 5.1 for the detailed coding reference of the location codes.

### 3.3.3.4 Model File View Code (*Field iv*)

This code identifies the drawing view of the model file as illustrated below:

<b>Code</b>	<b>View Description</b>
A	Artistic, presentation, perspective etc.
C	Schematic
D	Detail
E	Elevation
I	Isometric
L	Line diagram (including block diagram, circuit diagram, flow diagram, etc.)
P	Plan
S	Section

### 3.3.3.5 ID Reference Code (*Field v*)

This is a user-define coding for the Originator's reference. It shall not be less than 4 or more than 8-alphanumeric characters.

### 3.3.4 MODEL FILE NAME EXAMPLES

Originator shall ensure the assigned Model file names are in good sequence and without any duplication. Examples are illustrated as below:

File Name	Remarks
MTR_ISKW_P_CFGA02.DGN	Refers to a general arrangement(GA) plan (P) of the concourse floor (CF) at Shau Kei Wan Station (SKW) of Island Line (I) railway line, as created by the Corporation (MTR).
MTR_WNAC_C_TELCCTV5.DGN	Refers to a schematic drawing (C) for the CCTV subsystem of the telecommunications system for Nam Cheong Station (NAC) of West Rail (W) railway line, as created by the Corporation (MTR).

### 3.3.5 OTHER TITLE BLOCK ATTRIBUTES

#### 3.3.5.1 Originator (Originator Ref.)

Where necessary the Originator box can be filled in with the originator reference attributes, such as the source drawing no. and revision from which this drawing is referenced. For example, for Rolling Stock drawings, this will be put in the manufacturer component reference for the ease of traceability.

**END OF SECTION 3**

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## **4. CADD LAYER CODING**

### **4.1 DRAWING FILE LAYERING**

#### **4.1.1 LAYER ASSIGNMENT**

Some requirements on the assigning layers (levels) to the drawing and model files are specified as follows:

- 1) Layers shall be separated from the graphics elements.
  - The text layer;
  - The dimension layer including the texts, dimension lines, leaders and arrowheads, etc.
- 2) All the layers coding shall be in accordance with the Element Coding section of CSWP.
- 3) Levels nos. and names shall maintain consistency through out the whole project, contract or drawing set.
- 4) If the user definable suffix code is required, the Originator shall submit the user-assigned coding to M-CADD for endorsement and attached it as part of the Drawing Issue for reference.

#### **4.1.2 LAYERS PER DRAWING FILE**

There is no limitation on the quantity of layers that can be used per CADD drawing file.

#### **4.1.3 TYPICAL LAYERS FOR DRAWING FILE**

The Corporation standard layers shall be reserved and be used for every drawing as illustrated in the Section 4.2.3.

#### **4.1.4 LAYERS COMPATIBLE WITH OLD VERSION MICROSTATION**

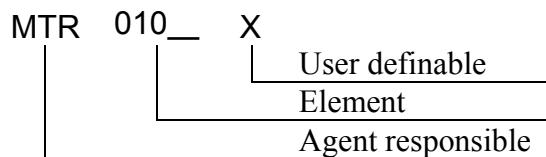
If a new drawing is required to be compatible with another MicroStation drawing that is earlier than version 8; that drawing shall not contain more than 63 layers, such that their layers can be directly matched up for copying or transfer data.

## **4.2 LAYERS CODING**

### **4.2.1 LAYER NAMING**

MicroStation layer names (levels) shall be assigned in accordance with the CSWP layer naming convention as follows:

Agent Responsible Code (ARC) + Element + User definable



The Agent Responsible code and the Element code can be obtained from the latest version of CSWP.

It applies to all drawings production related to the external parties such as Government Departments, Consultants and other companies.

#### 4.2.2 LAYER NAMING FOR IN-HOUSE DRAWINGS

For Corporation in-house drawing production, it is not necessary to include the “Agent Responsible Code”, i.e. the first field shall be deleted :-

“MTR010\_” → “010\_”

#### 4.2.3 TYPICAL CORPORATION LAYERS CODING

Below is the typical Corporation layers coding matching table. It matches up the “Level No.” of MicroStation earlier than V8 with the latest MicroStation version 8 Level Nos., in accordance with the layering standard of CSWP.

MicroStation before V8	MicroStation V8 (CSWP Layering Standard)		Typical Layers for Corporation
Level No.	Level No.	Level Name	Description
1	1	010_	Titles and Frames (Grouped)
2	2	012_	Drawing Number
3	3	013_	Drawing Title
:	:	:	:
:	:	:	:
60	60	071_	Current revision clouds & marks
61	61	073_	<i>Not Plotted</i>
62	62	082_	File data sheet (if applicable) <i>Not Plotted</i>
63	63	081_	User draft records (construction line and reference clip boundary) <i>Not Plotted</i>

**END OF SECTION 4**

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## 5. CODING REFERENCE TABLES

### 5.1 LOCATION CODE TABLE

Abbrev. Code	Station / Building Name	Station / Building Name (Chinese)	Line (Abbrev.)	Station Line (Chinese)
000	System-wide Location			
201	QUB Overrun		KTL	
202	QVB to QUB Both		KTL	
203	CVB to QVB Both		KTL	
204	LAT to CVB Both		KTL	
205	KWT to LAT Both and all		KTL	
206	NTK to KWT Both and all		KTL	
207	KOB to NTK Both		KTL	
208	KBD Arrival, Departure & Reception Tracks,		KTL	
209	CHH to KOB Both and all		KTL	
210	DIH to CHH Both and all		KTL	
211	WTS to DIH Both		KTL	
212	LOF to WTS Both		KTL	
213	KOT to LOF Both		KTL	
214	SKM to KOT Both		KTL	
215	PRE to SKM Both and all		KTL	
216	MOK to PRE Both KWT Line		KTL	
217	YMT to MOK Both and all KWT Line		KTL	
218	YMT Overrun		KTL	
219	TSW Headshunts Both and all		TWL	
220	TWD Reception Tracks Both		TWL	
221	TWH to TSW Both		TWL	
222	KWH to TWH Both and all		TWL	
223	KWF to KWH Both		TWL	
224	LAK to KWF Both		TWL	
225	MEF to LAK Both and all		TWL	
226	LCK to MEF Both		TWL	
227	CSW to LCK Both		TWL	
228	SSP to CSW Both		TWL	
229	PRE to SSP Both		TWL	
230	MOK to PRE Both TSW Line		TWL	
231	MOK Upper Level Interlocking Area		TWL	
232	MOK Lower Level Interlocking Area		TWL	
233	YMT to MOK Both TSW Line		TWL	
234	JOR to YMT Both		TWL	
235	TST to JOR Both and all		TWL	
236	NVB to TST Both		TWL	
237	SVB to NVB Both (Immersed Tube)		TWL	
238	ADM to SVB Both		TWL	
239	ADM to CEN Sidings Both and all		TWL	
240	CEN to ADM Both and all TSW Line		TWL	
241	CEN Overrun		TWL	
242	CHW Overrun		ISL	
243	HFC to CHW Both and all		ISL	
244	CWD Reception Tracks		ISL	
245	SKW to HFC Both		ISL	
246	SWH to SKW Both		ISL	
247	TAK to SWH Both and all		ISL	

Abbrev. Code	Station / Building Name	Station / Building Name (Chinese)	Line (Abbrev.)	Station Line (Chinese)
248	QUB to TAK Both and all		ISL	
249	NOP to QUB Both		ISL	
250	FOH to NOP Both		ISL	
251	TIH to FOH Both		ISL	
252	CAB to TIH Both		ISL	
253	WAC to CAB Both and all		ISL	
254	ADM to WAC Both		ISL	
255	CEN to ADM Both Island Lind		ISL	
256	ADM Upper and Lower Level Interlocking Area		ISL	
257	SHW to CEN Both		ISL	
258	SHW Overrun		ISL	
261	AIR to AWE and both		LAL	
262	AIR to TUC and both		LAL	
263	TUC Overrun		LAL	
264	TUC to TSY and both (Rambler Channel Bridge)		LAL	
266	SUN to TSY and both		LAL	
267	TUC to SUN and both		LAL	
268	TSY to LAK and both		LAL	
269	LAK to OLY and both		LAL	
272	OLY to KOW and both		LAL	
273	KOW to HOK and both (Western Immersed		LAL	
274	HOK overrun		LAL	
287	POA Overrun		TKL	
288	POA to HAH and both		TKL	
289	HAH to TKO and both		TKL	
290	TKO to TIK and both		TKL	
291	TIK to YAT and both		TKL	
292	YAT to QVB and both		TKL	
293	YAT to LAT and both		TKL	
294	QVB to QUB and both (obsolete)		TKL	
295	TKO to TKS/TKD and both		TKL	
296	NOP Overrun		TKL	
*300~399	Reserved for Railway Extension Projects use			
501	Telford Gardens		KTL	
502	Telford Centre		KTL	
503	Luk Yeung Sun Chuen		TWL	
504	Luk Yeung Sun Chuen - Shopping Arcade		TWL	
505	New Kwai Fong Gardens		TWL	
506	Admiralty Centre		ISL	
507	World Wide House		KTL	
508	Fairmont House		ISL	
509	Hongway Garden		ISL	
510	Southorn Garden		ISL	
511	Kornhill		ISL	
512	Kornhill Gardens (PSPS)		ISL	
513	Fortress Metro Tower		ISL	
514	Felicity Garden		ISL	
515	Heng Fa Chuen		ISL	
516	Heng Fa Chuen - Shopping Centre		ISL	
517	Heng Fa Chuen - Club		ISL	
518	Perfect Mount Gardens		ISL	
519	Service Duct (Luk Yeung Sun Chuen)		ISL	
ADD	Admiralty Distribution Substation	金鐘配電分站	ISL	
ADM	Admiralty Station	金鐘	ISL/TWL	港島/荃灣綫

Abbrev. Code	Station / Building Name	Station / Building Name (Chinese)	Line (Abbrev.)	Station Line (Chinese)
AEL	Airport Express Line	機場快綫	AEL	機場快綫
AFF	Affluence	澤豐	LRL	輕鐵
AIR	Airport Station	機場	AEL	機場快綫
AUS	Austin Station	柯士甸	WRL	西鐵綫
AWE	AsiaWorld-Expo Station	博覽館	AEL	機場快綫
BAL	BaiShiLong	白石龍	SZ4	深圳4綫
BUT	Butterfly	蝴蝶	LRL	輕鐵
CAB	Causeway Bay Station	銅鑼灣	ISL	港島綫
CEN	Central Station	中環	ISL/TWL	港島/荃灣綫
CHC	Ching Chung	青松	LRL	輕鐵
CHE	Chestwood	翠湖	LRL	輕鐵
CHF	Chung Fu	頌富	LRL	輕鐵
CHH	Choi Hung Station	彩虹	KTL	觀塘綫
CHT	Chek Lap Kok Traction Substation	赤鱲角牽引配電站	LAL	
CHW	Chai Wan Station	柴灣	ISL	港島綫
CIO	City One Station	第一城	MOL	馬鞍山綫
CKP	Cha Kwo Ling Portal	茶果嶺隧道口	KTL	
CKT	Che Kung Temple Station	車公廟	MOL	馬鞍山綫
CKV	Chai Wan Kok Ventilation Building		WRL	
CLP	Citylink Plaza	連城廣場	EAL	
CRP	Central Refrigeration Plant	中央製冷廠	TWL	
CSP	Choi Shek Portal Ventilation Building	彩石隧道口	KTL	
CST	Cheung Sha Wan Traction Substation	長沙灣牽引配電站	TWL	
CSW	Cheung Sha Wan Station	長沙灣	TWL	荃灣綫
CTV	Chau Tau Ventilation Building		EAL	
CUT	Chung Uk Tsuen	鍾屋村	LRL	輕鐵
CVB	Cha Kwo Ling Ventilation Building	茶果嶺通風樓	KTL	
CWD	Chai Wan Depot	柴灣車廠	ISL	
CWV	Chai Wan Portal Ventilation Building	柴灣隧道口通風樓	ISL	
CYB	Choy Yee Bridge	蔡意橋	LRL	輕鐵
DIH	Diamond Hill Station	鑽石山	KTL	觀塘綫
DIS	Disneyland Resort Station	迪士尼	DRL	迪士尼綫
DRL	Disneyland Resort Line	迪士尼綫	DRL	迪士尼綫
E01	Ho Man Tin Feeder Station		EAL	
E02	Tai Wai Feeder Station		MOL	
E03	Tai Po Kau Track Section Cabin		EAL	
E04	Fanling Track Section Cabin		EAL	
E05	City One Track Section Cabin		MOL	
E06	Wu Kai Sha Track Section Cabin		MOL	
EA1	LMC Emergency Access Point 1		EAL	
EA2	LMC Emergency Access Point 2		EAL	
EA3	LMC Emergency Access Point 3		EAL	
EA4	LMC Emergency Access Point 4		EAL	
EA5	LMC Emergency Access Point 5		EAL	
EA6	LMC Emergency Access Point 6		EAL	
EA7	LMC Emergency Access Point 7		EAL	
EAL	East Rail Line	東鐵綫	EAL	東鐵綫
ELT	East Lantau Tunnel (East) Traction Substation	東大嶼山隧道牽引配電站	LAL	
ELV	East Lantau Tunnel (West) Ventilation Building	東大嶼山隧道通風樓	LAL	
EPV	East Portal Ventilation Building-KWH	東隧道口通風樓	TWL	
ERL	East Rail Lines (EAL + MOL + LMC + KSL)	東鐵綫	ERL	東鐵綫
ETS	East Tsim Sha Tsui Station	尖東	EAL	東鐵綫
F01	Kwai Fong Feeder Station		WRL	
F02	Tin Shui Wai Feeder Station		WRL	

Abbrev. Code	Station / Building Name	Station / Building Name (Chinese)	Line (Abbrev.)	Station Line (Chinese)
F03	Ho Pui Track Section Cabin		WRL	
F04	Pat Heung Maint. Cen. Track Sect. Cabin		WRL	
F05	Tuen Mun Track Section Cabin		WRL	
FAN	Fanling Station	粉嶺	EAL	東鐵綫
FBD	MTR Fo Tan Bus Depot	港鐵火炭巴士廠	EAL	
FEP	Ferry Pier Terminus	屯門碼頭	LRL	輕鐵
FHO	MTR Freight Head Office	港鐵貨運總辦事處	EAL	
FNR	Fung Nin Road	豐年路	LRL	輕鐵
FOB	MTR Freight Operations Building	港鐵貨運調度大樓	EAL	
FOH	Fortress Hill Station	炮台山	ISL	港島綫
FOT	Fo Tan Station	火炭	EAL	東鐵綫
FRH	Fo Tan Railway House (formerly KCRC House)	火炭鐵路大樓	EAL	
FTF	MTR Fo Tan Freight Terminal	港鐵火炭貨場	EAL	
FUM	FuMin	福民	SZ4	深圳4綫
FUT	Fung Tei	鳳地	LRL	輕鐵
GAR	Gascoigne Rd. Traction	加士居道牽引配電站	TWL	
GIN	Ginza	銀座	LRL	輕鐵
GOG	Goodview Garden	豐景園	LRL	輕鐵
HAH	Hang Hau Station	坑口	TKL	將軍澳綫
HBD	MTR Hung Shui Kiu Bus Depot	港鐵洪水橋巴士廠		
HEO	Heng On Station	恒安	MOL	馬鞍山綫
HFC	Heng Fa Chuen Station	杏花邨	ISL	港島綫
HFT	Hoh Fok Tong	何福堂	LRL	輕鐵
HHB	MTR Hung Hom Building	港鐵紅磡大樓	EAL	
HHF	MTR Hung Hom Freight Terminal	港鐵紅磡貨場	EAL	
HHI	Hang Hau Passenger Transport Interchange	坑口運輸交匯處	TKL	
HHR	Hammer Hill Road Ventilation Building	斧山道通風樓	KTL	
HIC	Hong Kong Cooling Water Intake for Station	香港海水泵房	LAL	
HID	Hong Kong Cooling Water Intake for	香港海水泵房	LAL	
HLR	Hong Lok Road	康樂路	LRL	輕鐵
HMT	Hang Mei Tsuen	坑尾村	LRL	輕鐵
HOK	Hong Kong Station	香港	AEL/TCL	機場/東涌綫
HOK2	Hong Kong Station Phase 2 (Project)			
HOS	HongShan	紅山	SZ4	深圳4綫
HOT	Ho Tin	河田	LRL	輕鐵
HPB	Hong Kong Power Supply Building	香港供電大樓	LAL	
HPE	Ho Pui Electric Substation		WRL	
HPV	Ho Pui Ventilation Building		WRL	
HSC	Hung Hom Station Car Park	紅磡站停車場	EAL	
HSK	Hung Shui Kiu	洪水橋	LRL	輕鐵
HTD	MTR Ho Tung Lau Depot	港鐵何東樓車廠	EAL	
HTR	Hung Tin Road Emergency Platform	洪天路	LRL	
HTT	Tunnel (Hung Hom to East Tsim Sha Tsui)		EAL	
HUG	HuangGang	皇崗	SZ4	深圳4綫
HUH	Hung Hom Station	紅磡	EAL	東鐵綫
HUV	Hung Hom Ventilation Building	紅磡通風樓	EAL	東鐵綫
HVB	Hong Kong Vent. Building with Traction	香港通風樓及牽引配電站	LAL	
HZZ	HuiZhanZhongXin	會展中心	SZ4	深圳4綫
ISL	Island Line	港島綫	ISL	港島綫
JOR	Jordan Station	佐敦	TWL	荃灣綫
KAF	Kwai Fong Ancillary Building		WRL	
KBD	Kowloon Bay Depot	九龍灣車廠	KTL	
KDC	Kwai Fong Distribution Centre	葵芳配電中心	TWL	
KEL	Kei Lun	麒麟	LRL	輕鐵

Abbrev. Code	Station / Building Name	Station / Building Name (Chinese)	Line (Abbrev.)	Station Line (Chinese)
KIC	Kowloon Cooling Water Intake for Station	九龍海水泵房	LAL	
KIO	Kin On	建安	LRL	輕鐵
KIS	Kin Sang	建生	LRL	輕鐵
KOB	Kowloon Bay Station	九龍灣	KTL	觀塘綫
KOT	Kowloon Tong Station	九龍塘	KTL/EAL	觀塘/東鐵綫
KOV	Kowloon Tong Ventilation Building	九龍塘通風樓	EAL	東鐵綫
KOW	Kowloon Station	九龍	AEL/TCL	機場/東涌綫
KSL	Kowloon Southern Link ( Project)	九龍南綫	EAL	東鐵綫
KSR	Kam Sheung Road Station	錦上路	WRL	西鐵綫
KST	Kwai Tsing Tunnel		WRL	
KTB	MTR Kam Tin Building (formerly West Rail)	港鐵錦田大樓	WRL	
KTE	Kwun Tong Line Extension (Project)			
KTL	Kwun Tong Line	觀塘綫	KTL	觀塘綫
KT <sub>T</sub>	Kai Tin Traction Substation/Kai Tin Portal	啓田牽引配電站	KTL	
KVB	Kowloon Vent. Building with Traction Substation	九龍通風樓及牽引配電站	LAL	
KWF	Kwai Fong Station	葵芳	TWL	荃灣綫
KWV	Kwai Fong Ventilation Building	葵芳通風樓	WRL	西鐵綫
KWH	Kwai Hing Station	葵興	TWL	荃灣綫
KWR	Kwun Tong Road Ventilation Building	觀塘道通風樓	KTL	
KWT	Kwun Tong Station	觀塘	KTL	觀塘綫
LAK	Lai King Station	荔景	TWL/TCL	荃灣/東涌綫
LAR	Lantau Airport Railway (AEL + TCL)	機場鐵路	LAR	機場鐵路
LAR2	Lantau Airport Extension (Project – AEL / TCL)			
LAT	Lam Tin Station	藍田	KTL	觀塘綫
LCK	Lai Chi Kok Station	荔枝角	TWL	荃灣綫
LCT	Lai Chi Kok Traction Substation	荔枝角牽引配電站	LAL	
LEK	Leung King	良景	LRL	輕鐵
LHB	LianHuaBei	蓮花北	SZ4	深圳4綫
LHD	LongHua Depot	龍華車輛段	SZ4	深圳4綫
LHP	LOHAS Park Station,	康城	TKL	將軍澳綫
LHR	LongHua Railway Station	龍華火車站	SZ4	深圳4綫
LHZ	LongHuaZhongXin	龍華中心	SZ4	深圳4綫
LKT	Lai King Traction Substation	荔景牽引配電站	TWL	
LMC	Lok Ma Chau Station	落馬洲	EAL	東鐵綫
LOC	Locwood	樂湖	LRL	輕鐵
LOF	Lok Fu Station	樂富	KTL	觀塘綫
LOP	Long Ping Station	朗平	WRL	西鐵綫
LOS	LongSheng	龍勝	SZ4	深圳4綫
LOT	LongTang	龍塘	SZ4	深圳4綫
LOW	Lo Wu Station	羅湖	EAL	東鐵綫
LRD	LRT Depot	輕鐵車廠	LRL	輕鐵
LRL	Light Rail	輕鐵	LRL	輕鐵
LTE	Lam Tei	藍地	LRL	輕鐵
LUM	Lung Mun	龍門	LRL	輕鐵
LVB	Lai King Ventilation Building	荔景通風樓	TWL	
LWC	Lai Wan Chiller Plant Building		WRL	
LWM	MTR Lo Wu Marshalling Yard	港鐵羅湖編組站	EAL	東鐵綫
MEF	Mei Foo Station	美孚	TWL/WRL	荃灣/西鐵綫
MEG	Melody Garden	美樂	LRL	輕鐵
MHQ	MTR Headquarters Building (Currently MTR Tower)	港鐵總部大樓	KTL	
MIK	Ming Kum	鳴琴	LRL	輕鐵
MIL	MinLe	民樂	SZ4	深圳4綫
MKF	MTR Mong Kok Freight Terminal	港鐵旺角貨場	EAL	
MKK	Mong Kok East Station	旺角東	EAL	東鐵綫

Abbrev. Code	Station / Building Name	Station / Building Name (Chinese)	Line (Abbrev.)	Station Line (Chinese)
MOK	Mong Kok Station	旺角	KTL/TWL	觀塘/荃灣綫
MOL	Ma On Shan Line	馬鞍山綫	MOL	馬鞍山綫
MOS	Ma On Shan Station	馬鞍山	MOL	馬鞍山綫
MTR	MTR (MTR network)	港鐵	MTR	
MTV	Mid Tunnel Ventilation Building	隧道中段通風樓	TWL	
NAC	Nam Cheong Station	南昌	TCL/WRL	東涌/西鐵綫
NAW	Nai Wai	泥圍	LRL	輕鐵
NCB	New Cha Kwo Ling Ventilation Building	新茶果嶺通風樓	TKL	
NGW	Ngan Wai	銀圍	LRL	輕鐵
NIC	North Intake Cell	北海水泵房	TWL	
NIL	North Island Line (Project)			
NOL	Northern Link (Project)			
NOP	North Point Station	北角	ISL/TKL	港島/將軍澳綫
NPB	North Point New Plant Building	北角新機樓	ISL	
NTK	Ngau Tau Kok Station	牛頭角	KTL	觀塘綫
NVB	North Ventilation Building	北通風樓	TWL	
OCC	AEL/TCL Operation Control Centre	車務控制中心	LAL	
OLY	Olympic Station	奧運	TCL	東涌綫
ONT	On Ting	安定	LRL	輕鐵
PAS	Pak Shek Kok Section	白石角段	EAL	東鐵綫
PEV	Prince Edward Ventilation Building		WRL	
PFD	Pak Fuk Distribution Substation	百福配電分站	ISL	
PHD	MTR Pat Heung Depot	港鐵八鄉車廠	WRL	
PIS	Ping Shan	屏山村	LRL	輕鐵
POA	Po Lam Station	寶琳	TKL	將軍澳綫
PRE	Prince Edward Station	太子	KTL/TWL	觀塘/荃灣綫
PRV	Prime View	景峰	LRL	輕鐵
PSK	Ping Shek Ventilation Building	坪石通風樓	TKL	
PUT	Pui To	杯渡	LRL	輕鐵
PVB	Pak Shing Kok Ventilation Building	百勝角通風樓	TKL	
QEX	Quarry Bay East Plant Building	東鰲魚涌機樓	ISL	
QIH	QingHu	清湖	SZ4	深圳4綫
QIS	Quarry Bay Infeed Substation	鰲魚涌饋電站	ISL	
QUB	Quarry Bay Station	鰲魚涌	ISL/TKL	港島/將軍澳
QVB	Quarry Bay Ventilation Building	鰲魚涌通風樓	ISL	
R01	Ferry Pier Terminus Rectifier Station		LRL	
R02	Tsing Wun Rectifier Station		LRL	
R03	Oi Lin Loop Rectifier Station		LRL	
R04	Ho Tin Rectifier Station		LRL	
R05	Ming Kum Rectifier Station		LRL	
R06	Siu Hong Rectifier Station		LRL	
R07	Nai Wai Rectifier Station		LRL	
R08	Ping Shan Rectifier Station		LRL	
R09	Shui Pin Wai Rectifier Station		LRL	
R10	Yuen Long Terminus Rectifier Station		LRL	
R11	Tuen Mun Maint. Centre Rectifier Station		LRL	
R12	Hoh Fuk Tong Rectifier Station		LRL	
R13	Tin Shui Rectifier Station		LRL	
R14	Tin Tsz Rectifier Station		LRL	
R15	Tin Wing Rectifier Station		LRL	
R16	Tin Yat Rectifier Station		LRL	
RAC	Racecourse Station	馬場	EAL	東鐵綫
RCN	Racecourse North Section	馬場北段	EAL	東鐵綫
RCS	Racecourse South Section	馬場南段	EAL	東鐵綫

Abbrev. Code	Station / Building Name	Station / Building Name (Chinese)	Line (Abbrev.)	Station Line (Chinese)
S01	Ho Tin CL&P Primary Sub-Station		LRL	
S02	Shui Pin Wai CL&P Primary Sub-Station		LRL	
S03	Tin Yat CL&P Primary Sub-Station		LRL	
SAH	San Hui	新墟	LRL	輕鐵
SAS	Sam Shing Terminus	三聖	LRL	輕鐵
SAW	San Wai	新圍	LRL	輕鐵
SCL	Sha Tin to Central Link (Project)			
SDT	Siu Ho Wan Depot Traction Substation	小濠灣牽引配電站	LAL	
SHD	Siu Ho Wan Depot	小濠灣車廠	AEL / TCL	機場/東涌綫
SHD2	Siu Ho Wan Depot Extension (Project)			
SHE	Siu Hei	兆禧	LRL	輕鐵
SHL	Siu Hong	兆康	LRL	輕鐵
SHM	Shek Mun Station	石門	MOL	馬鞍山綫
SHO	Siu Ho Wan	小濠灣	LAL	
SHP	Shek Pai	石排	LRL	輕鐵
SHS	Sheung Shui Station	上水	EAL	東鐵綫
SHT	Sha Tin Station	沙田	EAL	東鐵綫
SHW	Sheung Wan Station	上環	ISL	港島綫
SIC	South Intake Cell	南海水泵房	ISL	
SIH	Siu Hong Station	兆康	WRL	西鐵綫
SIL	Siu Lun	兆麟	LRL	輕鐵
SKM	Shek Kip Mei Station	石硶尾	KTL	觀塘綫
SKN	Shan King (North)	山景北	LRL	輕鐵
SKS	Shan King (South)	山景南	LRL	輕鐵
SKW	Shau Kei Wan Station	筲箕灣	ISL	港島綫
SML	ShangMeiLin	上梅林	SZ4	深圳4綫
SMZ	ShiMinZhongXin	市民中心	SZ4	深圳4綫
SNN	Sha Tin North Section	沙田北段	EAL	
SNS	Sha Tin South Section	沙田南段	EAL	
SNG	ShaoNianGong	少年宮	SZ4	深圳4綫
SPW	Shui Pin Wai	水邊圍	LRL	輕鐵
SSP	Sham Shui Po Station	深水埗	TWL	荃灣綫
SST	Sham Shui Kok Traction Substation	深水角牽引配電站	LAL	
SSV	Sheung Shui Ventilation Building		EAL	
STF	MTR Sha Tin Freight Terminal	港鐵沙田貨場	EAL	
STS	Sai Wan Ho Traction Substation	西灣河牽引配電站	ISL	
STW	Sha Tin Wai Station	沙田圍	MOL	馬鞍山綫
SUN	Sunny Bay Station	欣澳	TCL / DRL	東涌/迪士尼綫
SVB	South Ventilation Building	南通風樓	ISL	
SWH	Sai Wan Ho Station	西灣河	ISL	港島綫
SWT	Sheung Wan Traction Substation	上環牽引配電站	ISL	
T01	Tunnel No.1		EAL	
T02	Tunnel No.2 (Beacon Hill Tunnel)		EAL	
T05	Tunnel No.5 (Tai Po Kau – Down Track)		EAL	
T1A	Tunnel No.1A (Ho Man Tin)		EAL	
T5A	Tunnel No.5A (Tai Po Kau – Up Track)		EAL	
TAD	MTR Tai Wai Depot	港鐵大圍車廠	EAL	
TAK	Tai Koo Station	太古	ISL	港島綫
TAP	Tai Po Market Station	大埔墟	EAL	東鐵綫
TAW	Tai Wai Station	大圍	EAL	東鐵綫
TCC	Tung Chung Cable Car	東涌纜車	TCC	
TCL	Tung Chung Line	東涌綫	TCL	東涌綫
TCP	Tung Chung Tunnel Portal	東涌隧道口	LAL	
TFU	Tin Fu	天富	LRL	輕鐵

Abbrev. Code	Station / Building Name	Station / Building Name (Chinese)	Line (Abbrev.)	Station Line (Chinese)
THE	Tin Heng	天恒	LRL	輕鐵
THN	Tai Hing (North)	大興北	LRL	輕鐵
THS	Tai Hing (South)	大興南	LRL	輕鐵
THT	Tin Hau Traction Substation	天后牽引配電站	ISL	
THW	Tai Ho Wan	大濠灣	LAL	
TIC	Tai Kok Tsui Intake Cell	大角咀海水泵房	TWL	
TIH	Tin Hau Station	天后	ISL	港島綫
TIK	Tiu Keng Leng Station	調景嶺	KTL / TKL	觀塘/將軍澳綫
TIS	Tin Shui Wai Station	天水圍	WRL	西鐵綫
TIT	Tin Tsz	天慈	LRL	輕鐵
TIY	Tin Yiu	天耀	LRL	輕鐵
TKD	Tseung Kwan O Depot	將軍澳車廠	TKL	
TKI	Tiu Keng Leng Passenger Transport	調景嶺運輸交匯處	TKL	
TKL	Tseung Kwan O Line	將軍澳綫	TKL	將軍澳綫
TKO	Tseung Kwan O Station	將軍澳	TKL	將軍澳綫
TKS	Tseung Kwan O South (Project)	將軍澳南	TKL	
TKV	Tai Kok Tsui Ventilation Building	大角咀通風樓	LAL	
TLT	Tai Lam Tunnel		WRL	
TBD	MTR Tuen Mun Bus Depot	港鐵屯門巴士廠	LRL	
TMB	MTR Tuen Mun Building	港鐵屯門大樓	LRL	
TMD	MTR Tuen Mun Depot	港鐵屯門車廠	LRL	
TMH	Tuen Mun Hospital	屯門醫院	LRL	輕鐵
TML	Tuen Mun	屯門	LRL	輕鐵
TNK	Tin King	田景	LRL	輕鐵
TOC	Town Centre	市中心	LRL	輕鐵
TOF	Tong Fong	塘坊村	LRL	輕鐵
TOI	Tseung Kwan O Passenger Transport	將軍澳運輸交匯處	TKL	
TPC	MTR Tai Po Kau Staff Club House	港鐵大埔滘員工會所	EAL	
TPK	Tai Po Kau Section	大埔滘段	EAL	
TRV	Trackside Villas (Tai Po Kau Staff Quarter)	策誠軒 (大埔滘員工宿舍)	EAL	
TSH	Tai Shui Hang Station	大水坑	MOL	馬鞍山綫
TSL	Tin Shui Wai	天水圍	LRL	輕鐵
TSP	Tuen Mun Swimming Pool	屯門泳池	LRL	輕鐵
TSS	Tsing Shan Tsuen	青山村	LRL	輕鐵
TST	Tsim Sha Tsui Station	尖沙咀	TWL	荃灣綫
TSU	Tin Shui	天瑞	LRL	輕鐵
TSV	Tsim Sha Tsui Ventilation Building	尖沙咀通風樓	EAL	東鐵綫
TSW	Tsuen Wan Station	荃灣	TWL	荃灣綫
TSY	Tsing Yi Station	青衣	AEL / TCL	機場/東涌綫
TTI	TKO Traction Infeed Substation	將軍澳饋電站	TKL	
TTR	Tai Tong Road	大棠道	LRL	輕鐵
TTS	Tai Kok Tsui Traction Substation	大角咀牽引配電站	LAL	
TUC	Tung Chung Station	東涌	TCL	東涌綫
TUM	Tuen Mun Station	屯門	WRL	西鐵綫
TUT	Tung Chung Traction Substation	東涌牽引配電站	LAL	
TVB	Tsing Yi Vent. Building with Traction Substation	青衣通風樓	LAL	
TWD	Tsuen Wan Depot	荃灣車廠	TWL	
TWH	Tai Wo Hau Station	大窩口	TWL	荃灣綫
TWI	Tin Wing	天榮	LRL	輕鐵
TWL	Tsuen Wan Line	荃灣綫	TWL	荃灣綫
TWN	Tsing Wun	青雲	LRL	輕鐵
TWO	Tai Wo Station	太和	EAL	東鐵綫
TWU	Tin Wu	天湖	LRL	輕鐵
TWW	Tsuen Wan West Station	荃灣西	WRL	西鐵綫

Abbrev. Code	Station / Building Name	Station / Building Name (Chinese)	Line (Abbrev.)	Station Line (Chinese)
<b>TYA</b>	Tin Yat	天逸	LRL	輕鐵
<b>TYI</b>	Tsing Yi Cooling Water Intake for Station	青衣海水泵房	LAL	
<b>TYT</b>	Tsing Yi Traction Substation	青衣牽引配電站	LAL	
<b>TYU</b>	Tin Yuet	天悅	LRL	輕鐵
<b>UNI</b>	University Station	大學	EAL	東鐵綫
<b>URL</b>	Urban Lines (KTL + TWL + ISL + TKL)	市區綫	URL	市區綫
<b>WAC</b>	Wan Chai Station	灣仔	ISL	港島綫
<b>WEP</b>	Wetland Park	濕地公園	LRL	輕鐵
<b>WIL</b>	West Island Line (Project)			
<b>WKS</b>	Wu Kai Sha Station	烏溪沙	MOL	馬鞍山綫
<b>WPV</b>	West Portal Ventilation Building-TSW	西隧道口通風樓	TWL	
<b>WRL</b>	West Rail Line	西鐵綫	WRL	西鐵綫
<b>WTS</b>	Wong Tai Sin Station	黃大仙	KTL	觀塘綫
<b>XRL</b>	Express Railway Link (Project)	區域快綫		
<b>YAO</b>	Yau Oi	友愛	LRL	輕鐵
<b>YAT</b>	Yau Tong Station	油塘	KTL / TKL	觀塘/將軍澳綫
<b>YLL</b>	Yuen Long Terminus	元朗	LRL	輕鐵
<b>YMT</b>	Yau Ma Tei Station	油麻地	KTL / TWL	觀塘/荃灣綫
<b>YOT</b>	Yam O Traction Substation	陰澳牽引配電站	LAL	
<b>YUL</b>	Yuen Long Station	元朗	WRL	西鐵綫
<b>YVB</b>	Yau Tong Ventilation Building	油塘通風樓	TKL	

\* Location codes 300~399 are reserved for Railway Extension Projects use. Originators shall define the location reference and assign a set of unique location codes to be used solely for the specific project. Originators shall submit the designation to M-CADD for record.

#### Note

This Location Code Table is to be updated regularly; Originators can contact M-CADD or designated representative to obtain the most up-to-date version where necessary.

## 5.2 SUBJECT CODE TABLES

### 5.2.1 SUBJECT CODE

For the purposes of planning drawing production and assigning drawing numbers, drawings shall be classified in terms of the type of works or installation represented in accordance with the table of Subject codes below. The Originator can propose new Subject codes using alpha-numeric characters not yet been assigned in the tables below, subject to submission to M-CADD for review and endorsement.

### 5.2.2 SUBJECT CODE TABLE (1<sup>ST</sup> CHARACTER)

The first character of the Subject Code is to differentiate the Subject / System grouping.

Code	Subject / System Group Description
A	Architectural, STIC / SSCC Submission
B	Aerial Ropeway
C	Civil & Structural, Permanent Way, Geotechnical, Survey
D	Drainage
E	Electrical - Low Voltage
F	Fire Services
G	Power Supply System
H	Automatic Fare Collection System
I	Sea Water Intake
J	Communication System
K	Main Control System
L	Combined Services Drawings
M	Environmental Control System
N	Lift, Escalator and Moving Walkway
O	(NOT USE)
P	Civil Planning
Q	Overhead Line
R	Signalling
S	Structural E&M
T	Temporary Works
U	Rolling Stock
V	Platform Screen Door
W	Plumbing
X	Property Development
Y	(NOT USE)
Z	Coordination

### 5.2.3 SUBJECT CODE TABLES (2<sup>ND</sup> AND 3<sup>RD</sup> CHARACTERS)

The 2nd and the 3rd characters denote the Sub-Subject / System and shall be in sequence with the 1st character to form the full definition of the Subject Code. The Originator can propose new Sub-Subject / System codes using those alphanumeric characters not yet been assigned in the tables below, subject to submission to M-CADD for review and endorsement.

#### A Architectural, STIC / SSCC Submission

<b>Code</b>	<b>Description</b>
A01 Series	Scheme Design Drawings
A10 Series	Architectural General Arrangement
A11	Location & site plan
A12	GA plan
A13	Section
A14	Elevation
A15	Reflected ceiling plan
A20 Series	Statutory & other submissions, TSSC Submission
A21	STIC Submission
A22	SSCC Submission
A23	Dedicated Routes for the Disabled
A24	BD Submission (only if Property included)
A25	Section 16 Submission (if applicable)
A30 Series	Detailed plan & special room layout
A31	Lift
A32	Escalator
A33	Moving walkways
A34	Stairs
A35	Operation Rooms (SCR, Audit Revenue Room, Fire Control Room)
A36	Staff Rooms (Staff lockers, toilets, Mess Room)
A37	Plant Rooms (Power Equipment Room)
A40 Series	Schedules
A41	Finishes
A42	Doors,
A43	Roller shutter
A44	Access panel
A45	Louvres
A46	Sanitary ware
A47	Signs & advertising panel
A48	Catladder
A49	Ironmongery
A50 Series	General Builders Work
A51	Blockwork
A52	Internal finishes
A53	Doors & Fenestration (doors, access panels, roller shutters, louvers and windows)
A54	Ladders & platforms
A55	Balustrade & railings
A56	Fixtures & fittings (Flood board, bumper rail, pantry)
A57	External finishes
A58	External works & soft landscape
A59	Miscellaneous (hoarding)
A60 Series	Special works packages
A61	Floors (stonework, access floor)
A62	Walls (VE panels, compact laminate, stonework)

A63	Ceilings
A64	Common components (CuC PSB, CIS, Help Line, Tel Stand, Litter bin)
A65	External cladding
A66	Glazing
A67	Special roofing
A68	Signage
A69	Advertising Panels
A70 Series	Standard Architectural Components (Entrance Portal, Headwall / tailwall units, concession shopfront)
A71	Entrance Signage Bulkhead
A72	Head and Tailwall Unit
A73	Concession Shop Front
A80 Series	Systemwide components/E&M Interface (PSD, PEP)
A81	Platform Screen Door / Automatic Platform Gate
A90 Series	Special Elements & Details

## B Aerial Ropeway

Code	Description
B00	General information
B01	Item belonging to track rope station equipment (eg, anchoring, tensioning, & deviation of track rope)
B02	Item belonging to haul rope station equipment (without drive) (eg, tensioning, and deviation of haul rope)
B03	Item belonging to drive equipment for moving the installation (eg, bull wheel, counter wheel, gearbox, motor & brake)
B04	Item belonging to line equipment(eg, saddles for track rope and pulleys for haul rope)
B05	Item belonging to carrier (eg, cabin, carriage, hanger and grip)
B06	Item belonging to tower structure
B07	Item belonging to rescue equipment used if the installation is not moving (eg, winch, rescue carrier)
B08	Item belonging to station equipment (eg, security device, guiding, synchronisation, magazine, rails)
B09	Item belonging to station structure

## C Civil & Structural, Permanent Way, Geotechnical, Survey

Code	Description
C01	General information
C02	Line location & setting out
C03	Tunnel layout
C04	Surveys (topographical & hydrographical)
C05	Geotechnical interpretative detail
C06	Geotechnical detail
C07	Geotechnical 'as-found' detail
C10	Civil general arrangement
C11	Civil detail
C12	R C Drawing
C13	Prestressing
C14	Drainage
C15	Bearing
C16	Joint
C17	Perimeter wall – layout
C18	Perimeter wall – detail
C19	Piling – layout
C20	Piling – detail

C21	Construction sequence & traffic management
C22	Site formation
C23	Structural steelwork
C24	External works
	<b>Permanent Way</b>
C30 Series	Alignment
C31	Schematics
C32	Standard Details
C33	Junction Layout
C35	Track Component – Plain Line
C36	Work Areas
C39	Operation Facility
C50	E&M Services
C60	Fencing and Noise Barriers
C90	Track Component – Special Trackwork
	<b>Survey</b>
C80	As-built survey
C81	Wriggle survey

**D Drainage**

<b>Code</b>	<b>Description</b>
D00	Drainage schematic & general info. (notes, symbols, legends & abbreviations)
D01	Drainage - sump pumping system
D02	Drainage - foul drainage system
D03	Drainage - storm water drainage
D04	Drainage - track drainage
D05	Drainage installation detail
D06	Drainage layout
D07	Sewage treatment
D08	Waste water treatment
D91	Typical drainage sump pumping equipment room layout
D92	Typical drainage foul drainage equipment room layout

**E Electrical - Low Voltage**

<b>Code</b>	<b>Description</b>
E00	Electrical Schematic & general info. (notes, symbols, legends & abbreviations)
E01	Electrical lighting & small power
E02	Electrical emergency power, UPS, generator
E03	Electrical earthing & lightning protection system
E04	Electrical lighting protection
E05	Electrical advertising panel, station sign
E06	Electrical security & burglar alarm
E07	Electrical L.V. distribution system & switchboard general arrangement
E08	Electrical containment system
E09	Electrical Fire Alarm & Detection system
E10	Electrical Traffic Management system
E11	Electrical Services layout – Miscellaneous
E12	Electrical distribution board schedule
E13	Electrical installation detail
E92	Typical emergency power equipment room layout
E97	Typical LV distribution equipment room layout

**F Fire Services**

<b>Code</b>	<b>Description</b>
F00	Fire Services schematic & general info. (notes, symbols, legends & abbreviations)
F01	Fire Services fire hydrant, hose reel
F02	Fire Services sprinkler
F03	Fire Services Drencher system
F04	Fire Services water spray
F05	Fire Services total gas flooding
F06	Fire Services layout – combined
F07	Fire Services installation detail
F08	Fire alarm and detection system, power supply and interface
F09	Fire extinguisher
F91	Typical fire hydrant, hose reel equipment room layout
F92	Typical FS sprinkler equipment room layout
F95	Typical FS total gas flooding equipment room layout
F96	Typical combined FS equipment room layout

## G Power Supply System

<b>Code</b>	<b>Description</b>
G00	General
G01	Standards
G02	System design – a.c. transmission and distribution
G03	System design – d.c. traction
G04	Traction Substation layout
G05	Services substation layout
G06	Trackside cable route
G07	Track Bonding
G09	Miscellaneous
G10	Trackside/tunnel lighting
G11	Portal lighting
G12	Signage
G13	Earthing
G14	Trackside/ tunnel power socket system
G15	Lightning protection
G16	Environmental control system
G17	MCS control & PRC control
G18	System design – a.c. traction
G20	Switchgear – 33kV
G21	Switchgear – 11kV
G22	Switchgear – 11kV RMU
G23	Switchgear – d.c. Traction
G24	Switchgear – LV
G25	Switchgear – 25kV
G30	Transformer – Infeed
G31	Transformer – 33/11 kV
G32	Transformer – Rectifier
G33	Transformer – Services
G40	Cable – 33kV
G41	Cable – 11kV
G42	Cable – d.c. Traction positive
G43	Cable – Track bonding
G44	Cable – LV
G45	Cable – Pilot and control
G46	Cable – Installation
G47	Cable – 25kV
G50	Rectifier

G52	Tunnel drainage plumbing system
G54	Tunnel fire protection system
G56	Cable & pipe support system
G57	Cable bracket disposition
G60	Battery and charger
G63	Uninterruptable Power Supply
G65	Standby generator set
G70	Protection and Control
G75	Alarm and Telemetry
G80	Stray current corrosion control
G91	Typical equipment room
G98	Combined Services Drawings
G99	Structural E&M Drawings

**H Automatic Fare Collection System**

<b>Code</b>	<b>Description</b>
H01	General
H02	Few fare machine
H03	Multi fare machine
H04	Ticket office machine
H05	Station computer
H06	Station control unit
H07	Gate manual
H08	Gate automatic
H09	Gate interchange
H10	Luggage chute
H11	Wiring and interfaces
H12	Overhead beam
H13	G.L.A.P.
H14	Route information system
H15	Software system
H16	Installation
H17	Access control
H91	Typical equipment room
H99	Builders work

**I Sea Water Intake**

<b>Code</b>	<b>Description</b>
I01	Sea Water Intake schematic
I02	Sea Water Intake layout
I03	Sea Water Intake schedule

**J Communication System**

<b>Code</b>	<b>Description</b>
J00	General
<b>MTR Related System (Group 1)</b>	
J01	General
J02	Radio system
J03	CCTV system
J04	Transmission system
J05	PABX telephone system
J06	Direct line telephone system
J07	Public address system

J08	Passenger information system
J01	General
	<b>Commercial Systems</b>
J11	General
J12	Cable way provision
J13	CT-2 system
J14	Paging system
J15	Mobile telephone network
J16	Mobile payphone
J17	Public payphone
J18	Commercial information system
	<b>Security System</b>
J31	General
J32	CCTV system
J33	Telephone system
J34	Security Access Management System
	<b>Traffic Interchange</b>
J41	General
J42	Radio system
J43	CCTV system
J44	Telephone system
J45	Public address system
J46	Passenger information system
	<b>MTR Related Systems (Group 2)</b>
J61	Network
J62	Clock system
J63	Teleprinter
J91	Typical equipment room

## K Main Control System

Code	Description
	<b>Central System</b>
K00	General
K01	Central monitoring & control system (CMCS)
K02	Data communication network
K03	Central control room
K04	Central equipment room
K05	Backup control centre
K06	Expert system
	<b>Station/Depot Systems</b>
K10	Station Management System (SMS)
K11	Station LAN
K12	Depot Management System (DMS)
K13	Depot LAN
K14	LAK Remodeling
	<b>Data Acquisition System</b>
K20	Power remote control system (PRC)
K21	Environmental control system (ECS)
K22	Automatic train supervision / regulation (ATS/ATR)
K23	Automatic fare collection (AFC)
K24	Communication Systems
K25	Fire protection systems
K26	Station and tunnel services
K27	Access control system
K28	Variable signage system

K29	Patronage monitoring system
K30	Escalator/lift monitoring system
K31	Master clock
K33	Platform screen door
K35	Traffic management control system
<b>MIS Systems</b>	
K50	Management information system
K51	Maintenance support system
K52	Geographic information system
K53	Office automation system
K54	TURS
<b>Interfaces to External Systems</b>	
K60	Interfaces to existing CCR
K61	Interfaces to CLP
K65	Interfaces to HEC
K91	Typical equipment room

## L Combined Services Drawings

Code	Description
L00	Combined Services Drawings – Symbols, legends, abbreviations
L01	Combined Services Drawings
L02	Combined Services Reflected Ceiling Plans
L91	Typical Combined Services Drawings

## M Environmental Control System

Code	Description
M00	ECS general info. (notes, symbols, legends, abbreviations)
M01	ECS Air Side schematic
M02	ECS Air Side layout
M03	ECS Air Side Schedule
M04	ECS Water Side Schematic
M05	ECS Water Side Layout
M06	ECS Water Side Schedule
M07	ECS Controls Schematic
M08	ECS Controls Layout (compressed air system, E/P control system & VAC)
M09	ECS layout – combined
M10	ECS & Smoke Control layout (smoke extraction Layout & smoke zone)
M11	ECS installation detail
M12	ECS equipment schedule
M13	ECS refrigerant system
M14	ECS electrical schematic
M15	ECS electrical layout
M16	ECS pneumatic schematic
M17	ECS mode table
M98	Typical ECS Control equipment room layout
M99	ECS plant room layout

## N Lift, Escalator and Moving Walkway

Code	Description
	<b>Lift</b>
N80	Fixture (Car and landing)
N81	Car cab
N82	Entrance

N83	Circuit wiring / control logic diagram
N84	Delivery routing/access plan
N91	Typical equipment room
	<b>Escalator &amp; Moving Walkway</b>
N01	Drive machinery
N02	Emergency brake
N03	Motor & gearbox bedplate
N05	Speed detector
N07	Idler machinery
N08	Upper tracks
N09	Incline tracks
N10	Lower tracks
N11	Steps and chains
N12	Upper truss
N13	Lower truss
N14	Incline truss
N15	Civil/Structural Engineering support
N16	Truss fittings
N17	Handrail and support
N18	Upper handrail stand
N19	Lower handrail stand
N20	Countershaft
N21	Combplates and floorplates
N22	Maintenance barriers
N23	Lubrication system
N24	Chain guide
N25	Electricity (wiring & components)
N26	Step safety system
N28	Drip tray
N44	Mechanical products, catalogue
N45	Electrical products, catalogue
N46	Electrical cabinet
N51	Balustrade decking
N52	Newel decking
N53	Glass support beam
N54	Skirting
N55	Dress guard
N56	Skirt moulding
N57	Exterior moulding
N58	Support profile of ext. cladding (balustrade)
N59	Support profile of ext. cladding (truss sides and bottom)
N60	Interior panel (balustrade)
N61	Exterior panel (balustrade)
N62	Exterior panel (truss)
N63	Bottom panel (truss)
N64	Decking between paired escalators
N65	Junction decking with wall
N66	Box cladding under escalator
N67	Fittings on decking
N70	Upper and lower landings
N75	Tools
N91	Typical equipment room
N99	Builder's works

**O (Not Used)**

<b>Code</b>	<b>Description</b>

**P Civil Planning**

<b>Code</b>	<b>Description</b>
P01	Land requirement
P02	Railway area plan, land resumption plan
P03	Location of entrusted works
P04	Utility coordination/agreement
P05	Location of existing utilities
P06	Relocation of utilities
P07	Works area
P08	Access to works area
P09	Site office
P10	Running line lease plan
P11	Maintenance responsibility matrix drawing
P12	Railway Protection Plan
P13	MTR Plan

**Q Overhead Line**

<b>Code</b>	<b>Description</b>
Q01	General
Q02	Schematic
Q03	General Arrangement
Q04	Chart, Calculation, Diagram
Q05	OHL Layout
Q06	SCADA Cable Route
Q07	Assembly Drawing for OHL Equipment
Q08	Assembly Drawing for OHL Mast and Footing
Q09	Assembly Drawing for Tunnel Drop Vertical
Q10	Assembly Drawing for Earthing and Bonding System
Q11	Assembly Drawing for Back Stay
Q12	Assembly Drawing for Miscellaneous Items
Q13	Sub-Assembly Drawing
Q14	Component Drawing For Proprietary Products
Q15	Component Drawing For Non-Proprietary Products
Q16	Cross Section Drawing for Tension Length

**R Signalling**

<b>Code</b>	<b>Description</b>
R01	Air Conditioning
R02	ATC Trainborne
R03	ATO (Trackside)
R04	ATP (Trackside)
R05	Automatic Train Supervisory System
R06	Auxiliary Electrical Systems
R07	Auxiliary Converter (ACV)
R08	Auxiliary Inverter (AIV)
R09	Axle Counter
R10	Battery Loco
R11	Brake

R12	Camshaft
R13	Carbody & Underframe
R14	Chopper
R15	Central Control Room Equipment
R16	Control & Monitoring System
R17	Control Circuit
R18	Diesel Locomotive
R19	Door System
R20	Vehicle Exterior & Interior Fitting
R21	Couplers & Gangways
R22	Information System
R23	Locomotives (Diesel / Battery)
R24	Solid State Interlocking
R25	Pneumatics & Air Distribution System
R26	Power Supply System
R27	Point
R28	Rail Grinding Vehicle
R29	Railway Task Trainer
R30	SACEM On-Board Equipment SACEM
R31	SACEM Telemetry Equipment SACEM
R32	SACEM Trackside Equipment SACEM
R33	ATC Indicator Circuit
R34	Signalling Test Equipment
R35	Station
R36	Traction Camshaft
R37	Traction Chopper
R38	Track Circuit
R39	Traction & Braking System
R40	Trailer

**S Structural E&M**

Code	Description
S00	Structural E&M Drawing – general notes, legend
S01	Structural E&M Drawing – slab
S02	Equipment access route, Delivery Route Drawing
S03	Structural E&M Drawing - wall

**T Temporary Works**

Code	Description
T01	Site layout, works area
T02	Geotechnical
T03	Cofferdam
T04	Earthworks, excavation, dewatering
T05	Dredging
T06	Falsework
T07	Formwork
T08	IMT detail
T09	IMT fitting out
T10	Marine operation
T11	Other temporary work
T12	Temporary drainage
T13	Temporary water supply
T22	Segment catalogue
T25	Construction principles/method

T26	Substructure method
T27	Precast method
T28	Erection method

**U Rolling Stock**

<b>Code</b>	<b>Description</b>
U01	Air conditioning system
U02	Automatic train control
U03	Auxiliary electrical system
U04	Bogies
U05	CMS & event recorder
U06	Door system
U07	Vehicle exterior & interior fittings
U08	Gangways & couplers
U09	Information systems
U10	Pneumatic & air distribution system
U11	Traction & braking system
U12	Vehicle structure

**V Platform Screen Door**

<b>Code</b>	<b>Description</b>
V00	General
V01	Platform supervisor booth
V02	PSD cabinetry room
V03	PSD equipment room
V04	Platform side system
V40	Automated Platform Gate (APG)

**W Plumbing**

<b>Code</b>	<b>Description</b>
W00	Plumbing schematic & general info. (notes, symbols, legends & abbreviations)
W01	Plumbing main water distribution
W02	Plumbing flushing water
W03	Plumbing irrigation
W04	Plumbing services layout – combined
W05	Plumbing installation detail
W06	Fresh water system
W07	Hot water system
W08	Swimming pool filtration plant
W09	Gas services
W94	Typical combined plumbing services equipment room layout

**X Property Development**

<b>Code</b>	<b>Description</b>
X01	General
X10	Lease Plans – Legal portion boundary
X11	Lease Plans – construction sequence & extent

**Y (NOT USE)**

<b>Code</b>	<b>Description</b>


**Z      Coordination**

<b>Code</b>	<b>Description</b>
Z01	Coordination drawings (master layout)
Z10	Government
Z20	Utilities
Z30	Contractor
Z40	Consultant
Z50	Third Parties
Z60	Artwork / Graphic

**END OF SECTION 5**

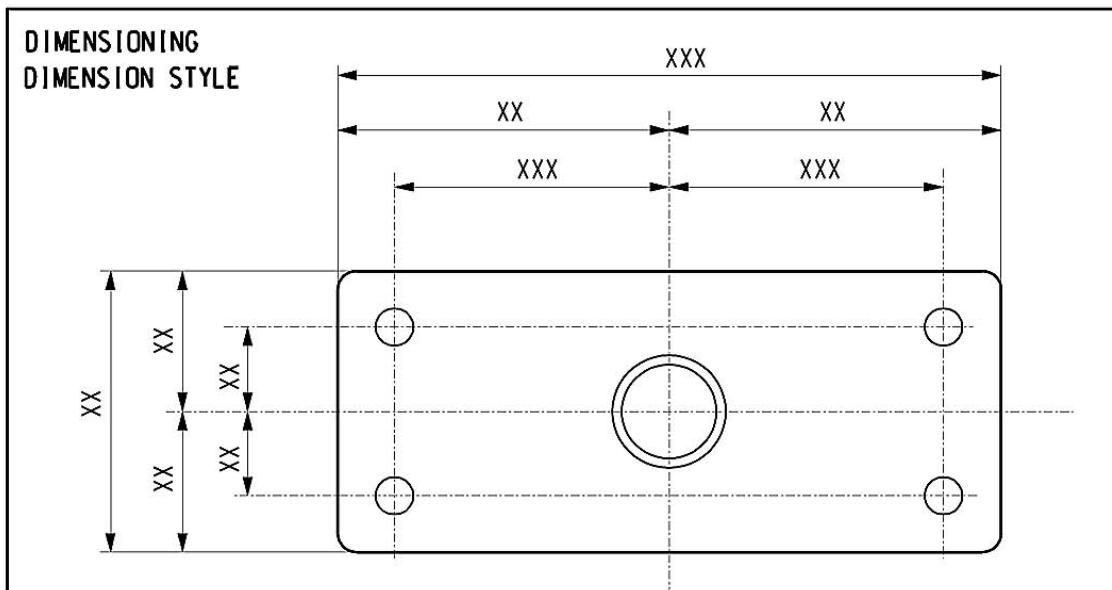
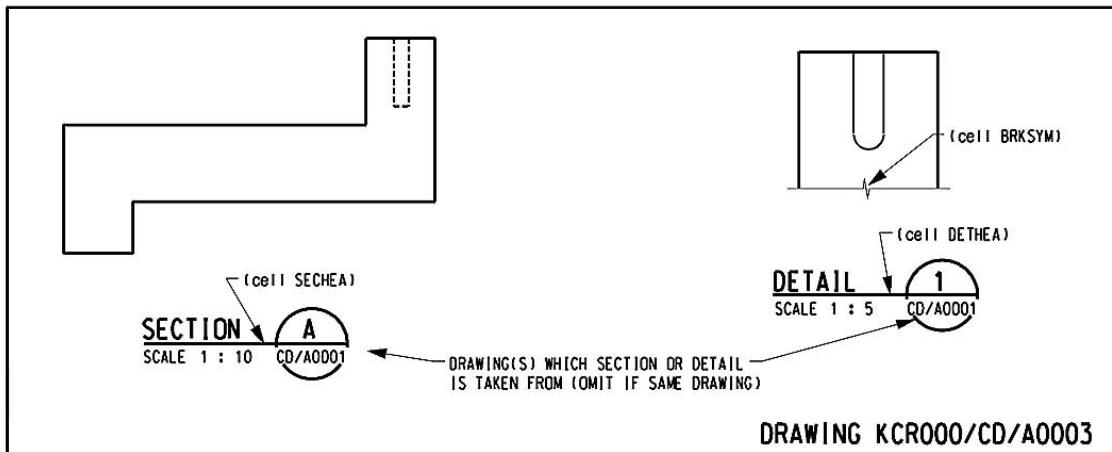
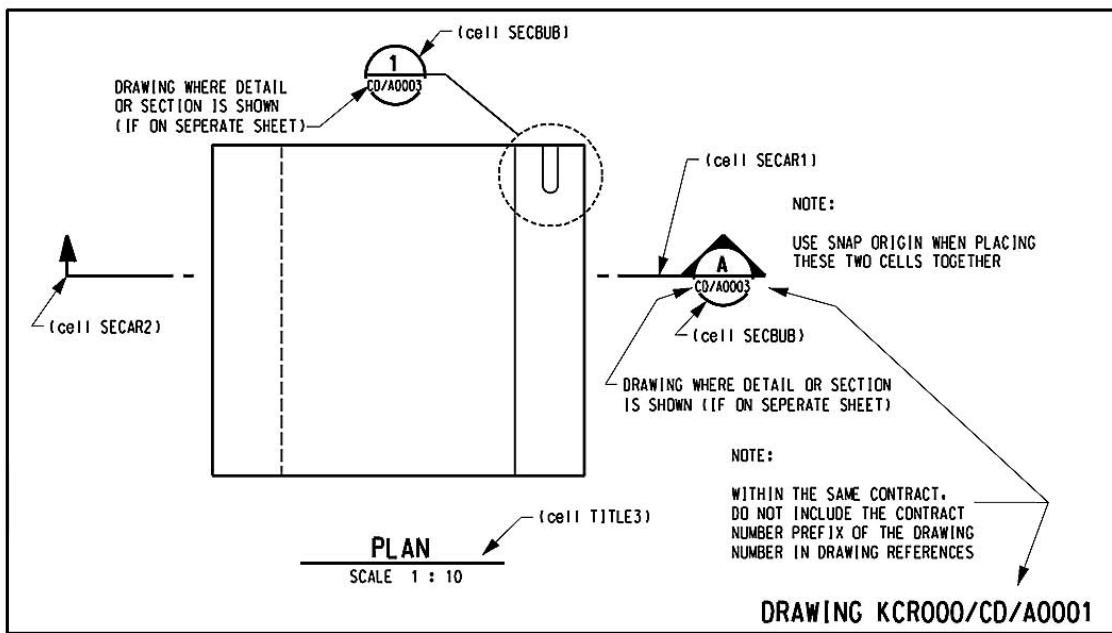
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## **6. APPENDICES**

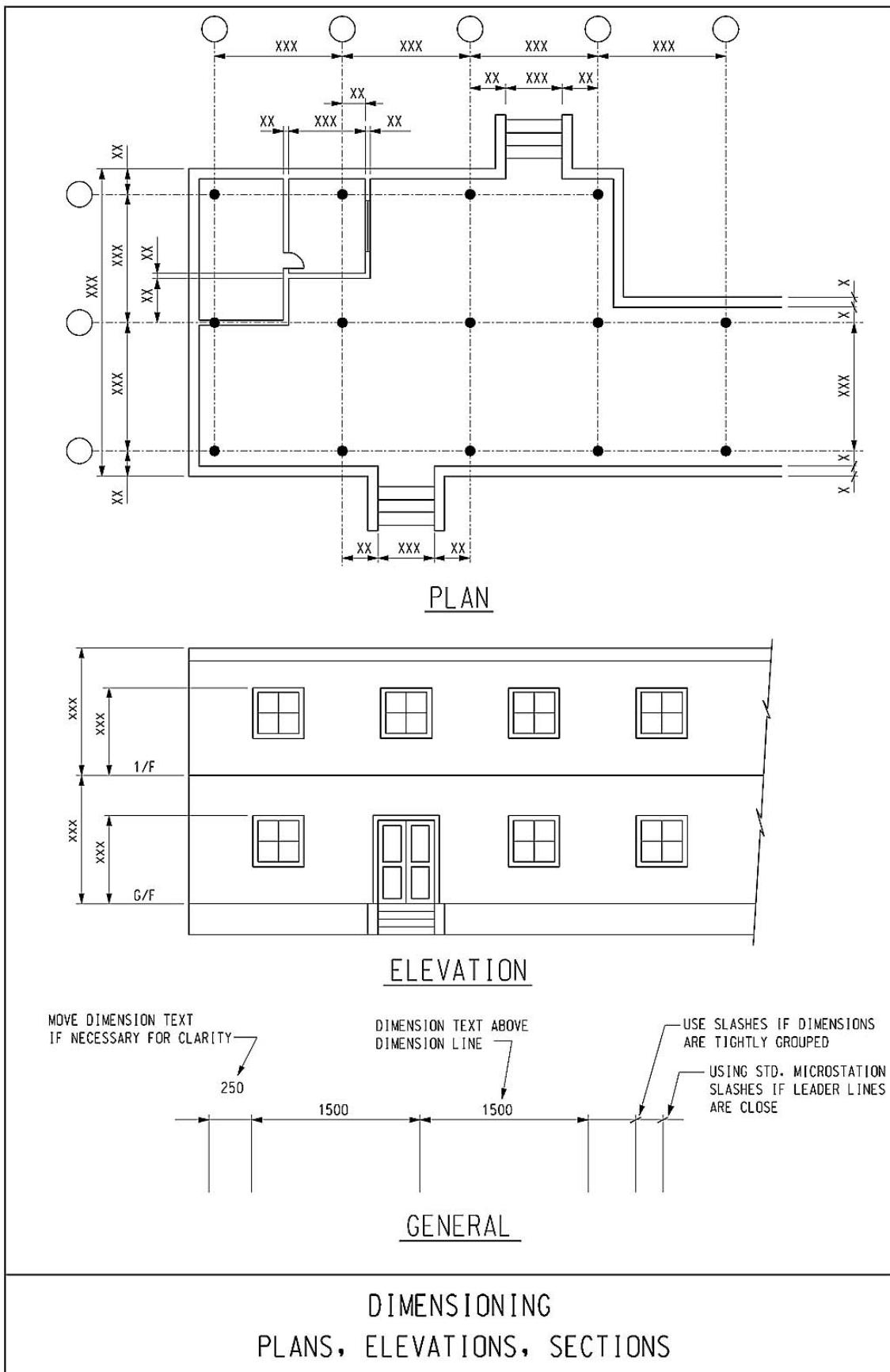
## **6.1 APPENDIX A – DRAWING ISSUE HISTORY (DIH)**

## **6.2 APPENDIX B – DRAWING ISSUE LIST (DIL)**

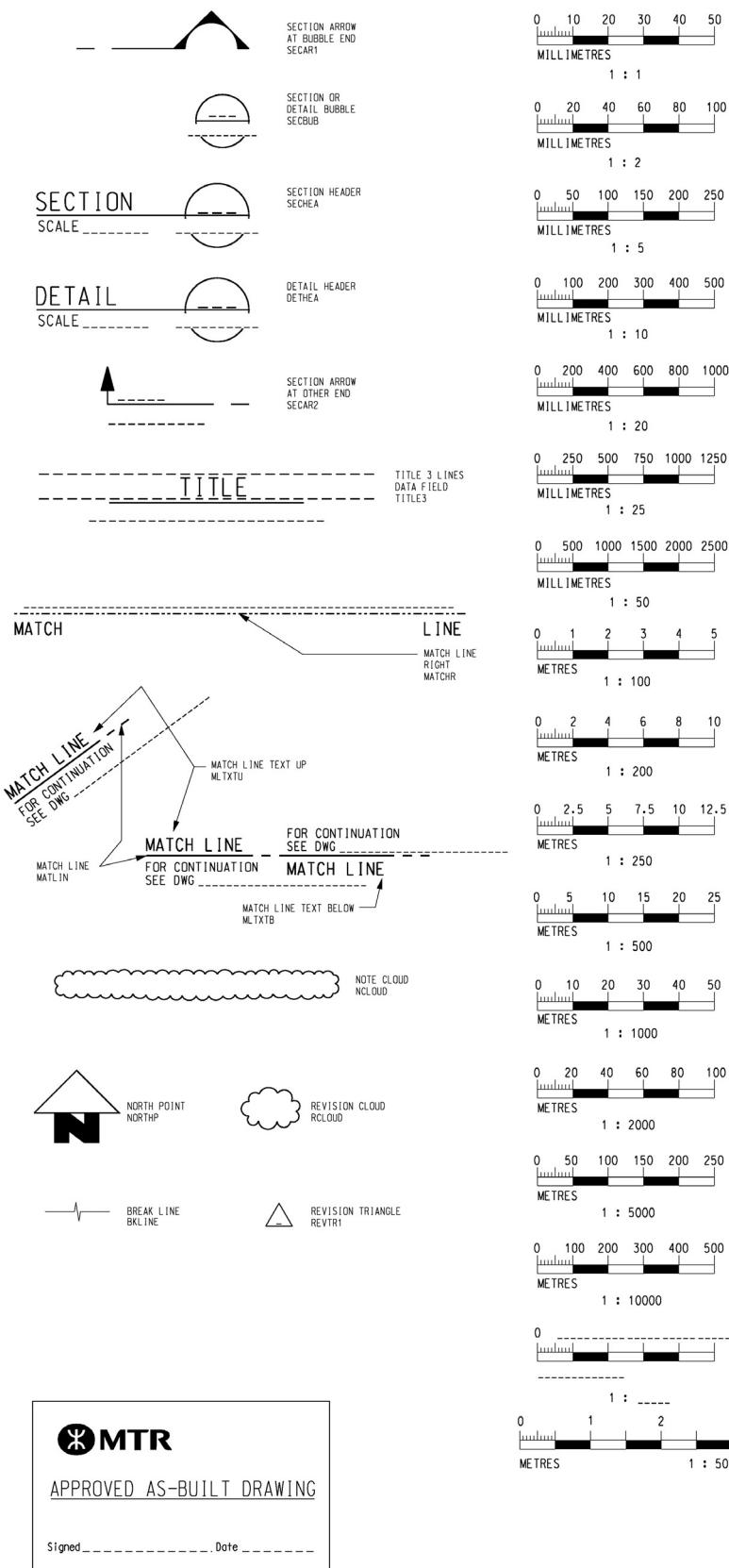
## 6.3 APPENDIX C – MISCELLANEOUS DETAILING



**MISCELLANEOUS DETAILING *continued***



## 6.4 APPENDIX D – COMMON SYMBOLS



## **6.5 APPENDIX E – GENERAL DRAWING TYPES AND ARRANGEMENT**

### **6.5.1 SKETCHES**

A Sketch is used to deliver a preliminary idea, concept, feasibility design or graphical presentation. Sometimes it will be the part-print of a drawing for clarification, design change, amendment and for distribution for comments etc. As long as sketches are not the standard or formalized drawings, it may not be necessary to log them into the DMS subject to the decision of Originator.

### **6.5.2 STANDARD DRAWINGS**

A Standard drawing is used to deliver common or repeated details, standards, or designs which are to be applied for the whole project or drawing set.

#### **6.5.2.1 Standard Drawings of the Corporation**

Corporation Standard drawings shall not be modified by Originators or outside parties themselves. Where necessary, proposed amendments can be submitted to M-CADD for consideration and, if endorsed, updating of the respective Standard Drawings.

#### **6.5.2.2 Standard Drawings of Consultants / Contractors**

Standard drawings produced by consultants or contractors shall be used solely for an individual project or contract. If other projects or contracts will make use of a standard drawing originated from another project/contract, it shall be reproduced to another drawing set to match with the drawing numbering series of the relevant new projects / contracts.

For the purpose of traceability within a Capital Project, the cross-reference of the 1<sup>st</sup> origin of the Standard drawing shall be marked on the note column of other replicated drawings.

FOR THE ORIGINATOR'S REFERENCE ONLY

STANDARD DRAWING – REFER ALSO TO SAME DRG. NO. ##### ######

#### **6.5.2.3 Standard Drawings from Government Authorities**

Standard drawings from Government Departments such as Highways Department (HyD), Civil Engineering and Development Department (CEDD), etc. should not be incorporated into the drawing. If reference to these Standard drawings is required, the relevant Department and drawing number can be clearly shown on the drawing as follows:

SLOPE REGISTRATION NUMBER SIGNS SHALL BE IN ACCORDANCE WITH  
CEDD STANDARD DRAWING NOS. C 2505/1 AND C 2505/2.

**6.5.3 DIRECTIVE DRAWINGS**

A Directive drawing is the primitive standard used as the basis and reference for the further build-up or development of corresponding detailed drawings. Its purpose is to ensure all the ground information such as appearances, sizes and formats are consistent. For example, a directive drawing for Station signages would specify the required signage's form, layout, colours, letters, graphics, logo arrangement, etc.

**6.5.4 GENERAL ARRANGEMENTS (PLANS, SECTIONS AND ELEVATIONS)**

A General Arrangement drawing shows the general layout and dimensions for the architecture and structures of buildings, or the civil works and site surveys, etc. It is also applicable to EMU, electrical, mechanical, fire service installations and ECS duct layouts, etc.

**6.5.5 DIAGRAMS AND SCHEMATICS**

Diagrams and Schematics drawings are correlated to physical elements and are not scaleable. They are used to show the conceptual arrangements of electrical circuits, radio systems, plumbing, drainage isometrics, piping, etc.

**6.5.6 ASSEMBLY, COMPONENT AND PARTS DRAWINGS**

Assembly, Components, and Parts drawings are used in Rolling Stock and Overhead Line equipment drawings. In general they will be in three-dimensional isometric or exploded view. Assembly drawings shall be provided clearly enough with cut-away sections, individual parts and components, etc.

**6.5.7 SCHEDULES AND TABLES**

Schedules and Tables are in tabular or matrix format, used to specify the materials, door & ironmongery, analysis drawings, etc.

**6.5.8 DETAIL DRAWINGS**

Detail Drawings are used to illustrate individual elements, component or a portion of a structure in more specific details. Normally they are directly referenced from a larger scale general arrangement plan.

**6.5.9 METHOD STATEMENT DRAWINGS**

Method Statement drawings are used to explain how a work can be done by the illustration of detailed construction methods and installation description in chronological working sequences.

**6.5.10 MASTER PLAN DRAWINGS**

A Master Plan drawing is the entire layout plan of a construction or a defined portion of a project and provides a common platform for the production of all the respective layouts and facilities drawings based on the entire boundary layout. Master Plan drawings are not the official drawings in the drawing set for submission or construction.

**6.5.11 STATION-BOX DRAWINGS**

The nature of Station-Box drawings is similar to the Master Plan drawings but are Station-base. They are used to maintain the modified layouts, structures, and facilities in an up-to-date condition after the as-built of the C&R or A&A Works have been completed. They contain all the drawings regarding the different engineering disciplines for the use by relevant sections such as Infrastructure Maintenances, Operations and Property.

**END OF APPENDICES**

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## 7. SUPPLEMENTS

### 7.1 SUPPLEMENT A - CADD STANDARDS FOR AUTOCAD

This supplement highlights the differences between AutoCAD and MicroStation operation platforms, the latter of which is to be applied as the CADD standard for the Corporation. For any standards or requirements that have not been described in this Section, users should refer to the Main sections of the Drawing and CADD Manual, as such standards or requirements are common to those CADD operation platforms.

AutoCAD software can be used for production of drawings so as to maintain their information integrity and consistency. For example, if the set of a drawing series is originated in AutoCAD format, then AutoCAD may be retained for its on-going amendment and appending of new drawings, subject to the approval of M-CADD as required below.

#### 7.1.1 CADD DRAWING REQUIREMENTS

All drawings prepared for the Corporation shall be prepared in MicroStation format and compatible with MicroStation file format.

For exceptional cases, Originators shall seek the written approval from M-CADD where it is necessity to use AutoCAD software in drawing updating / production, such as in the example of MTR Urban Lines and EMU / Light Rail Vehicle design, etc.

M-CADD or his delegated Representative of CADD Office (RCO) is responsible for accepting and registering receipt of all the deliverables of CADD files and accompanying documentation.

##### 7.1.1.1 CADD Utilities Package

Upon the appointment of the Originator, the Corporation shall provide the softcopies of a CADD utilities package to the Originator as soon as practicable after appointment. The package shall comprise the following :

- Drawing & CADD Manual
- AutoCAD seedfiles
- The Corporation standard title block MTR-A1.DWG
- Drawing file samples for the Project or Contract

##### 7.1.1.2 Drawing Format and CADD System

Subject to 7.1.1 above, all AutoCAD files provided to the Corporation shall be compatible with AutoCAD 2006 or above format, in a software version to be agreed by the Corporation. All files shall be capable of being implemented, revised and plotted through standard AutoCAD production techniques (i.e. not to attach reference files with "CADD drawing contents" in bitmap, jpg or raster format to a AutoCAD title frame). For any exceptional case, Originators shall seek the approval from the M-CADD.

## 7.1.2 CADD STANDARD FOR DRAWING PRODUCTION

### 7.1.2.1 File Setting - File Type 2D / 3D

In AutoCAD there is no limitation and by default in 3D file type.

### 7.1.2.2 Working Units (CADD System)

The Working Unit for AutoCAD is using the default setting, choosing either metres or millimetres.

### 7.1.2.3 Global Origin

Global Origin is not required for AutoCAD system.

### 7.1.2.4 Text Sizes

English and Chinese font faces and their sizes shall be in accordance with the below table or CSWP. English text shall be upright and uppercase. All texts shall be top left justified. Centre justification shall only be used in title-boxes.

Using of non-standard types of text sizes, fonts, and cases shall only be allowed for particular drawings for statutory submission, presentation, public consultation, customer-related poster, media, etc.

For drawing in A1-size format, the nominal text height for any drawing notes and annotations should be 3.5mm for English text, and 3.75mm for Chinese text.

**Table 7.1.2.4 General Requirement for Font Setting**

Fonts	MicroStation	AutoCAD	
Standard English Font	Font No.3 (Engineering)	Romans Font Style name : Standard	
Standard Width Factor	0.80 x Text Height	0.80	
Standard Chinese Font	MING	MING	
Standard Width Factor	1.00 x Text Height	1.00	
<b>For MicroStation &amp; AutoCAD</b>			
English Text Sizes	Text Height (mm)	Width Factor	Thickness (mm)
	2.0mm	0.80	0.18mm
	2.50mm	0.80	0.25mm
	3.50mm	0.80	0.35mm
	5.00mm	0.80	0.50mm
	7.00mm	0.80	0.70mm
	10.00mm	0.80	1.00mm

For MicroStation & AutoCAD			
Chinese Text Sizes	Text Height (mm)	Width Factor	Thickness (mm)
	3.75mm	1	0.25mm
	5.25mm	1	0.35mm
	7.50mm	1	0.50mm
	10.50mm	1	0.70mm

### 7.1.2.5 General Plotting Setting

**Table 7.1.2.5 General Requirement for Plotting Setting**

Plot Settings Common to MicroStation and AutoCAD		
Paper Size	Format	Size (mm)
	A0	841 x 1189
	A1	594 x 841
	A2	420 x 594
	A3	297 x 420
	A4	210 x 297
	B0	1000 x 1414
Pen Thickness	MicroStation	AutoCAD
	Weight 0 = 0.18mm	0.18mm
	Weight 1 = 0.25mm	0.25mm
	Weight 2 = 0.35mm	0.35mm
	Weight 3 = 0.50mm	0.50mm
	Weight 4 = 0.70mm	0.70mm
	Weight 5 = 1.00mm	1.00mm
	Weight 6 = 2.00mm	2.00mm

## **7.2 SUPPLEMENT B – BUILDING INFORMATION MODELING (BIM)**

### **7.2.1 GENERAL**

#### **7.2.1.1 Purpose and Scope**

This supplement defines the standards to be followed in the production of BIM Model for:

- a) Design coordination
- b) Visualization and presentation
- c) Clash analysis during design and construction stages of a project

The requirement of BIM is project specific. Where required, BIM Database shall form part of the as-built deliverables to the Corporation after project completion.

#### **7.2.1.2 Definitions and Abbreviations**

##### **Definitions**

BIM : Building Information Modeling, a process of generating and managing parametric building data

BIM Database : A complete set of BIM deliverables which contains all necessary disciplines and files (BIM model(s), standard templates, standard families, exported view(s)/sheet(s), Navisworks file(s), DWF(x) file(s), BIM Specification and all essential reference information & documents etc.) for continuous manipulation of the BIM Models by the successor

BIM Model : A parametric building data model generated and managed by a BIM authoring application

BIM Originator : A person or an organisation responsible for producing a BIM model for the Corporation or for a Corporation project

##### **Abbreviations**

BIM      Building Information Modeling

#### **7.2.1.3 Deliverables**

A complete BIM Database shall be submitted by the BIM Originator together with a submission list to describe every file in the deliverables. The media submission can be either CD-ROM or DVD format.

The BIM Originator shall verify and ensure the folder structure in the deliverable is well established and tested such that all necessary reference information shall be

loaded seamlessly by any workstation with standard installation of the BIM authoring application required by the Corporation.

All essential links (CAD format, Revit and DWF Markups) in the BIM model(s) shall maintain in the deliverables correctly.

A set of PDF/DWF(x)/NWD/DGN files of any output (views, sheets, schedules, rendering, clash analysis report etc.) from the BIM Database shall be included in the deliverable. The BIM Originator shall seek advice from M-CADD or his delegate whether to submit individual or combined PDF/DWF(x)/NWD/DGN files in the deliverable.

M-CADD or his delegate shall be responsible for accepting and registering receipt of the BIM Database and their accompanying documentation.

#### **7.2.1.4 Drawing and Documentation Production**

The BIM Originator shall collaborate and agree with the Consultant / Contractor's CADD Manager of the drawing production team for the drawing details to be exported from the models for drawing production. The Consultant / Contractor's CADD Manager shall document, maintain and submit the corresponding project drawing list, drawing numbering system, view/sheet naming system and the conversion details to M-CADD for approval to ensure that the drawing comply with MTR Drawing and CADD Manual standard.

The naming convention of views, legends, schedules, sheets and links shall contain a common reference to the corresponding 2D design drawings, tender drawings, working drawings and as-built drawings where appropriate.

#### **7.2.1.5 BIM Database Verification Checks**

Verification checks of BIM standards/contents compliance shall be conducted for each of the BIM Database submissions for conformity with all the requirements as illustrated below:

- BIM model shall be fully co-ordinated between disciplines (Architectural, Structural, Building Services and MTR Systems & Components where appropriate.).
- BIM model shall include individual saved views/sheets of all layout plans, sections and elevation drawings that the BIM model aligned with, then exported to DGN format and included in every BIM Database submission. The naming convention and the arrangement of such saved views/sheets in the BIM model and the exported DGN file shall be the same as the submission drawing number and the submission drawing layout respectively for cross reference and verification. The exported DGN file shall also be overlaid on the corresponding layout plans, sections and elevation drawings with PDF files generated and included in the BIM Database submission.
- BIM Database integrity.

### 7.2.1.6 BIM Database Production Life-Cycle Submissions

Stage	Submission Requirements
Design/Tender	<p>In general, tenderers are required to submit a preliminary BIM Database Production Plan containing information such as :</p> <ul style="list-style-type: none"> <li>• The resume / CV of Consultant / Contractor's BIM Co-ordinator;</li> <li>• Number of BIM modeler and BIM workstations proposed to be employed for the Contract;</li> <li>• Summary of the approach to setup the BIM Database to co-ordinate between disciplines;</li> <li>• Modeling definition and level of detail in accordance with the Scope of Services.</li> </ul>
Upon Contract award	<ol style="list-style-type: none"> <li>1) M-CADD shall provide the latest version of the Drawing &amp; CADD Manual together with the relevant project template to the Project team / Consultant / Contractor.</li> <li>2) Where necessary, the Project Manager shall arrange a briefing session for M-CADD to brief the Consultant / Contractor and their BIM Co-ordinator on the requirements of the Corporation's BIM standards, the submission procedures, verification issues, etc.</li> <li>3) The Consultant / Contractor shall submit the BIM Database Production Plan, which are to be included in the Quality Plan(s) in accordance with the Contract.</li> </ol>
All stages of the Contract / Construction	<ul style="list-style-type: none"> <li>• The BIM Originator shall submit the new / revised BIM Database in accordance with the relevant design, consultancy or contract agreement.</li> <li>• BIM Database submission shall include all documents and files required in the supplement.</li> <li>• The BIM Originator shall maintain and submit the BIM Specification for every BIM Database submission. The BIM Specification is to fully describe the BIM Database that serve as a product / user manual. The content to be documented is project specific and to be agreed with M-CADD.</li> <li>• The BIM Originator shall continuous update the BIM Database Production Plan, and shall submit to M-CADD.</li> <li>• M-CADD or his designate shall be responsible for carrying out checks on BIM Database for BIM standard compliance.</li> </ul>

### 7.2.2 BIM STANDARDS

#### 7.2.2.1 BIM Authoring Application

BIM Database and model submitted for the Corporation shall be prepared in Autodesk Revit Architecture Version 2010 or above, Autodesk Revit Structure Version 2010 or above, Autodesk Revit MEP Version 2010 or above, or other software version to be agreed by the Corporation.

#### **7.2.2.2 BIM Review Application**

The arrangement of the BIM Database and model shall be capable of exporting to DWF(x)/NWD format, such that the free Autodesk Design Review software/Navisworks Freedom software can view, print, measure, mark up the design model without the original BIM authoring application. This facilitates everyone in the review chain, sharing, visualizing and collaborating on the overall design. For NWD file, the Grids and Levels shall be incorporated to facilitate the navigation and walk-through. The BIM originator shall also submit the proposed “Selection Tree” and “Saved Viewpoints” setup in NWD file to M-CADD for approval.

#### **7.2.2.3 Project Folder Structure**

The BIM Originator shall maintain and document the project folder structure in the BIM Specification to suit the project size and nature. The proposed folder structure shall seek prior approval from M-CADD including subsequent updating. The folder structure shall meet the deliverable requirements as stated in Section 7.2.1.3.

The top level folder shall be named with the Contract / Project Number as defined in Section 3.1.2.1. Some subfolder naming conventions are listed below for reference:

- Archive
- Background
- Central\_File
- Incoming
- Photo
- Presentation
- BIM\_Admin
- Project\_Specific\_Families
- Project\_Template
- Common\_Families
- Fonts
- References
- BIM\_Specification

#### **7.2.2.4 Co-ordinate System & Orientation**

The BIM Originator shall ensure that all elements in the BIM Database are able to locate and annotate directly and correctly in the BIM Model based on the Hong Kong Grid (1980) System and Hong Kong Principal Datum. The setup of the BIM Database shall facilitate the seamless import/export of 2D CADD drawings

developed in accordance with MTR Drawing & CADD Manual without additional transformation.

#### **7.2.2.5 Project Template**

The BIM Originator shall develop and provide the project template in the BIM Database deliverable or use the MTR project template if provided. This will be subject to the instruction from M-CADD in considering the nature of the project.

The project template developed and applied in the project by the BIM Originator shall have the settings in line with the MTR Drawing and CADD Manual for 2D drawings. The following is a list of some examples of the settings the BIM Originator need to define for the template:

- Working units
- Colors
- Default families loaded
- Line styles
- Line weights
- Line patterns
- Time Data & place
- Annotation text note leader arrow
- Dimension style parameters
- Annotation symbol styles
- Default loaded tags
- Temporary dimension defaults
- Properly formatted schedules
- Custom host elements
- Named views and sheets
- View properties
- View display
- Fill patterns
- Material definitions
- Object styles
- Export layers definitions
- View templates
- Partition types
- General notes / legends
- Drawing titleblocks
- Standard details in drafting views
- Custom stair / railing types

#### **7.2.2.6 Naming Convention**

##### **Model file naming**

Revit model file name shall comply with the convention specified below:

***NATURE / STAGE CODE \_ LINES \_ LOCATION CODE \_ DISCIPLINE \_ AREA \_ TYPE.rvt***

Example: **D\_SCL\_HUH\_STR\_ALL\_CEN.rvt**

Each field is defined as follows:

**NATURE / STAGE CODE –**

Nature / Stage Code (Section 3.1.2.2)

**LINES –**

Refer MTR Operations Engineering Standard (Name and Location Code for Railway Lines and Associated Infrastructures)

**LOCATION CODE –**

Location Code (Section 3.1.2.3)

**DISCIPLINE –**

ARC	Architectural
CIV	Civil (including external Drainage optional)
DRN	Drainage Services (internal)
ELE	Electrical
FPS	Fire Protection Services
ECS	Environmental Control System
PLM	Plumbing Services
STR	Structural
GEO	Geotechnical

**AREA (3-alphanumeric characters) –**

For sub-divided models, this will indicate the zone or level of the project in the model file. Use “ALL” if build on one model file.

**TYPE (Revit BIM model file type) –**

LOC	Local file
CEN	Central file

**Family naming**

Family name shall comply with the convention specified below:

**CATEGORY-SUBCATEGORY-ORIGINATOR-DESCRIPTION1-DESCRIPTION2.rfa**

Example: **SCL-CON-MTR-Rect.rfa (Rect – Rectangular Column)**

**DOR-DBL-MTR-Steel\_Door.rfa**

**DCT-SAD-MTR-Air\_Grille.rfa (SAD – Supply Air Duct)**

**SPR-FPS-ATK-Hose\_Reel.rfa (Sprinkler system, Supply Pipe)**

**CATEGORY –**

Refer “Modeling Definition and Level of Detail” of the contract document for the Category code to use.

**SUBCATEGORY –**

This includes the routing names for BS components; type of doors or windows for ARC e.g. single or double and type of materials for STR e.g. steel or concrete.

**ORIGINATOR –**

Originator / Agent Code (Section 3.1.2.4)

**DESCRIPTION 1 & 2 –**

This is an optional text field to describe the family in details.

### **7.3      SUPPLEMENT C – MTR OPERATIONS DIVISION DRAWING NUMBERING SYSTEM**

This supplement gives the pointer to the MTR Operations Division - Operations Engineering Standard document no. S/COM/GP/010 (Engineering Drawing Standard) which defined the OED Drawing Numbering System being used by MTR Operations Engineering Department since 1994. The Drawing Numbering System described shall only be used by MTR internally. For any standards or requirements that have not been described in that document, users should refer to the Main sections of the Drawing and CADD Manual.

**END OF SUPPLEMENT**

## Appendix 1 – Applicability of A4 version of Drawing & CADD Manual

Amendments	Category A	Category B	Category C	Category D	Category E
WIL	✓	✓	✓		
SIL(E)	✓	✓	✓		
SCL	✓	✓	✓	✓ (if BIM is to be adopted)	
KTE	✓	✓	✓	✓	
XRL	✓	✓	✓	✓	
On-going Operations Projects	✓	✓	✓		✓
All Future Projects	✓	✓	✓	✓	✓

### Category of Amendments:

#### Category A - Minor Amendments

- Add manual updates to control changes up to next D&CM revision in section 1.3.2.1.
- Specify hardcopy drawings in PDF format and MS Excel Version 2003 in section 1.5.1.1.
- Specify hardcopy drawings in PDF format in sections – 1.5.1.4, 1.5.5 and 2.2.1.
- Replace “hardcopy” with “drawing” in section 1.5.3 (1) & (15)
- Specify hardcopy drawing shall be plotted from PDF drawing to order to maintain direct scaling effect of drawing in section 2.4.
- Better clarification to approver’s signature in Revision Box in section 2.6.2.2.
- Increase characters of Project Number / Job Reference Code as needed in section 3.1.2.1.
- For better clarification, use “character”, “alphanumeric character” and “alphabetic” to replace “digit” and “digits” in sections - 3.1.2 and 5.2.2.
- Use alphanumeric character for Agent, Railway Line and Location code in section 3.3.2.
- Delete “digits of” for better clarification in section 3.3.3.5.

#### Category B - New Codes/Descriptions

- Add “0” for “General” in section 3.3.3.2.
- Add “G18, G25 and G47” to section 5.2.3. G.
- Add ‘N70” to section 5.2.3. N.
- Add “Delivery Route Drawing” to section 5.2.3. S.

#### Category C - Signature and As-built Stamp for Drawings

- Clarify no signature is required for ACP/Interim stages of drawing revisions in section 2.6.2.2.
- Add as-built stamp with signature for as-built drawings in section 2.6.2.4.
- Add as-built stamp to Appendix D – Common Symbols in section 6.4.

**Category D - Overall review of section 7.2, Supplement B – Building Information Modeling (BIM)**

- BIM specification is reviewed according to the KTE BIM pilot project and the revised Supplement B will be issued for KTE and XRL BIM application.

**Category E - Section 7.3, Supplement C – MTR Operations Division Drawing Numbering System**

- The new supplement defines the Operations Engineering Department (OED) drawing numbering system used by OED and is for MTR internal use only.

Architect Department  
2 August 2011

TMSG\_CADD Manual Rev\_2011-8-17.doc

Issue : 1

Rev. : 0 01/02/2023

Contract C3855-22E  
Provision of In-Train Remote CCTV System  
and Train Car Loading Indicator for M-Trains  
Particular Specification

**Appendix H Control & Communications Cable Standard**

---

# Operations Engineering Standard

S/CC-gen/DS/01(99)

Former number: S/C&C/DS/001(2)

**Title:**  
Control & Communications Cable Standard

**Revision:** D                    **Date:** 2018-11-1

Safety related standard

---

This standard is mandatory and applied from the date of issue.

## ENDORSEMENT & AUTHORIZATION

Approved by standards owner:

HW Chan  
Communications and Control Engineering Manager

Date: 11/01/2019

Endorsed by (for safety related standard only):

N/A  
Chairman – Technical Standards Sub-committee

Date: \_\_\_\_\_

Authorized for issue by:

Michael Leung  
Deputy General Manager - Technical & Asset Engineering

Date: 15 JAN 2019



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## Revision Record

This standard will be updated when necessary by issuing a complete document. Amendments to the former issue will be summarized in the revision record below. The latest revision of this standard is mandatory and applied immediately from the authorized date for issue unless otherwise stated in the document.

<u>Rev.</u>	<u>Date</u>	<u>Amendment</u>	<u>Writer</u>
A	2009-06-23	i) Signalling related clauses deleted. ii) Re-issued under new format and document number	K.P. Tam
B	2012-09-27	3-yearly regular review with “10Base5 - Thick Ethernet Cable” deleted from Chapter 9 “Computer System Cables” and some general editing made.	Matthew Chung
C	2015-12-15	3-yearly regular review with: i) update of fire performance requirements; ii) addition of Unshielded Twisted Pair - UTP Cable (Category 6); iii) amendment of the specification of Unshielded Twisted Pair - UTP Cable (Category 5); iv) amendment of Optical Fibre Cables; v) amendment of Telephone Cables; and vi) some general editing made.	Ricko Lor
D	2018-11-1	3-yearly regular review with some corrections and international standards updated.	Ricko Lor

## Summary of Applicable Railway Lines

**Check this box for common standards and leave blank to all railway lines below.**

Please check the appropriate box(es) preceding the railway lines to which this standard shall apply; provide comments and/or any particulars / exceptions if applicable:

<u>Railway Line</u>	<u>Abbreviation</u>	<u>Comment</u>
<input checked="" type="checkbox"/> Operating Railway	OPR	_____
<input type="checkbox"/> East Rail Lines:	ERL	_____
<input type="checkbox"/> East Rail Line	EAL	_____
<input type="checkbox"/> Ma On Shan Line	MOL	_____
<input type="checkbox"/> Airport Express, Tung Chung & Disneyland Resort Lines:	AT&D	_____
<input type="checkbox"/> Airport Express Line	AEL	_____
<input type="checkbox"/> Disneyland Resort Line	DRL	_____
<input type="checkbox"/> Tung Chung Line	TCL	_____
<input type="checkbox"/> Light Rail	LR	_____
<input type="checkbox"/> Urban Lines:	URL	_____
<input type="checkbox"/> Island Line	ISL	_____
<input type="checkbox"/> Kwun Tong Line	KTL	_____
<input type="checkbox"/> Tseung Kwan O Line	TKL	_____
<input type="checkbox"/> Tsuen Wan Line	TWL	_____
<input type="checkbox"/> West Rail Line	WRL	_____

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## 1. PREFACE

### 1.1 Scope and Purpose

- 1.1.1 This standard covers the design and construction requirements for LS0H cables for cabling of control and communications systems throughout the Railway.
- 1.1.2 This standard does not cover the special needs of equipment specific cables, the specifications of which are peculiar to the performance of the item of equipment.
- 1.1.3 This standard does not cover LV power cables and associated accessories needed for powering control and communications systems. The specifications of these are detailed in the MTR Operations Engineering Standard “S/EM-lov/MW/01(99) – Material & Workmanship Standard for LV Electrical System” which shall apply if and where applicable.
- 1.1.4 The requirements of this standard shall apply to all MTR electrical installations, such that all installations and equipment are of a pre-determined quality and of consistent design throughout.
- 1.1.5 Any deviations from this standard shall be subject to the prior approval of the Engineer.

### 1.2 Definitions and Abbreviations

#### 1.2.1 Definitions

Definitions of terms are given in the Corporation’s “Railway Terminology”.

#### 1.2.2 Ducts

The term "ducts" in this standard shall mean any pipe, open or covered trench or cavity formed for the specific purpose of routing electrical and/or other services, other than electrical conduits, trunking and cable trays.

#### 1.2.3 Corrosive and acid gases

Corrosive and acid gases are defined as those which are determined to be Hydrochloric acid (HCl).

#### 1.2.4 Abbreviations

AWG	American Wire Gauge
BS	British Standard
CCTV	Closed Circuit Television
EMC	Electro-magnetic Compatibility
EN	European Norm for the European Union

FC	Face Contact
FC/PC	Face Contact/Physical Contact
FCC	Federal Communications Commission
HCl	Hydrochloric Acid
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
ITU-T	Telecommunication Standardization Sector of the International Telecommunication Union
LDF	Light Distribution Frame
LS0H	Low Smoke Zero Halogen
NTT	Nippon Telephone & Telegraph
PA	Public Address
PVC	Polyvinyl Chloride
S/N	Signal to Noise (Ratio)
URL	Urban Lines
UTP	Unshielded Twist Pair
UV	Ultra Violet

### 1.3 Safety Considerations

All cables shall conform to uniform standards of fire resistance/retardant and smoke emission properties, to ensure that hazardous conditions arising from the overheating or ignition of cables are avoided. Cables shall therefore be manufactured from fire resistant/retardant, low smoke and halogen free materials, and utilised at locations as specified herein.

## 2. GENERAL REQUIREMENTS

### 2.1 Cables

- 2.1.1 All the cable requirements listed herein shall be met without compromising the anti-vermin, pest resistant, mechanical and electrical properties of the cables both during and after installation. Resistance of cables to insect or vermin shall not require the use of any chemical additives.
- 2.1.2 Cables used in external or open areas shall be able to withstand Ultra Violet (UV) rays.
- 2.1.3 The Engineer or appointed representative shall have such access to the works of the manufacturer as is reasonable to enable him to determine the quality of the material and the workmanship. The Engineer or appointed representative shall have power to reject any part of the cable which may appear defective either in material or workmanship.
- 2.1.4 All cables shall be tested for their mechanical, optical or electrical properties meeting requirements as specified in this standard. Test results and certificates shall be submitted for the Approval of the Engineer.

2.1.5 In lieu of no relevant test certificates being available tests shall be carried out by the manufacturer as those laid down in the relevant specification but this shall not preclude any test desired by the Engineer to determine the quality of the cable. The manufacturer must satisfy the Engineer by tests carried out in the presence of the Engineer or his appointed representative and/or production of a test certificate from a recognised testing laboratory or otherwise that the materials used and the cable itself is of the highest possible standards and complies with all relevant specifications.

## 2.2 Cable Drums

- 2.2.1 Immediately after the Works Tests both ends of every length of cables shall be sealed by enclosing them with approved caps, tight fitting and secured to prevent ingress of moisture.
- 2.2.2 The ends of the factory lengths of cable shall be marked "A" and "Z", "A" being the end at which the sequence of core numbers is clockwise and "Z" the end at which the sequence is anti-clockwise.
- 2.2.3 The end which is left projecting from the drum shall be consistently "A" or "Z", and shall be protected against damage in such a manner that the enclosure cannot be bumped or vibrated loose during handling while in transit.
- 2.2.4 Cables shall be supplied on drums in the longest possible lengths consistent with it being practicable that the drum when mounted on a cable wagon shall not exceed the specified Load Gauge of the railway.
- 2.2.5 All cable drums shall be arranged to take a 100mm diameter round spindle and shall be lagged with strong closely-fitting battens so as to prevent damage to the cable. Each drum shall bear a distinguishing number, either printed or legibly chiselled on the outside of one flange. A suitable spindle shall be provided with each consignment for loading and unloading where the gross weight of the drum and cable exceeds 10 tonnes.
- 2.2.6 Particulars of the cable, i.e. voltage, length, conductor size, number of cores, finish, section and length number, gross and net weights, shall be shown in clear view on one flange of the drum. In addition the words "Running End 'A'" or "Running End 'Z'" as appropriate shall be marked on the flange and the direction for rolling shall be indicated by an arrow.
- 2.2.7 All cables and accessories shall be packed for transport and storage on site in such a manner that they are protected against all climatic conditions, particular attention being paid to the possibility of deterioration during transport to the site by sea or over-land and to the conditions prevailing on the site.

- 2.2.8 Wooden cable drums shall be constructed to avoid distortion due to shrinkage. The drums shall be designed for use in conjunction with any special cable-laying equipment complete with spindles and cable drum braking gear, which shall be used to install the cables in tunnel, stations or elevated sections of the railway system.
- 2.3 Defined Areas of Cable Use
- 2.3.1 Underground Station
- Cabling shall be fire retardant, low smoke and halogen free or low halogen.
- 2.3.2 Tunnel-Trackside Areas
- Cabling shall be fire retardant, low smoke and halogen free with armouring for mechanical protection.
- 2.3.3 Elevated and Grade Stations
- Cabling shall be fire retardant, low smoke and halogen free.
- 2.3.4 Viaduct/Depot-Trackside Areas
- Cabling shall be fire retardant, low smoke and halogen free with armouring for mechanical protection.
- 2.3.5 Depot/Ancillary Buildings/Plant Rooms
- Cabling shall be fire retardant, low smoke and halogen free.
- 2.4 Cable Containment
- 2.4.1 Cable Trays
- 2.4.1.1 Cable trays shall be of a factory-made type complete with factory made bends, tees and fixing accessories. The cable trays shall be made from mild steel sheet, perforated, and hot-dipped galvanized.
- 2.4.1.2 Unless otherwise specified, widths of cable trays, accessories, thickness of steel, flanges of trays, and bends or tees, shall be nominally as shown in Table 1:

Width of Tray (mm)	Thickness of Steel (mm)	Flanges of Tray Bends or Tees (mm)
50	0.9	13
75	0.9	13
100	0.9	13
150	0.9	13
225	1.2	13

Width of Tray (mm)	Thickness of Steel (mm)	Flanges of Tray Bends or Tees (mm)
300	1.6	20
375	1.6	20
450	1.6	20
600	2	20
800	2	20
1000	2	50

Table 1 - Thickness of steel in trays

- 2.4.1.3 All trays that are cut for installation shall have their ends painted with a zinc coating to ensure continuous protection.
- 2.4.1.4 Trays shall have suitable strength and rigidity to provide adequate support for all contained cabling.
- 2.4.1.5 Cable trays shall not present any sharp edges, burrs, or projections that could damage the insulation or sheathing of the cables.
- 2.4.1.6 Each run of cable tray shall be completed and cleared of debris before the installation of any cables.
- 2.4.1.7 Sufficient space shall be provided and maintained above the cable trays to permit adequate access for the installation and maintenance of the cables. Where cable tray is suspended from the ceiling, wall or structure, it shall be supported by hot dipped galvanized steel supports or hangers of approved design.

## 2.5 Cable Trunking

- 2.5.1 Trunking and fittings shall comply with IEC 61084. Factory fabricated bends and tee's shall be used.
- 2.5.2 Trunking shall be manufactured in mild-steel sheet and shall be hot-dip galvanized. Trunking shall have a removable cover throughout its length with centre-screw latch fixing, or quick-fixing device to the Engineer's approval, size up to 100×100mm shall be 1.6mm thick and 150×75mm to 150×150mm shall be 1.8mm thick. The trunking shall be supplied in 2400mm lengths (unless this is not convenient for subsequent installation), each length being supplied with a sleeve-type coupling and a copper earth bonding link. Bonding link shall be fixed on external surfaces unless otherwise specified.
- 2.5.3 All inter rack trunking shall be of the same material as the rack.

2.5.4 Unless otherwise agreed by the Engineer, the minimum size shall be 50×50mm.

2.5.5 All bends, tee pieces, stop ends, outlets, inter-sections and adapters shall be of the same manufacture as the trunking. All inside edges of trunking shall be smooth and provision shall be made to prevent abrasion at bends.

## 2.6 Pipes and Ducts

The material and construction of pipes and ducts where specified shall submitted for the Approval of the Engineer. Pipes and ducts into which cables are to be drawn shall be such that the usable spare capacity is not less than 55%.

## 2.7 Conduit and Conduit Boxes

### 2.7.1 General

2.7.1.1 All conduits shall be heavy gauge, hot-dipped galvanized welded steel complying with BS EN 61386 Part 1.

2.7.1.2 All conduit fittings and components shall be in accordance with BS EN 61386.

2.7.1.3 Flexible conduit and filings shall comply with BS EN 61386 Part 1 and in addition shall be of the metallic watertight pattern, oversheathed with low smoke halogen free material, and with a separate earth wire enclosed within the conduit.

2.7.1.4 The minimum size of conduit used in the installation shall be 20mm diameter.

2.7.1.5 Separate conduits shall be provided for extra low voltage circuits.

2.7.1.6 Inspection - type conduit bends, elbows and tees shall not be permitted.

2.7.1.7 All boxes and conduit accessories used in outdoor locations shall be weatherproof. Weatherproof boxes and conduit accessories shall also be used in locations other than outdoors when so specified or as directed by the Engineer.

2.7.1.8 All draw boxes and junction boxes shall comply with the appropriate BS and be of ample size to permit the cables being drawn in and out. They shall be made of galvanized malleable iron with jointing surfaces machined to ensure a dust-tight joint. All circular boxes shall be provided with long spouts internally

threaded incorporating a shoulder for the flush butting of the conduit and a tapped 5mm hole in the base to accept a solid brass earth terminal.

#### 2.7.2 Surface Conduit

All conduit boxes and accessories for surface conduits shall be of a type manufactured specifically for that purpose.

### 3. FIRE PERFORMANCE REQUIREMENTS

The following requirements in respect of fire performance shall apply to all cables unless otherwise specified.

#### 3.1 Fire Resistance

- 3.1.1 All cables shall be flame retardant unless otherwise specified to be fire resistant.
- 3.1.2 Fire resistant cables shall comply with the requirements of IEC 60331 and BS 6387 category 'CWZ' in addition to compliance with all fire performance requirements for flame retardant cables.

#### 3.2 Flammability

- 3.2.1 All plastic components of the cable including oversheath, bedding, insulation, filler, binder, etc. shall be low smoke halogen free compounds and shall have a minimum oxygen index of 35 when tested in accordance with **ASTM D2863 / BS EN ISO 4589-2**.
- 3.2.2 The temperature index of the low smoke halogen free plastic components of the cable including oversheath, bedding, insulation, filler, binder, etc. shall not be less than 280°C when tested in accordance with BS EN ISO 4589-3.

#### 3.3 Flame Propagation

- 3.3.1 The cable shall be flame retardant and shall comply with the requirements of IEC 60332-1 for tests on a single cable under fire conditions.
- 3.3.2 The cables shall comply with the requirements of IEC 60332-3-24 for tests on bunched cables under fire conditions.

#### 3.4 Corrosive and Acid Gas Emission

The level of HCl of the low smoke halogen free compound (fillers, bedding, oversheath, etc) and the insulation of the cable shall not be greater than 0.5% when tested in accordance with IEC 60754-1.

All non-metallic constituent materials of all cables shall be halogen free and shall comply with the performance requirements in IEC 60754-2 when tested in accordance with that standard.

### 3.5 Smoke Emission

The level of light transmittance shall meet the requirements of IEC 61034-2.

### 3.6 Fire Performance Test

All cables shall be tested for their fire performance conforming to requirements as specified in this standard which shall include the following:

- a) Oxygen Index Measurement (Type and Sample Test)
- b) Temperature Index Measurement (Type and Sample Test)
- c) Flame Propagation (Type Test)
- d) Corrosive & Acid Gas Emission (Type and Sample Test)
- e) Smoke Emission (Type and Sample Test)

## 4. OPTICAL FIBRE CABLES

### 4.1 Optical Fibre Trunk Cable

#### 4.1.1 ITU-T and Other Standards

The cable shall comply with the International Telecommunication Union- Telecommunication Standardization Sector (ITU-T) Recommendations G.652D and IEC 60793 standards specifications unless otherwise specified hereinafter.

#### 4.1.2 Optical Requirements

The cable shall have the optical properties shown in Table 2.

Type	Single Mode
Mode Field Diameter	$10\mu \pm 1\mu\text{m}$
Cladding Diameter	$125\mu \pm 3\mu\text{m}$
Optical Attenuation	$\leq 0.36 \text{ dB/km} @ 1300 \pm 25\text{nm}$ $\leq 0.22 \text{ dB/km} @ 1550 \pm 25\text{nm}$
Chromatic Dispersion	$\leq 3.5 \text{ ps/nm.km} @ 1285-1330\text{nm}$ $\leq 18 \text{ ps/nm.km} @ 1525-1575\text{nm}$
Polarization Mode Dispersion Coefficient	$\leq 0.20 \text{ ps}/\sqrt{\text{km}}$
Cut Off Wave Length	$\leq 1260 \text{ nm}$

Table 2 - Optical properties of optical fibre trunk cables

#### 4.1.3 Construction Requirements

##### 4.1.3.1 Features

The cable shall be tight buffered or loose tube type.

#### 4.1.3.2 Bedding

The bedding of the cable shall consist of an extruded layer of reduced flame propagation LS0H compound complying with the fire performance requirements stated herein.

#### 4.1.3.3 Armour

Armour for the cable shall consist of single layer of steel tape or galvanized steel wire to BS 5467.

#### 4.1.3.4 Moisture Barrier

One side plastic coated aluminium tape (0.15mm) with flooding compound.

#### 4.1.3.5 Oversheath

The oversheath of the cable for underground sections shall be an extruded layer of anti-corrosion, reduced flame propagation, LS0H compound complying with the fire performance requirements stated herein.

The oversheath of the cable for above ground sections shall be an extruded layer of anti-corrosion, flame retardant and UV resistance material.

#### 4.1.3.6 Identification

Each fibre shall be colour-coded to provide easy unit identification.

The oversheath of the cable shall be embossed with "OPTICAL FIBRE CABLE"

### 4.1.4 Mechanical Requirements

4.1.4.1 The allowed pulling tensions of the cable shall not be less than 300kgf.

4.1.4.2 Bending Radius with rated pulling tension as specified above shall be approx.  $20 \times$  outer diameter.

4.1.4.3 Bending Radius without pulling tension shall be approx.  $10 \times$  outer diameter.

### 4.1.5 Environmental Requirements

The cable shall be of outdoor type and operating in temperature range of -20°C to 60°C.

#### 4.1.6 Testing

- 4.1.6.1 Test methods of the cable shall conform to the ITU-T Recommendation G.652D, IEC 60793 and IEC 60794 where appropriate.
- 4.1.6.2 Test results and certificates shall be submitted for the Approval of the Engineer.
- 4.1.6.3 Bending Radius with rated pulling tension as specified shall be approx.  $20 \times$  outer diameter.
- 4.1.6.4 Bending Radius without pulling tension shall be approx.  $10 \times$  outer diameter.

#### 4.2 Internal Optical Fibre Cable

##### 4.2.1 ITU-T and Other Standards

The cable shall comply with the ITU-T Recommendations G.652D for single mode fibres or G.651.1 for multi mode fibres.

##### 4.2.2 Optical Requirements

The cable shall have the optical properties given in Table 3.

Type	Multi Mode	Single Mode
Core / Mode Field Diameter	$50\mu\text{m} \pm 3\mu\text{m}$ or $62.5\mu\text{m} \pm 3\mu\text{m}$	$10\mu\text{m} \pm 1\mu\text{m}$
Cladding Diameter	$125\mu\text{m} \pm 3\mu\text{m}$	$125\mu\text{m} \pm 3\mu\text{m}$
Optical Attenuation	$\leq 3.0 \text{ dB/km} @ 850\text{nm}$ $\leq 1.0 \text{ dB/km} @ 1300\text{nm}$	$\leq 0.36\text{dB/km} @ 1300 \pm 25\text{nm}$ $\leq 0.22\text{dB/km} @ 1550 \pm 25\text{nm}$
Chromatic Dispersion		$\leq 3.5\text{ps/nm.km} @ 1285-1330\text{nm}$ $\leq 18\text{ps/nm.km} @ 1525-1575\text{nm}$
Cut Off Wave Length		$\leq 1260\text{nm}$

Table 3 - Optical properties of internal optical fibre cables

##### 4.2.3 Flame Propagation

The cable shall comply with the requirement of IEC 60332-1 for test on single cable under fire conditions.

The cable shall comply with the requirement of IEC 60332-3-24 for tests on bunched cables under fire conditions.

##### 4.2.4 Construction Requirements

###### 4.2.4.1 Features

The cable shall be tight buffered or loose tube type.

#### 4.2.4.2 Oversheath

The oversheath of the cable shall be an extrude layer of anti-corrosion, reduced flame propagation, low smoke halogen free compound complying with the fire performance requirements stated herein.

#### 4.2.4.3 Identification

The oversheath of the cable shall be printed with "OPTICAL FIBRE CABLE".

### 4.2.5 Testing

- 4.2.5.1 Test methods of the cable shall conform to the ITU-T Recommendations G.651 for multi-mode fibre cables or G.652D for single mode fibre cables.
- 4.2.5.2 Test results and certificates shall be submitted for the Approval of the Engineer.

### 4.3 Optical patch cords and pigtails

#### 4.3.1 ITU-T and Other Standards

- 4.3.1.1 All jumpers and patch cords shall be fitted with NTT FC/PC connectors at the factory.
- 4.3.1.2 The optical Patch Cord and Pigtail shall comply with the ITU-T Recommendations G.652D.

#### 4.3.2 Optical Requirements

The cable shall have the optical properties given in table 4.

Type	Multi Mode	Single Mode
Mode Field Diameter	$50\mu \pm 3\mu m$ or $62.5\mu m \pm 3\mu m$	$10\mu \pm 1\mu m$
Cladding Diameter	$125\mu \pm 3\mu m$	$125\mu \pm 3\mu m$
Optical Attenuation	$\leq 3.0 \text{ dB/km} @ 850\text{nm}$ $\leq 1.0 \text{ dB/km} @ 1300\text{nm}$	$\leq 0.36 \text{ dB/km} @ 1300 \pm 25\text{nm}$ $\leq 0.22 \text{ dB/km} @ 1550 \pm 25\text{nm}$
Chromatic Dispersion		$\leq 3.5 \text{ ps/nm.km} @ 1285 - 1330\text{nm}$ $\leq 18 \text{ ps/nm.km} @ 1525 - 1575\text{nm}$
Cut Off Wave Length		<1260nm

Table 4 - Optical properties of optical patch cords and pigtail cables

#### 4.3.3 Packaging

4.3.3.1 Patch cords and pigtails shall be in single fibre package.

#### 4.3.4 Bending Radius

4.3.4.1 The minimum bending radius shall be less than 40mm.

### 4.4 Optical Accessories

#### 4.4.1 Light Distribution Frame (LDF)

4.4.1.1 All fibre cores terminating in the LDF shall be spliced pigtails fitted with connectors at the factory.

4.4.1.2 Optical couplers (NTT FC type) shall be provided with the patch panel to terminate the incoming/outgoing pigtails to the patch cord.

4.4.1.3 Optical patch cords shall be provided to connect the optical terminal to the patch panel.

4.4.1.4 All spare fibre couplers shall be protected with PVC jackets.

4.4.1.5 Fibre organizers shall be provided in the combined distribution frame and the light guide distribution case to coil up the excess length of pigtail and patch cords.

#### 4.4.2 Connectors

4.4.2.1 All optical connectors used, including the pigtail of the optical line transmission equipment and optical patch cords shall be of NTT FC/PC Single mode 10/125 $\mu$ m type.

4.4.2.2 All optical connectors shall comply with the ITU-T Recommendation G.652D.

4.4.2.3 Mating face dimensions in accordance with IEC 61300.

#### 4.4.3 Optical Performance

Optical connectors shall have the performance characteristics given in Table 5.

	Items	Requirement
Attenuation	Average	$\leq 0.6\text{dB}$
	Maximum	$\leq 1.0\text{dB}$
Return Loss	Average	$\geq 22\text{dB}$

	Minimum	$\geq 20\text{dB}$
Life expected		$\geq 20$ years
Repeatability		change in attenuation $\leq 0.2\text{dB}$ after 500 Matings
Fibre pull out strength		$\geq 9$ kgf
Environmental	Temperature Range	-20°C to +60°C
	Humidity Range	>95%

Table 5 - Optical performance of optical connectors

## 5. TELEPHONE CABLES

### 5.1 Trackside Telephone Cable

#### 5.1.1 Construction Requirements

##### 5.1.1.1 Conductors

5.1.1.1.1 The Conductor sizes, cores and colours correspond to the Post Office Corporation (POC) requirements and to IEC 60189.

5.1.1.1.2 Each conductor in the cable shall consist of a solid wire of annealed high conductivity copper or copper clad aluminium, drawn so as to have an even cross-section and no surface irregularities, circular in cross-section uniform in quality, free from defects and coated with a uniformly layer of pure tin.

5.1.1.1.3 Cable construction shall be designed to limit the generation of dangerous voltages and noise or interference on all circuits connected with the telephone system to levels not greater than those specified in the relevant ITU-T directives.

##### 5.1.1.2 Insulation

5.1.1.2.1 The cable insulation shall consist of extruded Low smoke Halogen Free material.

5.1.1.2.2 The nominal thickness of the insulation shall be as specified in BS 6724.

5.1.1.2.3 The insulation shall not break down when spark tested in accordance with BS EN 62230.

##### 5.1.1.3 Core Identification

5.1.1.3.1 The insulated cores shall be clearly identified by colours, and the identification scheme shall be in accordance with IEC 60189.

5.1.1.3.2 The required number of pairs shall be laid up in concentric layer to form a compact symmetrical cable.

5.1.1.4 Pairs

The insulated cores shall be twisted together to form either pairs or quads.

5.1.1.5 Bedding

The bedding shall consist of an extruded layer of LS0H bedding compound. When tested in accordance with IEC 60754-1, the level of HCl shall not be greater than 0.5%.

5.1.1.6 Screening

5.1.1.6.1 Screening shall be achieved by the use of laminated tape, consisting of an aluminium foil bonded to a polyester film for the strength, applied to the cable with an overlap so that full 100% coverage of the conductors is afforded (Note : spray on types of construction are not acceptable).

5.1.1.6.2 The cable shall be individually screened pair cables for the circuits where to improve cross talk immunity are required.

5.1.1.6.3 A drain wire or continuity conductor, laid under and in contact with the aluminium foil shall be provided and shall be in accordance with BS5308 clauses 7 and 10 as appropriate. The tinned annealed copper conductor, which may be solid or a stranded construction, in keeping with current manufacturing techniques, shall have a minimum cross-sectional area of 0.5mm.

5.1.1.6.4 The maximum resistance of the drain wire or continuity conductor provided shall meet with the requirements of IEC 60228.

5.1.1.7 Armour

#### 5.1.1.7.1 General

Armouring the cables, when specified, shall be by means of galvanised steel wire or tape, or alternatively brass tape. In addition to providing protection against accidental damage the armour shall also form a resistive barrier against the ingress of rodents.

#### 5.1.1.7.2 Wire Armour

Armouring shall be of galvanized steel wire to BS 5467. The direction of lay of the armour shall be left hand, and the wire shall be sized in accordance with the manufacturers' recommendations.

#### 5.1.1.7.3 Tape Armour

The cable shall be armoured with a brass or steel tape wound or lapped to at least 30% minimum. Brass tape shall be a minimum of 0.1mm thick and shall comply with the requirements of BS EN 1652. Steel tape thickness shall comply with the relevant British Standard.

The metal flat tape shall consist of a single flat tape applied helically directly over the bedding sheath with a suitable lay and overlap as specified in BS EN 1652. Alternatively, two tapes may be applied each with a slight gap, the second tape covering the gap of the first.

#### 5.1.1.7.4 Oversheath

The oversheath of the cable shall be an extruded layer of anti-corrosion, reduced flame propagation, LS0H compound complying with the fire performance requirements stated herein.

The colour of the oversheath shall be black.

### 5.1.2 Electrical Requirements

Diameter of the conductor	0.64mm (22AWG)
Conductor Resistance	65Ω/km max.
Insulation Resistance	50MΩ km min.
Mutual Capacitance at 1kHz	90nF/km max.

Resistance Unbalance	$\pm 2\%$ max
Near End Cross-talk	$\geq 60\text{dB}$ at 800Hz
Attenuation:	1.5dB/km max. @ 1kHz
	2.5dB/km max. @ 10kHz
	5.5dB/km max. @ 100kHz

### 5.1.3 Mechanical Requirements

Maximum pulling tension	250 kgf
Minimum bending radius	$15 \times \text{OD}$
Operational Conditions	-20°C to 60°C

### 5.1.4 Cable Construction Identification

The oversheath of the cable shall be embossed with the words 'TELECOMMUNICATION CABLE'. Tail cables such as trackside telephone cables are excluded from this requirement.

### 5.1.5 Testing

#### 5.1.5.1 Electrical Test

5.1.5.1.1 Electrical tests as specified in IEC 60708 shall be carried out on every length of cable and shall include the following:

- a) Conductor resistance
- b) Insulation resistance
- c) Mutual capacitance
- d) Resistance Unbalance
- e) Near end cross talk

5.1.5.1.2 Dielectric strength of the cable shall be tested in accordance with IEC 60189-1 Section 5.2.2 using a voltage of 5KV (r.m.s).

#### 5.1.5.2 Mechanical Test

Mechanical test as specified in IEC 60708 shall be carried out and shall include the following:

- i) Conductors - Elongation test
- ii) Insulation -Elongation
- iii) Insulation - Breaking force
- iv) Insulation - Resistance to compression
- v) Insulation - Retraction
- vi) Metal sheath thickness
- vii) Dimensions of magnetic screen tapes
- viii) Extruded anti-corrosion flame retardant sheath

thickness

## 5.2 Internal Telephone Cable

### 5.2.1 Construction Requirements

#### 5.2.1.1 Conductors

5.2.1.1.1 The conductor sizes, cores and colours correspond to the Post Office Corporation (POC) requirements and to IEC 60189.

5.2.1.1.2 Each conductor in the cable shall consist of a solid wire of annealed high conductivity copper or copper clad aluminium, drawn so as to have an even cross-section and no surface irregularities, circular in cross-section uniform in quality, free from defects and coated with a uniform layer of pure tin.

5.2.1.1.3 Cable construction shall be designed to limit the generation of dangerous voltages and noise or interference on all circuits connected with the telephone system to levels not greater than those specified in the relevant ITU-T directives.

#### 5.2.1.2 Insulation

5.2.1.2.1 The cable insulation shall consist of extruded Low Smoke Halogen Free material.

5.2.1.2.2 The nominal thickness of the insulation shall be as specified in BS 6724.

5.2.1.2.3 The insulation shall not break down when spark tested in accordance with BS EN 62230.

#### 5.2.1.3 Core Identification

5.2.1.3.1 The insulated cores shall be clearly identified by colours, and the identification scheme shall be in accordance with IEC 60189.

5.2.1.3.2 The required number of pairs shall be laid up in concentric layers to form a compact symmetrical cable.

#### 5.2.1.4 Pairs

The insulated cores shall be twisted together to form pairs.

#### 5.2.1.5 Bedding

The bedding shall consist of an extruded layer of LS0H bedding compound. When tested in accordance with IEC 60754-1, the level of HCl shall not be greater than 0.5%.

#### 5.2.1.6 Screening

5.2.1.6.1 Screening shall be achieved by the use of laminated tape, consisting of an aluminium foil bonded to a polyester film for the strength, applied to the cable with an overlap so that full 100% coverage of the conductors is afforded (Note : spray on types of construction are not acceptable).

5.2.1.6.2 The cable shall be individually screened pair cables where in transmission of high speed data circuit to provide improved cross talk performance characteristic.

5.2.1.6.3 For the application at frequency within 10 kHz, the cable shall be individual twisted pair.

5.2.1.6.4 A drain wire or continuity conductor, laid under and in contact with the aluminium foil shall be provided and shall be in accordance with **BS EN 50288-7** clauses 4 as appropriate.

5.2.1.6.5 The maximum resistance of the drain wire or continuity conductor provided shall meet with the requirements of IEC 60228.

#### 5.2.1.7 Oversheath

The oversheath of the cable shall be an extruded layer of anti-corrosion, reduced flame propagation, LS0H compound complying with the fire performance requirements stated herein.

### 5.2.2 Electrical Requirements

Diameter of the conductor	0.64mm (22AWG)
Conductor Resistance	65Ω/km max.

Insulation Resistance	50MΩ km min.
Mutual Capacitance at 1kHz	90nF/km max.
Resistance Unbalance	±2% max
Near End Cross-talk	≥60dB at 800Hz
Attenuation:	1.5dB/km max. @ 1kHz
	2.5dB/km max. @ 10kHz
	5.5dB/km max. @ 100kHz

### 5.2.3 Mechanical Requirements

Maximum pulling tension	25 kgf
Minimum bending radius	10 × OD
Operational Conditions	0°C to 60°C

### 5.2.4 Cable Construction Identification

The oversheath of the cable shall be permanent print with the words 'TELECOMMUNICATION CABLE'.

### 5.2.5 Testing

#### 5.2.5.1 Electrical Test

Electrical tests as specified in IEC 60708 shall be carried out on every length of cable and shall include the following:

- i) Conductor resistance
- ii) Insulation resistance
- iii) Mutual capacitance
- iv) Resistance Unbalance
- v) Near End Cross-talk

#### 5.2.5.2 Mechanical Test

Mechanical test as specified in IEC 60708 shall be carried out and shall include the following:

- i) Conductors - Elongation test
- ii) Insulation - Elongation
- iii) Insulation - Breaking force
- iv) Insulation - Resistance to compression
- v) Insulation - Retraction
- vi) Dimensions of magnetic screen tapes
- vii) Extruded anti-corrosion flame retardant sheath thickness

## 5.3 Jumper Cable

### 5.3.1 Construction Requirements

#### 5.3.1.1 Conductors

5.3.1.1.1 The Conductor sizes, cores and colours correspond to the Post Office Corporation (POC) requirements and to IEC 60189.

5.3.1.1.2 Each conductor in the cable shall consist of a solid wire of annealed high conductivity copper, drawn so as to have an even cross-section and no surface irregularities, circular in cross-section uniform in quality, free from defects and coated with a uniform layer of pure tin.

5.3.1.1.3 Cable construction shall be designed to limit the generation of dangerous voltages and noise or interference on all circuits connected with the telephone system to levels not greater than those specified in the relevant ITU-T directives.

#### 5.3.1.2 Insulation

5.3.1.2.1 The cable insulation shall consist of extruded low smoke halogen free material.

5.3.1.2.2 The nominal thickness of the insulation shall be as specified in BS 6724.

5.3.1.2.3 The insulation shall not break down when spark tested in accordance with BS EN 62230.

#### 5.3.1.3 Core Identification

The insulated cores shall be clearly identified by colours, and the identification scheme shall be in accordance with IEC 60189.

#### 5.3.1.4 Pairs

5.3.1.4.1 The insulated cores shall be twisted together to form pairs.

5.3.1.4.2 The attenuation of each pair shall be measured and shall not exceed 0.73dB per 1000m 0.73dB/km at 1kHz at a temperature of 20°C.

### 5.3.2 Testing

### 5.3.2.1 Electrical Test

Electrical tests as specified in IEC 60189-1 shall be carried out on every length of cable and shall include the following:

- i) Conductor resistance
- ii) Insulation resistance
- iii) Mutual capacitance

### 5.3.2.2 Type Test

Type test as specified in IEC 60708 shall be carried out and shall include the following:

- i) Conductors - Elongation test
- ii) Insulation - Elongation
- iii) Insulation - Breaking force
- iv) Insulation - Resistance to compression
- v) Insulation - Retraction
- vi) Extruded anti-corrosion flame retardant sheath thickness

## 5.3.3 Cable Accessories

### 5.3.3.1 Termination Blocks

5.3.3.1.1 Termination blocks shall be vibration proof. Line side blocks shall have gas-discharge surge arrestors fitted and allow interruption of any circuit using plugs/jacks. Equipment side terminal blocks connecting distribution cable shall also allow for interruption of each circuit.

5.3.3.1.2 Termination blocks for V.11, V.24 or V.35 cable adaptors shall be corrosion-resistant, sturdy and weather proof.

5.3.3.1.3 Termination blocks shall be designed for operating environment at 0-60°C temperature range and up to 95% humidity.

5.3.3.1.4 Termination blocks shall be submitted for the Approval of the Engineer.

## 6. CLOSED CIRCUIT TELEVISION (CCTV) CABLES

### 6.1 Outdoor Coaxial Cable

#### 6.1.1 Construction Requirements

#### 6.1.1.1 Conductors

- 6.1.1.1.1 The Inner conductors shall be of stranded, high conductivity annealed copper or tinned copper, or of copper clad steel wire complying with all the requirements of IEC 60228.
- 6.1.1.1.2 The outer conductors shall be of copper tape or braid, or of corrugated copper or aluminium tube.
- 6.1.1.1.3 Conductor shall be smooth, uniform in quality, free from scales, spills, splits and any other defects.

#### 6.1.1.2 Dielectric

- 6.1.1.2.1 The cable dielectric shall be air dielectric or semi-air dielectric with insulation spacer, or solid high density polyethylene.
- 6.1.1.2.2 The insulation spacer shall be uniformly spaced and hold the inner conductor centred within the sleeve and the outer conductor.

#### 6.1.1.3 Insulation

The insulation resistance shall be measured in accordance with BS EN 50117:Part 1.

#### 6.1.1.4 Spark Test for Sheath

The insulation shall not break down when spark tested in accordance with BS EN 62230.

#### 6.1.1.5 Double Screening (if required)

- 6.1.1.5.1 Screening shall be achieved by the use of copper braid or aluminium tube with an overlap so that full 100% coverage of the dielectric is afforded (Note : spray in types of construction are not acceptable)

- 6.1.1.5.2 The screening attenuation shall comply with BS EN 50117:Part 1.

#### 6.1.1.6 Oversheath

- 6.1.1.6.1 The oversheath of the cable shall be an extruded layer of anti-corrosion, reduced

flame propagation, LS0H compound complying with the fire performance requirements stated herein.

6.1.1.6.2 The oversheath of the cable shall be UV resistance and the colour of the oversheath shall be black.

### 6.1.2 Electrical Requirements

Capacitance	68pF/m max.
Characteristic impedance	$75 \pm 3\Omega$
Relative propagation velocity	at least 66%
Longitudinal loss at 100m	10MHz < 2.9dB 100MHz < 6.2dB 500MHz < 15.0dB 1000MHz < 22.0dB

### 6.1.3 Mechanical Requirements

Maximum pulling tension	80 kgf
Minimum bending radius	150mm
Operational conditions	-20°C to 60°C
Humidity	up to 100%

### 6.1.4 Cable Construction Identification

The oversheath of the cable shall be permanent print with the words "TELECOMMUNICATION CABLE".

### 6.1.5 Testing

6.1.5.1 Test methods of the cable shall conform to the IEC 60096: Part 4.

6.1.5.2 Test results and certificates shall be submitted for the Approval of the Engineer.

## 6.2 Indoor Coaxial Cable

### 6.2.1 Construction Requirements

#### 6.2.1.1 Conductors

6.2.1.1.1 The inner conductors shall be of stranded, high conductivity annealed copper or tinned copper, or of copper clad steel wire complying with all the requirements of IEC 60228.

6.2.1.1.2 The outer conductors shall be of copper tape

or braid.

6.2.1.1.3 Conductors shall be smooth, uniform in quality, free from scales, spills, splits and any other defects.

#### 6.2.1.2 Dielectric

The cable dielectric shall be solid high density polyethylene.

#### 6.2.1.3 Insulation

The insulation resistance shall be measured in accordance with BS EN 50117: Part 1.

#### 6.2.1.4 Spark Test for Sheath

The insulation shall not break down when spark tested in accordance with BS EN 62230.

#### 6.2.1.5 Double Screening (if required)

6.2.1.5.1 Screening shall be achieved by the use of copper braid or aluminium tube with an overlap so that full 100% coverage of the dielectric is afforded (Note : spray in types of construction are not acceptable)

6.2.1.5.2 The screening attenuation shall comply with BS EN 50117: Part 1.

#### 6.2.1.6 Oversheath

6.2.1.6.1 The oversheath of the cable shall be an extruded layer of anti-corrosion, reduced flame propagation, LS0H compound complying with the fire performance requirements stated herein.

6.2.1.6.2 The colour of the oversheath shall be black.

#### 6.2.2 Electrical Requirements

Capacitance	68pF/m max.
Characteristic impedance	$75 \pm 3\Omega$
Relative propagation velocity	at least 66%
Longitudinal loss at 100m	10MHz < 2.9dB 100MHz < 6.2dB 500MHz < 15.0dB 1000MHz < 22.0dB

#### 6.2.3 Mechanical Requirements

Maximum pulling tension	60 kgf
Minimum bending radius	50mm
Operational Conditions	0°C to 60°C
Humidity	up to 95%

#### 6.2.3.1 Cable Construction Identification

The oversheath of the cable shall be permanent print with the words "TELECOMMUNICATION CABLE".

#### 6.2.4 Testing

- 6.2.4.1 Test methods of the cable shall conform to the IEC 60096: Part 4.
- 6.2.4.2 Test results and certificates shall be submitted for the Approval of the Engineer.

#### 6.2.5 Coaxial Accessories

##### 6.2.5.1 Coaxial Connectors

- 6.2.5.1.1 The coaxial connectors shall be either N-type, or BNC of  $75\Omega$  impedance.
- 6.2.5.1.2 BNC type shall be of weatherproof bayonet locking construction.
- 6.2.5.1.3 The Coaxial connectors shall be manufactured from brass, the body of the connector silver or nickel plated and the contacts silver or gold plated.
- 6.2.5.1.4 Special tools for fitting shall be employed where required.

## 7. RADIO CABLES

### 7.1 Radiating Coaxial Cable

#### 7.1.1 Construction Requirements

##### 7.1.1.1 Conductors

- 7.1.1.1.1 The Inner conductors shall be of high conductivity annealed copper or copper clad aluminium wire tube complying with all the requirements of IEC 60228.

- 7.1.1.1.2 The outer conductors shall be of punched copper tape, or of corrugated copper or aluminium tube. The outer conductors which

are cut having longitudinal slots so that part of the energy transmitted through the cable is coupled to the transmission system formed by the outer conductor of the cable and the external environment and vice versa.

7.1.1.1.3 Conductors shall be smooth, uniform in quality, free from scales, spills, splits and any other defects.

#### 7.1.1.2 Dielectric

7.1.1.2.1 The cable dielectric shall be either air dielectric with disc spacer or foamed polyethylene.

7.1.1.2.2 The disc spacer shall be uniformly spaced and hold the inner conductor centred within the sleeve and the outer conductor.

#### 7.1.1.3 Insulation

The insulation resistance between inner and outer conductors shall be not less than  $20,000\text{M}\Omega\text{-km}$  and that between outer conductor and separate moisture barrier shall be not less than  $50\text{M}\Omega\text{-km}$ .

#### 7.1.1.4 Spark Test for Sheath

The insulation shall not break down when spark tested in accordance with BS EN 62230.

#### 7.1.1.5 Oversheath

7.1.1.5.1 The oversheath of the cable shall be an extruded layer of anti-corrosion, reduced flame propagation, LS0H compound complying with the fire performance requirements stated herein.

7.1.1.5.2 The oversheath of the cable shall be UV resistance and the colour of the oversheath shall be black.

### 7.1.2 Electrical Requirements

Capacitance	78pF/m max.
Characteristic impedance	$50 \pm 3\Omega$
Relative propagation velocity	at least 87%
Coupling loss to a half-wave	
Dipole at 2m distance	Range of 65-75dB with propagation in free space

Longitudinal loss at 100m	100MHz < 2.2dB 400MHz < 3.6dB 900MHz < 5.5dB
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#### 7.1.3 Mechanical Requirements

Maximum pulling tension	200 kgf
Minimum bending radius	350mm
Operational Conditions	-20°C to 60°C
Humidity	up to 100%

#### 7.1.4 Cable Construction Identification

The oversheath of the cable shall be embossed with the words "TELECOMMUNICATION CABLE".

#### 7.1.5 Testing

- 7.1.5.1 Test methods of the cable shall conform to the IEC 60096: Part 4.
- 7.1.5.2 Test results and certificates shall be submitted for the Approval of the Engineer.

### 7.2 Low Loss Coaxial Cable

#### 7.2.1 Construction Requirements

##### 7.2.1.1 Conductors

7.2.1.1.1 The Inner conductors shall be of high conductivity annealed copper or copper clad aluminium wire tube complying with all the requirements of IEC 60228.

7.2.1.1.2 The outer conductors shall be either of corrugated copper or aluminium tube, or of plain annealed copper tape.

7.2.1.1.3 Conductors shall be smooth, uniform in quality, free from scales, spills, splits and any other defects.

##### 7.2.1.2 Dielectric

7.2.1.2.1 The cable dielectric shall be either air dielectric with disc spacer or foam with high density polyethylene helix.

7.2.1.2.2 The disc spacer shall be uniformly spaced and hold the inner connector centred within the sleeve and the outer conductor.

#### 7.2.1.3 Insulation

The insulation resistance between inner and outer conductors shall be not less than 20,000MΩ-km and that between outer conductor and separate moisture barrier shall be not less than 50MΩ-km.

#### 7.2.1.4 Spark Test for Sheath

The insulation shall not break down when spark tested in accordance with BS EN 62230.

#### 7.2.1.5 Screening (if required)

7.2.1.5.1 Screening shall be achieved by the use of copper braid or aluminium tube with an overlap so that full 100% coverage of the dielectric is afforded (Note : spray in types of construction are not acceptable).

7.2.1.5.2 The screening attenuation shall comply with BS EN 50117: Part 1.

#### 7.2.1.6 Oversheath

7.2.1.6.1 The oversheath of the cable shall be an extruded layer of anti-corrosion, reduced flame propagation, LS0H compound complying with the fire performance requirements stated herein.

7.2.1.6.2 The colour of the oversheath shall be black.

#### 7.2.2 Electrical Requirements

Capacitance	78pF/m max.
Characteristic impedance	50 ±3Ω
Relative propagation velocity	at least 87% $c$
Longitudinal loss at 100m	100MHz < 1.7dB 400MHz < 2.7dB 900MHz < 4.5dB

#### 7.2.3 Mechanical Requirements

Maximum pulling tension	200 kgf
Minimum bending radius	8 × OD approx.
Operational Conditions	-20°C to 60°C
Humidity	up to 100%

#### 7.2.4 Cable Construction Identification

The oversheath of the cable shall be embossed with the words

## "TELECOMMUNICATION CABLE".

### 7.2.5 Testing

7.2.5.1 Test methods of the cable shall conform to the IEC 60096: Part 4.

7.2.5.2 Test results and certificates shall be submitted for the Approval of the Engineer.

## 7.3 Feeder Coaxial Cable

### 7.3.1 Construction Requirements

#### 7.3.1.1 Conductors

7.3.1.1.1 The Inner conductors shall be of stranded, high conductivity annealed copper or copper clad aluminium wire complying with all the requirements of IEC 60228.

7.3.1.1.2 The outer conductors shall be of copper/aluminium braid, tape or helix.

7.3.1.1.3 Conductors shall be smooth, uniform in quality, free from scales, spills, splits and any other defects.

#### 7.3.1.2 Dielectric

The cable dielectric shall be solid high density polyethylene.

#### 7.3.1.3 Insulation

The insulation resistance between inner and outer conductors shall be not less than 20,000MΩ-km and that between outer conductor and separate moisture barrier shall be not less than 50MΩ-km.

#### 7.3.1.4 Spark Test for Sheath

The insulation shall not break down when spark tested in accordance with BS EN 62230.

#### 7.3.1.5 Double Screening (if required)

7.3.1.5.1 Screening shall be achieved by the use of copper braid or aluminium tube with an overlap so that full 100% coverage of the dielectric is afforded (Note : spray in types

of construction are not acceptable).

7.3.1.5.2 The screening attenuation shall comply with BS EN 50117: Part 1.

#### 7.3.1.6 Oversheath

7.3.1.6.1 The oversheath of the cable shall be an extruded layer of anti-corrosion, reduced flame propagation, LS0H compound complying with the fire performance requirements as stipulated.

7.3.1.6.2 The colour of the oversheath shall be black.

#### 7.3.2 Electrical Requirements

Capacitance	101pF/m max.
Characteristic impedance	50±3Ω
Relative propagation velocity	at least 66% $c$
Longitudinal loss at 100m	150MHz < 7.2dB 400MHz < 13.8dB 900MHz < 23.0dB

#### 7.3.3 Mechanical Requirements

Maximum pulling tension	60 kgf
Minimum bending radius	5 × OD approx.
Operational Conditions	0°C to 60°C
Humidity	up to 95%

#### 7.3.4 Cable Construction Identification

The oversheath of the cable shall be permanent print with the words "TELECOMMUNICATION CABLE".

#### 7.3.5 Testing

7.3.5.1 Test methods of the cable shall conform to the IEC 60096: Part 4.

7.3.5.2 Test results and certificates shall be submitted for the Approval of the Engineer.

### 7.4 Radio Cable Accessories

#### 7.4.1 Radio Frequency Connectors

7.4.1.1 The Radio Frequency (R.F.) connectors shall be either DIN, EIA, SMA, N-type, or BNC of 50Ω impedance.

7.4.1.2 BNC type shall be of weatherproof bayonet locking construction.

- 7.4.1.3 R.F. connectors shall have a VSWR of better than 1.05.
- 7.4.1.4 R.F. connectors shall be manufactured from brass, the body of the connector silver or nickel plated and the contacts silver or gold plated.
- 7.4.1.5 Special tools for fitting shall be employed where required.

## 8. PUBLIC ADDRESS AND INTERCOM CABLES

### 8.1 Loudspeaker Cables

#### 8.1.1 Construction Requirements

##### 8.1.1.1 Conductors

8.1.1.1.1 The conductors shall be of stranded, high conductivity annealed copper wire complying with all the requirements of IEC 60228.

8.1.1.1.2 Cables for fixed installations shall have conductors with stranding to table II class 2 of IEC 60228, and flexible cables shall have stranded conductors to table II class 5 of IEC 60228.

8.1.1.1.3 Conductors shall be smooth, uniform in quality, free from scale, spills, splits and any other defects. There shall be no joints in individual strands except those made in the Base rod or wire before final drawing.

##### 8.1.1.2 Insulation

8.1.1.2.1 The cable insulation shall consist of extruded low smoke halogen free material.

8.1.1.2.2 The nominal thickness of the insulation shall be as specified in BS 6724.

8.1.1.2.3 The insulation shall not break down when spark tested in accordance with BS EN 62230.

##### 8.1.1.3 Core Identification

8.1.1.3.1 The insulated cores shall be clearly

identified by colours, and the identification scheme shall be in accordance with IEC 60189.

- 8.1.1.3.2 The required number of pairs shall be laid up in concentric layer to form a compact symmetrical cable.

8.1.1.4 Pairs

- 8.1.1.4.1 The insulated cores shall be twisted together to form pairs.

- 8.1.1.4.2 The attenuation of each pair shall be measured and shall not exceed 0.88dB/km at 800 Hz at a temperature of 20°C.

8.1.1.5 Bedding

The bedding shall consist of an extruded layer of LS0H bedding compound. When tested in accordance with IEC 60754-1, the level of HCl shall not be greater than 0.5%.

8.1.1.6 Screening

- 8.1.1.6.1 Screening shall be achieved by the use of laminated tape, consisting of an aluminium foil bonded to a polyester film for the strength, applied to the cable with an overlap so that full 100% coverage of the conductors is afforded (Note: spray on types of construction are not acceptable).

- 8.1.1.6.2 A drain wire or continuity conductor, laid under and in contact with the aluminium foil shall be provided and shall be in accordance with BS 5308 clauses 7 and 10 as appropriate. The tinned annealed copper conductor, which may be solid or a stranded construction, in keeping with current manufacturing techniques, shall have a minimum cross-sectional area of 0.5mm.

- 8.1.1.6.3 The maximum resistance of the drain wire or continuity conductor provided shall meet with the requirements of IEC 60228.

8.1.1.7 Oversheath

- 8.1.1.7.1 The oversheath of the cable shall be an extruded layer of anti-corrosion, reduced

flame propagation, LS0H compound complying with the fire performance requirements stated herein.

8.1.1.7.2 The colour of the oversheath shall be black.

#### 8.1.2 Electrical Requirements

Conductor Resistance	12.6Ω/km max.
Insulation Resistance	100MΩ km min.
Mutual Capacitance at 800Hz	160nF/km max.
Attenuation at 800Hz	0.88dB/km max.
Inductance	0.75mH/km max.

#### 8.1.3 Mechanical Requirements

Maximum pulling tension	35 kgf
Minimum bending radius	7.5 × OD
Operational Conditions	-20°C to 60°C

#### 8.1.4 Cable Construction Identification

Not required for loudspeaker cables.

#### 8.1.5 Testing

##### 8.1.5.1 Electrical Test

Electrical tests as specified in IEC 60708 shall be carried out on every length of cable and shall include the following:

- i) Conductor resistance
- ii) Insulation resistance
- iii) Mutual capacitance

##### 8.1.5.2 Mechanical Test

Mechanical test as specified in IEC 60708 shall be carried out and shall include the following:

- iv) Conductors - Elongation test
- v) Insulation - Elongation
- vi) Insulation - Breaking force
- vii) Insulation - Resistance to compression
- viii) Insulation - Retraction
- ix) Metal sheath thickness
- x) Dimensions of magnetic screen tapes
- xi) Extruded anti-corrosion flame retardant sheath thickness

### 8.2 Microphone Cables

## 8.2.1 Construction Requirements

### 8.2.1.1 Conductors

8.2.1.1.1 The conductors shall be of stranded, high conductivity annealed copper wire complying with all the requirements of IEC 60228.

8.2.1.1.2 Cables for fixed installations shall have conductors with stranding to table II class 2 of IEC 60228, and flexible cables shall have stranded conductors to table II class 5 of IEC 60228.

8.2.1.1.3 Conductors shall be smooth, uniform in quality, free from scale, spills, splits and any other defects. There shall be no joints in individual strands except those made in the base rod or wire before final drawing.

### 8.2.1.2 Insulation

8.2.1.2.1 The cable insulation shall consist of extruded Low smoke halogen free material.

8.2.1.2.2 The nominal thickness of the insulation shall be as specified in BS 6724.

8.2.1.2.3 The insulation shall not break down when spark tested in accordance with BS EN 62230.

### 8.2.1.3 Core Identification

The insulated cores shall be clearly identified by colours, and the identification scheme shall be in accordance with IEC 60189.

### 8.2.1.4 Pairs

8.2.1.4.1 The insulated cores shall be twisted together to form pairs.

8.2.1.4.2 The attenuation of each pair shall be measured and shall not exceed 22dB/km 1.5dB/km at 1kHz at a temperature of 20°C.

### 8.2.1.5 Bedding

The bedding shall consists of an extruded layer of LS0H bedding compound. When tested in accordance with

IEC 60754-1, the level of HCl shall not be greater than 0.5%.

#### 8.2.1.6 Screening

Screening shall be achieved by the use of laminated tape, consisting of an plan annealed copper bonded to a polyester film for the strength, applied to the cable with an overlap so that full 100% coverage of the conductors is afforded (Note: spray on types of construction are not acceptable).

#### 8.2.1.7 Oversheath

8.2.1.7.1 The oversheath of the cable shall be an extruded layer of anti-corrosion, reduced flame propagation, LS0H compound complying with the fire performance requirements stated herein.

8.2.1.7.2 The colour of the oversheath shall be black.

### 8.2.2 Electrical Requirements

Conductor Resistance	89Ω/km max.
Insulation Resistance	50MΩ km min.
Mutual Capacitance at 1kHz	135pF/km max.

### 8.2.3 Mechanical Requirements

Maximum pulling tension	25 kgf
Minimum bending radius	5 × OD
Operational Conditions	0°C to 60°C
Humidity	up to 95%

### 8.2.4 Cable Construction Identification

Not required for microphone cables.

### 8.2.5 Testing

#### 8.2.5.1 Electrical Test

Electrical tests as specified in IEC 60708 shall be carried out on every length of cable and shall include the following:

- i) Conductor resistance
- ii) Insulation resistance
- iii) Mutual capacitance

#### 8.2.5.2 Mechanical Test

Mechanical test as specified in IEC 60708 shall be carried out and shall include the following:

- i) Conductors - Elongation test
- ii) Insulation - Elongation
- iii) Insulation - Breaking force
- iv) Insulation - Resistance to compression
- v) Insulation - Retraction
- vi) Metal sheath thickness
- vii) Dimensions of magnetic screen tapes
- viii) Extruded anti-corrosion flame retardant sheath thickness

## 9. COMPUTER SYSTEM CABLES

### 9.1 10Base2 - Thin Ethernet Cable

#### 9.1.1 Construction Requirements

##### 9.1.1.1 Centre Conductor

9.1.1.1.1 The centre conductor shall be of high conductivity annealed, stranded tinned copper complying with all the requirements of IEC 60228 and BS 6360.

9.1.1.1.2 The diameter of the centre conductor shall be  $0.89\text{mm} \pm 0.05\text{mm}$ .

##### 9.1.1.2 Dielectric Material

9.1.1.2.1 The cable dielectric shall be foamed with high density polyethylene helix.

9.1.1.2.2 The polyethylene shall comply with BS 6234 type 03 or type 02 without pigmentation.

##### 9.1.1.3 Shielding System

9.1.1.3.1 The shielding system may contain both braid and foil elements sufficient to meet the transfer impedance specification and the EMC specifications specified herein.

9.1.1.3.2 The inside diameter of the innermost shield shall be  $2.95\text{mm} \pm 0.15\text{mm}$  minimum.

9.1.1.3.3 The shielding system shall be greater than 95% coverage.

##### 9.1.1.4 Oversheath

9.1.1.4.1 The oversheath of the cable shall be an extruded layer of anti-corrosion, reduced flame propagation, low smoke zero halogen compound complying with the fire performance requirements stated herein.

9.1.1.4.2 The colour of the oversheath shall be white.

9.1.1.4.3 The oversheath shall be marked with manufacturer and type at a nominal frequency of at least once per meter along the cable.

## 9.1.2 Electrical Requirements

### 9.1.2.1 Characteristic Impedance

The average characteristic cable impedance shall be  $50 \pm 2\Omega$ . Periodic variations in impedance along a single piece of cable shall be less than  $\pm 3\Omega$  sinusoidal, centred around the average value, with a period of less than 2m.

### 9.1.2.2 Attenuation

The attenuation of a cable shall not exceed 16dB/km measured with a 10MHz sine wave, nor 13.3dB/km measured with a 5MHz sine wave.

### 9.1.2.3 Velocity of Propagation

The minimum required velocity of propagation shall be  $0.65c$ .

### 9.1.2.4 Cable Direct Current Loop Resistance

The sum of the centre conductor resistance plus the shield resistance, measured at 20°C, shall not exceed 50mΩ/m.

### 9.1.2.5 Transfer Impedance

The transfer impedance of the cable shall not exceed the values shown in Figure 1.

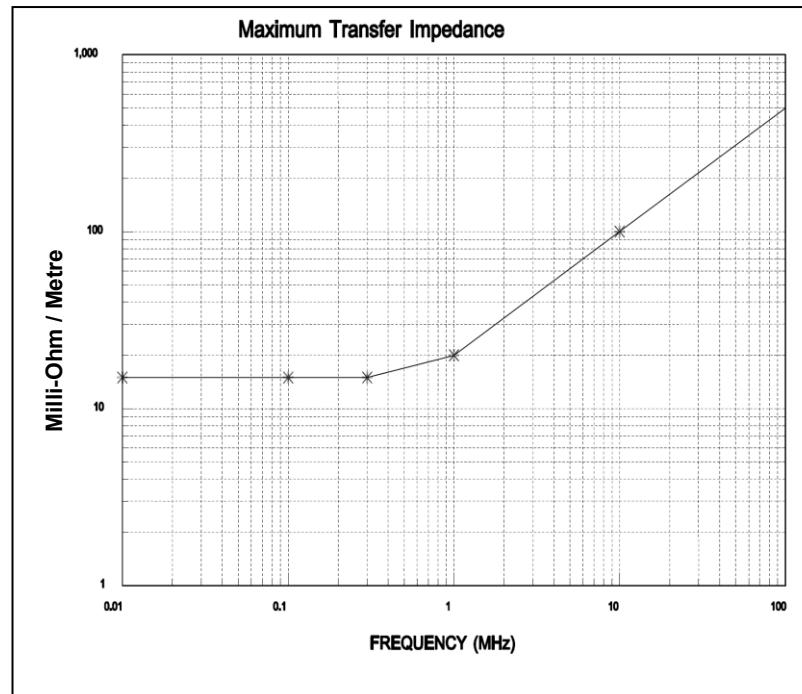


Figure 1 - Transfer Impedance of Thin Ethernet Cable

#### 9.1.2.6 Edge Jitter

Untapped cable shall exhibit edge jitter of no more than 8.0ns in either direction at the receiving end when 185m of the cable is terminated at both ends with  $50\Omega$  terminators and is driven at one end with pseudorandom Manchester ended binary data from a data generator which exhibits no more than 1.0ns of edge jitter in either direction on half bit cells of exactly  $\frac{1}{2}$  BT.

NOTE: The test shall be conducted in a noise-free environment.

#### 9.1.3 Mechanical Requirements

##### 9.1.3.1 General

The cable shall be suitable for routing in various environments, including but not limited to, dropped ceilings, raised floors, and cable troughs as well as throughout open floor space.

##### 9.1.3.2 Pierceability

The cable shall be capable of accepting coaxial cable connectors. The cable oversheath, shield system and dielectric material shall be able to be pierced by a tap probe without substantial dielectric deformation and without causing a short circuit between the centre

conductor and shield system.

#### 9.1.3.3 Bending radius

The cable shall be flexible enough to support a bending radius of 5cm without damage to the cable.

### 9.1.4 Environmental Specifications

#### 9.1.4.1 Electromagnetic Environment

##### 9.1.4.1.1 Susceptibility Levels

- a) The coaxial cable shall provide sufficient shielding capability to minimize its susceptibility to external noise. The cable shall meet its specifications when operating in either of the following conditions:
- b) Ambient plane wave field of 1V/m from 10kHz through 1GHz.
- c) Interference voltage of 15.10V peak 10MHz sine wave with a  $50\Omega$  source resistance applied between the coaxial cable shield and the DTE ground connection.

##### 9.1.4.2 Emission Levels

The cable system shall comply with FCC Docket 20780-1980[8].

##### 9.1.4.3 Temperature and Humidity

The cable shall meet its specifications when operating at 50°C and 95%RH.

### 9.1.5 Testing

All cable type tests shall be in accordance with BS 6724.

## 9.2 10Base F - Optical Fibre Cable

### 9.2.1 IEC and Other Standards

The cable shall comply with IEC publication 60793-2 type A1b and IEC 8802-3.

### 9.2.2 Optical Requirements

The cable shall have the optical properties given in Table 6.

Property	Value
Core / Mode Field Diameter	$62.5\mu\text{m} \pm 3\mu\text{m}$
Cladding Diameter	$125\mu\text{m} \pm 3\mu\text{m}$
Optical Attenuation	$\leq 3.75 \text{ dB/km } @850\text{nm}$
Modal bandwidth-length product	160MHz-km
Propagation delay	$\leq 5\mu\text{s/km}$

Table 6 - Optical properties of 10Base F - Optical Fibre cable

## 9.2.3 Construction Requirements

### 9.2.3.1 Features

The cable shall be tight buffered or loose tube type.

### 9.2.3.2 Oversheath

The oversheath of the cable shall be an extrude layer of anti-corrosion, reduced flame propagation, low smoke halogen free compound complying with the fire performance requirements stated herein.

### 9.2.3.3 Identification

The oversheath of the cable shall be printed with "OPTICAL FIBRE CABLE".

## 9.2.4 Testing

Test methods of the cable shall conform to IEC 60793.

## 9.3 Unshielded Twisted Pair - UTP Cable (Category 5 and 6)

### 9.3.1 Construction

The cable shall consist of 24 AWG / 23 AWG thermoplastic isolated conductor formed into four individually twisted pairs and enclosed by a thermoplastic jacket.

### 9.3.2 Electrical Requirements

DC Resistance	$< 9.37\Omega/100\text{m}$ at $20^\circ\text{C}$
DC Resistance Unbalance	$< 5\%$ at $20^\circ\text{C}$ between two conductors of any pair
Insulation Resistance	$50M\Omega \text{ km min.}$
Mutual Capacitance	$< 51.8\text{pF/m}@1\text{KHz}$ at $20^\circ\text{C}$
Capacitance Unbalance	$< 1.6\text{pF/m}@1\text{KHz}$ at $20^\circ\text{C}$
Pair to Ground	

### 9.3.3 Transmission Requirements

The performance of Category 5 UTP cable shall conform to the ISO/IEC 11801 Class D.

The cable shall have the transmission properties given in Table 10.

Frequency (MHz)	Impedance (ohms)	Attenuation (dB/100m)	Near-End Crosstalk (dB)	Return Loss (dB)
1	100 ±15%	2.07	65.3	20
10	100 ±15%	6.56	50.3	25
16	100 ±15%	8.2	47.3	25
20	100 ±15%	9.18	45.8	25
100	100 ±15%	21.97	35.3	20.1

Table 7 - Transmission properties of UTP Cable (Category 5)

The performance of Category 6 UTP cable shall conform to the ISO/IEC 11801 Class E.

The cable shall have the transmission properties given in Table 8.

Frequency (MHz)	Impedance (ohms)	Attenuation (dB/100m)	Near-End Crosstalk (dB)	Return Loss (dB)
1	100 ±15%	2.0	74.3	20
10	100 ±15%	6.0	59.3	23
16	100 ±15%	7.6	56.2	25
20	100 ±15%	8.5	54.8	25
100	100 ±15%	19.8	44.3	20.1
200	100 ±15%	29	39.8	18
250	100 ±15%	32.8	38.3	17.3

Table 8 - Transmission properties of UTP Cable (Category 6)

### 9.3.4 Testing

#### 9.3.4.1 Electrical Test

Electrical tests as specified in IEC 60708 shall be carried out and shall include the following:

Conductor resistance  
Insulation resistance  
Mutual capacitance

## 10. REFERENCES

- 10.1 MTR Operations Engineering Standards
- 10.1.1 Railway Terminology
- 10.1.2 S/EM-lov/MW/01(99) Material & Workmanship Standard for LV Electrical System
- 10.2 America Society for Testing and Materials Standards
- 10.2.1 ASTM D2863 Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
- 10.3 British Standards
- 10.3.1 BS EN 61386-1 Conduit systems for cable management. General requirements
- 10.3.2 BS EN ISO4589-2 Plastics - Determination of Burning Behaviour by Oxygen Index - Part 2: Ambient-Temperature Test
- 10.3.3 BS EN ISO4589-3 Plastics - Determination of Burning Behaviour by Oxygen Index Elevated-Temperature Test
- 10.3.4 BS EN 1652 Copper and Copper Alloys - Plate, Sheet, Strip and Circles for General Purposes
- 10.3.5 BS EN62230 Electric cables. Spark-test method
- 10.3.6 BS EN 50288-7 Multi-element metallic cables used in analogue and digital communication and control – Part 7: Sectional specification for instrumentation and control cables
- 10.3.7 BS EN50117-1 Coaxial Cables: Generic Specification
- 10.3.8 BS 5467 Electric cables – Thermosetting insulated, armoured cables of rated voltages of 600/1000V and 1900/3300V for fixed installations – Specification
- 10.3.9 BS 6234 Specification for polyethylene insulation and sheath of electric cables
- 10.3.10 BS 6724 Electric cables – Thermosetting insulated, armoured cablees of rated voltages of 600/1000V and 1900/3300V for fixed installation, having low emission of

**smoke and corrosive gases when affected  
by fire – Specificaion**

**10.4 International Electrotechnical Committee Standards**

- |         |               |   |
|---------|---------------|---|
| 10.4.1  | IEC 8802-3    | Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Standard for Ethernet |
| 10.4.2  | IEC 60228     | Specification for Conductors in Insulated Cables  |
| 10.4.3  | IEC 60331     | Tests for Electric Cables under Fire Conditions   |
| 10.4.4  | IEC 60332-1   | Tests on electric and optical fibre cables under fire conditions  |
| 10.4.5  | IEC 60332-3   | Tests on electric and optical fibre cables under fire conditions  |
| 10.4.6  | IEC 61084     | Cable trunking and ducting systems for Electrical Installations   |
| 10.4.7  | IEC 60189     | Low-frequency cables and wires with PVC insulation and PVC sheath   |
| 10.4.8  | IEC 61300     | Fibre Optic Interconnecting Devices and Passive Components  |
| 10.4.9  | IEC 60096     | Radio Frequency Cable   |
| 10.4.10 | IEC 60793-2   | Optical fibres - Product Specifications   |
| 10.4.11 | IEC 60794     | Optical fibre cables  |
| 10.4.12 | IEC 61034-2   | Measurement of smoke density of electric cables burning under defined conditions. Part 2: Test procedure and requirements   |
| 10.4.13 | IEC 60708     | Low-frequency cables with polyolefin insulation and moisture barrier polyolefin sheath  |
| 10.4.14 | IEC 60754-1   | Test on gases evolved during combustion of materials from cables – Part 1: Determination of the halogen acid gas content – Edition 3.0  |
| 10.4.15 | IEC 60754-2   | Test on gases evolved during combustion of materials from cables – Part 2: Determination of acidity (by pH measurement) and conductivity – Edition 2.0                              |
| 10.4.16 | ISO/IEC 11801 | Information technology – Generic cabling for customer premises  |

## 10.5 ITU-T Recommendations

10.5.1 G.651.1 Characteristics of a 50/125 $\mu$ m multimode graded index optical fibre cable for the optical access network

10.5.2 G.652 Characteristics of a single mode optical fibre cable

Issue : 1

Contract C3855-22E

Rev. : 0 01/02/2023

Provision of In-Train Remote CCTV System  
and Train Car Loading Indicator for M-Trains  
Particular Specification

**Appendix I      Cable Installation Standard**

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# Operations Engineering Standard

S/CC-gen/DS/02(99)

Former number: S/C&C/DS/002(3)

**Title:**  
Cable Installation Standard

**Revision:** D                    **Date:** 2019-02-20

Safety related standard

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This standard is mandatory and applied from the date of issue.

## ENDORSEMENT & AUTHORIZATION

Approved by standards owner:

Thomas Lam 

Communications & Network Engineering Manager

Date: 27 March 2019

Endorsed by (for safety related standard only):

N/A  
Chairman - Technical Standards Sub-committee

Date: \_\_\_\_\_

Authorized for issue by:

Michael Leung   
Deputy General Manager - Technical & Asset Engineering

Date: 3.4.2019



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## Revision Record

This standard will be updated when necessary by issuing a complete document. Amendments to the former issue will be summarized in the revision record below. The latest revision of this standard is mandatory and applied immediately from the authorized date for issue unless otherwise stated in the document.

<u>Rev.</u>	<u>Date</u>	<u>Amendment</u>	<u>Writer</u>
A	2009-06-10	i) Signalling related clauses deleted. ii) General update to fit the new standard template.	KP Tam
B	2012-09-27	3-yearly regular review with some general editing made.	Matthew Chung
C	2015-01-14	i) Additional clauses to include requirements of routing and termination of up-track and down-track tunnel fibre at critical locations including Central Equipment Rooms and Operations Control Centre. ii) Revised Clause 4.1.9(1) to include handling of cable containment. iii) Added Clause 4.1.9(6) to include the systems status verification.	Joyce Chan WK Ng
D	2019-02-20	3-yearly regular review with some general editing made.	Joyce Chan

## Summary of Applicable Railway Lines

**Check this box for common standards and leave blank to all railway lines below.**

Please check the appropriate box(es) preceding the railway lines to which this standard shall apply; provide comments and/or any particulars / exceptions if applicable:

<u>Railway Line</u>	<u>Abbreviation</u>	<u>Comment</u>
<input checked="" type="checkbox"/> Operating Railway	OPR	
<input type="checkbox"/> East Rail Lines:	ERL	
<input type="checkbox"/> East Rail Line	EAL	
<input type="checkbox"/> Ma On Shan Line	MOL	
<input type="checkbox"/> Airport Express, Tung Chung & Disneyland Resort Lines:	AT&D	
<input type="checkbox"/> Airport Express Line	AEL	
<input type="checkbox"/> Disneyland Resort Line	DRL	
<input type="checkbox"/> Tung Chung Line	TCL	
<input type="checkbox"/> Light Rail	LR	
<input type="checkbox"/> Urban Lines:	URL	
<input type="checkbox"/> Island Line	ISL	
<input type="checkbox"/> Kwun Tong Line	KTL	
<input type="checkbox"/> <b>South Island Line</b>	<b>SIL</b>	
<input type="checkbox"/> Tseung Kwan O Line	TKL	
<input type="checkbox"/> Tsuen Wan Line	TWL	
<input type="checkbox"/> West Rail Line	WRL	

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## 1. Scope and Purpose

This standard covers the installation of control and communications, and associated power distribution cables; conduits, trays, trunking and accessories throughout the Railway as it applies to Contractors performing works as part of a major Contract.

Any deviations from this standard shall be subject to the prior Approval of the Engineer.

## 2. Definitions

Definitions of terms are given in the “Railway Terminology”.

## 3. Safety Considerations

There are no special safety considerations in addition to those indicated in the General Specification applying to the activities described in this standard.

## 4. Cable Installation

### 4.1 All Cables

- 4.1.1 Cables shall be installed in accordance with this standard and the latest edition of the Code of Practice for the Electricity (Wiring) Regulations by Electrical and Mechanical Services Department. In case of conflict between these two standards, the latest Code of Practice for the Electricity (Wiring) Regulations shall apply.
- 4.1.2 Cables shall be run between their source and termination points on or in cable ladder/trays, ducts, cable brackets, trunking and conduits.
- 4.1.3 Cables running horizontally at greater than 2m above the surrounding floor level shall in general be supported by cable ladder and/or perforated cable trays or trunking. Where cables are installed in vertical ducts or on vertical cable ladder/tray, they shall be cleared at intervals not exceeding 1.2m.
- 4.1.4 Where cables pass through fire-rated walls and floors, all openings shall be sealed with fire-resistant material of a fire rating equivalent to that of the fire rating of the wall or floor. The fire resistant material shall be of a type accepted by the Hong Kong Building Ordinances Office and submitted to the Engineer for Approval.
- 4.1.5 Cables running through tunnels or along viaducts shall either be supported by cable brackets or laid in designated ducts.

4.1.6 Power cables shall be separated from the control and communication cables in accordance with the recommendations of the Regulations for the Electrical Equipment of Buildings.

4.1.7 The absolute minimum separation distances between cables shall be as set out in table 1. However, the separation between single core ac power cables and all fire resistant communication cables shall be increased by a factor of 1.56 since the core to core separation of these communication cables is larger than any other receptor cables, thus offering higher susceptibility to low frequency magnetic field interference.

	Stations, Ancillary Buildings, Depot Buildings	Other Locations including Trackside
Power Cable to Existing Receptor Cables	550 mm	1000 mm
Power Cable to New Receptor Cables	550 mm	900 mm
LV Power Cables having a Circuit Rating of 500A or less to Receptor Cables		150 mm
Receptor Cables to Receptor Cables of different contracts		50 mm

Table 1 - Cable Separation Distances

Definitions:

- a) Power cables shall be those cables carrying current having a fundamental frequency between 0 and 1200Hz and designed principally to distribute power.
- b) LV Power Cables shall be those power cables operating at or below 1000V ac and 1500V dc.
- c) Receptor Cables shall be all cables other than those defined in a. and b. above. Receptor cables are designed principally to transmit analogue and digital information and are found in railway signalling systems, communications systems, data transmission systems, control and monitoring systems.
- d) The separation distances shall be measured from the surface of Receptor Cables to the geometric centre of Power Cables; in the cases of Power Cables made up of individual single core cables per phase, these shall be in close trefoil configuration and the measurement shall be to the geometric centre of the nearest cable.

4.1.8 Cable jointing will not be allowed without approval of the Engineer. Jointing will be to an approved method and location and shall be performed by a cable jointer in possession of qualifications approved by the Engineer.

#### 4.1.9 Workmanship

- (1) The installation and handling of cables and containment including removing the trough cover shall be undertaken at all times by an adequate number of staff commensurate with the safe handling of the cabling works. These staff shall have been trained to the satisfaction of the Engineer to perform such work, and be equipped with all the necessary plant, equipment, tools and lighting.
  - (2) Reasonable precautions shall be taken to ensure that the cables and accessories are not installed in a manner or under conditions that may cause electrolytic or other corrosive action or damage to the cables, or be detrimental to the performance of the cable during operation.
  - (3) The maximum pulling force on any cable shall not exceed the design force of the cable.
  - (4) All bolts, studs and nuts supplied shall comply with the relevant requirements of the Materials and Workmanship Standard S/CC-gen/MW/01(99).
  - (5) All exposed metalwork surfaces shall be painted, finished and galvanised in accordance with the Materials and Workmanship Standard S/CC-gen/MW/01(99).
  - (6) The status of other systems at the concerned area shall be verified with the corresponding system controller before and after the works to ensure no abnormality is found.
- 4.1.10 The cable system shall be protected from mechanical damage and be accessible at all points for inspection.
- 4.1.11 All cables shall be installed such that their specified minimum bending radii is not infringed.
- 4.1.12 Should it prove necessary to cut any cables during installation, all cut ends shall be sealed.
- 4.1.13 All transitions where cables pass from one graded area to another shall have an approved means of sealing the aperture against fire transference.

#### 4.2 Cable Support

- 4.2.1 The design of all support and fixing items shall ensure freedom from rough edges, burrs and sharp corners. No materials shall be used which will promote electrolytic or other corrosive action in contact either between the various parts, or with the cable sheaths

or the building surfaces and other materials with which they may make contact. All cable supports shall be hot dipped galvanised.

- 4.2.2 All cables where required to be run on walls, ceilings or other building structures shall unless otherwise agreed by the Engineer be secured or enclosed in conduit or trunking.
- 4.2.3 Every cable whether in or out of sight shall be run vertically, horizontally or parallel to adjacent walls, beams or other structural members. Cables shall be laid flat side by side without crossing over each other on straight runs and fanned in the same manner around corners or bends.
- 4.2.4 Spacing of clips, saddles and cleats shall be such as to prevent sagging of the cables at all times during their installed life.
- 4.2.5 All steel trays, supporting steel work, brackets, clamps, hangers, cleats, saddles and other fixings necessary for the support of the cables shall be approved by the Engineer, and be of adequate strength for the cables they are supporting. All supporting steelwork and brackets shall be fitted with adjustable mechanisms, and shall be hot dipped galvanised.
- 4.2.6 Where a number of cables are terminated to any particular item of equipment, special care shall be taken to ensure that the cables finally approach the equipment from a common direction and are individually terminated in an ordered and symmetrical fashion.
- 4.2.7 Trunking shall be supported at regular intervals throughout its length. Trunking support and channel shall be quick-fixing type and shall be such as to space the trunking a minimum of 6mm from any part of the wall or bulkhead. The maximum spacing between fixings shall be as shown in Table 1:

Trunking Size	Maximum Distance
up to 50mm × 50mm	0.9m
up to 75mm × 75mm	1.2m
up to 150mm × 150mm	1.5m
up to 225mm × 150mm and greater	1.8m

Table 2 - Maximum spacings for trunking fixings

- 4.2.8 A minimum of two fixings shall be provided between joints in the trunking except where the distance between is less than the maximum spacing.
- 4.2.9 Where trunking is suspended, the suspension shall be rigid. At the suspension point the trunking shall be reinforced by a plate or washer of minimum thickness 3mm or 10 s.w.g. whose cross-

sectional area shall not be less than half that of the trunking (cross-sectional area). Unless additional stiffening which has been approved by the Engineer is provided, the spacing between suspension points shall not be greater than those shown in the table above.

- 4.2.10 Every section and joint of metal trunking carrying conducting wires shall be bonded with 3mm × 25mm copper tape to ensure overall continuity and to achieve an acceptable earth loop impedance level in compliance with the latest edition of the IEE Wiring Regulations. Removal of any lid no matter how it is fitted shall not affect the earth continuity of the trunking.
- 4.2.11 Where trunking is cut or drilled, the edges of the trunking which are cut shall be smoothed to prevent abrasion of the cables and shall be painted with anti-corrosion paint, to the same colour as the adjacent surfaces, such painting to be carried out as the work proceeds. In no circumstances will rough screw edges and nuts be allowed in the interior of the trunking. Round headed screws of a non-corrosive material shall be used when installing trunking. The round screw heads being on the interior of the trunking.
- 4.2.12 Flush or buried trunking shall only be used where specified. Under floor metal ducts shall only be provided if specified or with the written approval of the Engineer. Where these are specified they shall comply with BS EN 50085-1.
- 4.2.13 Joints in cables in trunking shall only be permitted where specified or with the written approval of the Engineer.
- 4.2.14 The space factor for cables installed in trunking shall not exceed 45%.
- 4.2.15 All lengths of vertical run trunking in excess of 3.0m, shall contain cable supports made of insulating, non-hygroscopic, non-combustible material. The spacing between such supports shall not exceed 1.8m. An additional support shall be provided at the top of all vertical runs exceeding 3.0m, to support the weight of the cable and distribute the cables within the trunking to prevent undue compression of the installation.
- 4.2.16 Where trunking crosses expansion joints, a trunking system shall be used which shall allow for expansion and maintain earth continuity.

### 4.3 Cable Trays

#### 4.3.1 General

- (1) Where two straight lengths of cable tray are joined together, an external coupler or joint plate shall be used to prevent

any sag or bending at that point. The coupler or joint plate shall be joined to each length of the tray by means of not less than two non-corrosive round-headed screws fixed from the inside of the tray.

- (2) All bends and tee's shall be 90° bends or tee-offs with minimum 50mm inside bend radius. Bends in cable trays shall be such that the bending radius of the largest cable to be clipped to the tray shall not exceed the bending radius limits as specified in the IEE Wiring Regulations.
- (3) The cable trays shall be fixed in such a manner that it is rigid throughout its length with a minimum of 13mm clearance between the tray and the structure.
- (4) Cable trays shall be supported at regular intervals, especially where bends and tee joints are fitted to the trays.
- (5) Where cable trays pass across structure movement/expansion joints, the cable trays shall be physically separated by an equal or greater gap than the width of the expansion/movement joint it is crossing. To maintain electrical/earth continuity of the cable trays a 150mm<sup>2</sup> copper flexible earth continuity conductor shall be installed across the gap and secured to each end of the cable trays.
- (6) Where cables are required to pass through the tray, or over the lip of the cable tray, a low smoke halogen free grummet or packing section shall be installed to protect the cable sheath from sharp edges.

#### 4.3.2 Cable Tray Earthing

Each joint shall have a 150mm<sup>2</sup> tinned copper bond bolted to each adjacent tray to ensure electrical continuity. The cable tray systems shall be bonded to the earthing system.

#### 4.4 Termination

- 4.4.1 Cable termination shall be by means of type of connector Approved by the Engineer.
- 4.4.2 The cable sheath shall be clasped by means of a gland of compression type, with a compression washer which will hold the cable sheath securely. A cable shroud shall be fitted to cover the body of the compression gland.
- 4.4.3 All cables/wires shall be terminated with an appropriate type of connector as recommended by the cable supplier or designed for that purpose.
- 4.4.4 Cables terminations shall be at least 300 mm above floor level.

4.4.5 For termination of tunnel fibre in critical locations including Central Equipment Rooms and Operations Control Centre, up-track and down-track fibre cables shall be terminated in separate locations to prevent single point of failure.

#### 4.5 Cables Routes

4.5.1 All cable routes are to be parallel or perpendicular to the running lines where possible.

4.5.2 In general cable routes shall be constructed with minimum changes of directions. Bends shall not exceed the manufacturer's recommended minimum bending radius for the cables to be installed.

4.5.3 For installations at grade, above ground and in open areas, all cable shall be shielded so as to preclude the possibility of direct sun light shining on the cable by means of ventilated sun shields of approved design. The ventilated sun shields shall be constructed from 20 gauge galvanized sheet metal and be earthed by braided copper strapping with impedance to earth of less than 0.5 ohms. The sun shields shall be capable of meeting the following wind loadings:

- Maximum hourly wind speed 133 km/h
- Maximum design gust speed 230 km/h

4.5.4 Where cables are laid in open ground they shall be bedded in 75mm of sieved sand, covered with a similar material, and protected by concrete slabbing or interlocking tiles, and the trench then back filled. Medium voltage cables shall have a minimum cover of 450mm, cables passing under road and railways shall be mechanically protected (i.e. cast iron sleeves) and have a minimum cover of 1.0m.

4.5.5 Track crossings shall be at right angles and at least 2 metres clear of any rail switches or crossing areas of leads.

4.5.6 Non-armoured cables which are direct buried shall be mechanically protected throughout their length.

4.5.7 Cables shall be installed without tee's or through joints unless otherwise approved by the Engineer.

4.5.8 Cable armour shall be earthed at one end or both ends of the cable as required by the installation and system in order to avoid any earth looping. Cleats shall be of the moulded reinforced nylon type.

4.5.9 Where cables are laid in concrete troughs, the trough opening shall be sealed with concrete slabs.

4.5.10 Cables shall be installed such that the bending radius as recommended by the cable manufacturer is not compromised.

4.5.11 For tunnel fibre cables that route to critical locations including Central Equipment Rooms and Operations Control Centre, up-track and down-track fibre cables shall have different cable routes to prevent single point of failure.

#### 4.6 Cable Pits

4.6.1 The walls and floors of cast in-situ pits shall have a minimum thickness of 100mm.

4.6.2 The cover over reinforcing shall be a minimum of 25mm.

4.6.3 Pits in excess of 1.2m deep shall have hand rungs of 16mm +/- 4mm diameter galvanised mild steel rod cast into one wall at convenient distances from top to bottom, or alternatively a galvanised steel ladder shall be provided and fixed to the wall.

4.6.4 Floors shall be graded down to a grid covered drainage hole to be located in each pit. All pits shall be located so that they can be drained either through the bottom or through the side. Suitable drain pipes shall be provided for each pit to the nearest approved drain or to an approved public drain or natural drainage course.

4.6.5 A galvanised steel chequer plate 6.35mm thick and reinforced as necessary to prevent noticeable deflection by pedestrians shall be provided as a lid for the pit. The lid shall be provided with hand holes and be retained in place by a step in the top of the pit.

4.6.6 Large pits must be fitted with sectionalised lids. Individual lid sections must not exceed 30kg in weight and must be designed so that they can be removed by one person. All exposed steel work shall be hot dipped galvanised.

4.6.7 Pits shall be provided on each side of all underline crossings where the route continues as a ground level or above ground route so that additional cables can be inserted.

4.6.8 The top of each pit shall be at least 100mm above the surrounding ground level provided it does not interfere with walkways, removal of sleepers, shunters access paths and operation of equipment.

4.6.9 All cable entries into the pit shall have rounded edges to prevent damage to cables during installation or during service or as a result of the weight of the cables themselves bearing against the edges.

#### 4.7 Cable Joints

- 4.7.1 Every connection at a cable joint shall be mechanically and electrically sound, be protected against mechanical damage and any vibration, shall not impose mechanical stress on the fixings of the connection and shall not cause any mechanical damage to the cable conductor.
- 4.7.2 The appropriate tools specified by the manufacturer of the joint shall be used when jointing cables.
- 4.7.3 The outer casing/outer sheath of the cable joint shall be fabricated from a low smoke zero halogen free material.
- 4.7.4 No cable joints shall be allowed without prior approval of the Engineer. All joints and accessories shall be submitted to the Engineer for his approval prior to any jointing of cables.

#### 4.8 Cable Identification

- 4.8.1 All cables shall be provided with identification markers, at each end of the cable, at each position where the cable changes direction, at entry and exit point of cable trays, both sides of wall/slab openings, ducts and trenches and in other such positions as are necessary to identify and trace the route of the cable. In the instances where multiple cables are run in the same duct or trough, labels shall be provided at 10m intervals.
- 4.8.2 Cable identification shall be assembled from elliptical profiled plasticised low smoke halogen free markers for cables and wire of 10 mm diameter or less. Carrier strip or nylon ties of a similar material shall be used for larger cables and wires.

#### 4.9 Cable Accessories

- 4.9.1 Non-armoured cables
  - (1) All cable glands and accessories shall be of an approved type and supplied by a single manufacturer.
  - (2) The cable glands shall have a water tight seal when fitted to a cable.
  - (3) Each cable gland shall be supplied with a brass gland locknut, an earthing lug and a flame retardant low smoke halogen free outer gland shroud. The shroud shall totally enclose the gland body and form an effective seal against the cable sheathing.

#### 4.9.2 Armoured cables

Cables shall be terminated in a gland fitted with an armour clamp. The gland body shall be provided with an internal conical seal to

receive the armour clamping cone, and a clamp nut, which shall secure the armour clamping cone, and conical armour seal. The spigot of the gland body shall be threaded to suit standard conduit accessories. A flame retardant low smoke halogen free shroud shall be fitted to cover the gland body.

#### 4.9.3 Cable ties

Cable ties shall be made from corrosion resistant, flame retardant and Ultra Violet resistant materials. At locations where cables are installed above tracks or in areas subjected to significant and constant vibration, cable ties shall be of metal construction type and coated with corrosion resistant and flame retardant materials.

## 5. Cable Support Installation

### 5.1 General

- 5.1.1 Care shall be taken to make the bends of pipe or duct lines as easy as practicable. In no case shall the radius be less than 2.5 times the outer diameter of the duct circular, or 2.5 times the minor dimension of the duct if rectangular.
- 5.1.2 Before drawing or installing cables in the duct, it shall be ensured that the duct is clean, dry and free from obstructions and of adequate size for the cables to be installed, having particular regard for the separation from other services and to the provision of adequate drawing pits, covers and marking, and allowance for bend radii. It shall ensure that adequate provision has been made for cables entering or leaving ducts. Any pipe or conduit provided for this purpose shall be bushed or radiused to prevent damage to the cables.
- 5.1.3 All cables run in open ducts or in ducts shared with other services, shall be secured to the wall of the duct by approved type saddles or hangers. Adequate precautions shall be taken to ensure that there is no interference to the cables from the other services both mechanically and electrically.
- 5.1.4 No equipment other than water-proof equipment may be installed in any duct, unless specified otherwise by the Engineer.
- 5.1.5 The duct shall be sealed to prevent the entry of water or vermin.
- 5.1.6 The ends of all conduits shall be reamed to remove all burrs or sharp edges after the screw threads have been cut. All dirt, paint or oil on the screwed threads of the conduit, sockets and accessories shall be removed before installation.
- 5.1.7 The ends of the conduit shall butt fully home in all couplings. Where they terminate in fuse-switches, fuse boards, adaptor boxes and switch boxes, they shall be connected by means of smooth bore male brass bushes, compression washers and sockets. All exposed threads and all bends shall be painted with aluminum spirit paint after installation. Exposed metal shall be similarly treated.
- 5.1.8 All conduits shall be kept 80mm clear of water, gas and other services. All necessary equipotential bonding shall be installed including that for piped services, in accordance with the IEE Wiring Regulations.
- 5.1.9 Particular care shall be taken to ensure that no water is allowed to enter the conduit at any time and all conduits shall be arranged with

adequate ventilation and drainage. Inaccessible junction boxes will not be allowed.

- 5.1.10 The ends of conduits laid or set in formwork prior to concreting shall be temporarily sealed off with a coupler and a solid brass plug.
- 5.1.11 All bends are to be made on site to suit site conditions. Hot-dip galvanized cast iron draw-in boxes shall be provided at convenient points in conduit runs to enable cables to be drawn in without damage. Draw-in boxes shall be fitted after every two bends, or after a maximum straight run of 15m. Tees, elbows and sleeves when used, shall be of an approved type.
- 5.1.12 All conduits shall be swabbed through before wiring is commenced and cables shall not be drawn into any section of the system until all conduits and draw boxes for that particular section are fixed in position.
- 5.1.13 Telescopic conduit systems shall be employed where conduits pass expansion joints of a building. Allowance shall be made for running an earth wire between each terminal fitted in the nearest conduit boxes each side of the telescopic joint.
- 5.1.14 All conduit systems shall be electrically and mechanically continuous and water-tight after installation.
- 5.1.15 Where flexible conduit is employed, the length shall not exceed two metres, and shall be provided with an earth continuity conductor of size not less than 2.5mm<sup>2</sup> copper conductor.
- 5.1.16 Wiring shall be carried out on the looping-in system and no joints other than the looping-in points will be allowed.
- 5.1.17 No cables installed in conduit shall be laced.
- 5.1.18 Conduit systems in electrical and mechanical plant rooms and within false ceiling void areas shall be surface mounted, on the walls or ceiling soffit, they shall be fixed by means of distance saddles and shall terminate in deep pattern conduit boxes. Surface conduits shall not be bent or set to enter accessories, and where they turn through walls, back-outlet boxes shall be provided.
- 5.1.19 All surface mounted conduits shall be run on the surface of the building and vertical and horizontal, supported at 1.2m centres on vertical runs and 900mm centres on horizontal runs. Such conduits shall be laid flat side by side without crossing over each other on straight runs and fanned in the same manner around corners or bends. Conduits in ceiling voids shall be supported independently of the suspended ceilings.

## 5.2 Conduits

- 5.2.1 Conduit installations that are in conspicuous locations within public areas shall be cast-in/concealed within the structural members.
- 5.2.2 All conduit boxes and accessories for concealed/cast-in conduit system shall be of the type specifically manufactured for that purpose.

## 5.3 Concealed conduits

- 5.3.1 Concealed conduits shall be mounted in formed chases and subsequently plastered-up after installation.
- 5.3.2 Spacing between concealed conduits entering the draw-in boxes shall not be less than 25mm so as to allow concrete aggregate to pass and set between conduits.

## 5.4 Cast-In conduit

A 1.6mm galvanized draw-wire shall be installed in each conduit to facilitate subsequent pulling of cables.

# 6. Joining of Optical Fibre Cables

## 6.1 Splicing

- 6.1.1 The splicing loss shall not exceed 0.1 dB/splice.
- 6.1.2 The splice shall be protected and housed in a light guide shelf.
- 6.1.3 The splices shall be of a type which allows operation in a temperature range of -20°C to 60°C.

## 6.2 Jointing

- 6.2.1 All fibre joints shall be protected by a suitable mechanical enclosure and shall be rated to IP65 (IEC 60529).
- 6.2.2 The joint must be air tight and waterproof without using any filling compound.
- 6.2.3 A fibre organizer shall be provided to store excess length of fibre cores inside the joint.
- 6.2.4 The joint shall be so designed to allow re-entry and re-use after the installation.

## 7. Joining of Telephone Cables

### 7.1 Main Distribution Frames and Termination Blocks

- 7.1.1 Cable to distribution frames shall terminate on approved connector blocks.
- 7.1.2 Line side and equipment side blocks shall be separated at the frame. All blocks shall be clearly labelled and cables numbered.
- 7.1.3 Distribution frames shall be manufactured with a copper earth bar to which all cable sheaths shall be connected. The earth shall be connected to the main earth.
- 7.1.4 Outdoor cable ends at distribution frames shall be sealed to prevent the ingress of moisture.
- 7.1.5 Line side blocks shall have gas-discharge surge arrestors fitted and allow interruption of any circuit using plugs/jacks.
- 7.1.6 Modular sockets shall be mounted at the front panel of the termination block for easy connection of cable adaptors. Cable adaptor and modular socket shall be mated and be locked by using a screwlock system.

### 7.2 Jointing

- 7.2.1 The joint shall be constructed of approved materials and shall be watertight, free from sharp points or ridges, clean internally to remove all traces of swarf, greases and other foreign matter, and designed to retain the filling medium and/or cable compound at all times without leakage.
- 7.2.2 The metal sheathing of the cables shall be plumbed to the joint box and the screening tape shall be electrically and mechanically bonded across the joint and to the box.
- 7.2.3 The joint, insulation of cores and method of jointing shall be designed to prevent migration of compound and interchange of compound between cable and joint.

## 8. References

- 8.1 MTR Operations Engineering Standards
  - 8.1.1 Railway Terminology
  - 8.1.2 S/CC-gen/MW/01(99) Materials and Workmanship Standard
- 8.2 European Standards
  - BS EN 50085-1 European standard for cable trunking and ducting systems- part 1 general requirements
- 8.3 International Electrotechnical Committee Standards
  - IEC 60529 Degrees of protection provided by enclosures (IP code)

Issue : 1

Contract C3855-22E

Rev. : 0 01/02/2023

Provision of In-Train Remote CCTV System  
and Train Car Loading Indicator for M-Trains  
Particular Specification

**Appendix J Electrical Earthing Standard**

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# Operations Engineering Standard

S/CC-gen/DS/04(99)

Former number: S/C&C/DS/006(2)

**Title:**

Electrical Earthing Standard for Communications and Controls Systems

**Revision:** D

**Date:** 2018-11-1

Safety related standard

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This standard is mandatory and applied from the date of issue.

## ENDORSEMENT & AUTHORIZATION

**Approved by standards owner:**

HW Chan

Communications and Control Engineering Manager

Date: 11/01/2019

**Endorsed by (for safety related standard only):**

N/A

Chairman - Technical Standards Sub-committee

Date: \_\_\_\_\_

**Authorized for issue by:**

Michael Leung

Deputy General Manager - Technical & Asset Engineering

Date: 15 JAN 2019



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## Revision Record

This standard will be updated when necessary by issuing a complete document. Amendments to the former issue will be summarized in the revision record below. The latest revision of this standard is mandatory and applied immediately from the authorized date for issue unless otherwise stated in the document.

<u>Rev.</u>	<u>Date</u>	<u>Amendment</u>	<u>Writer</u>
A	2009-06-10	Re-issued under new format and document number	KP Tam
B	2012-09-27	3-yearly regular review with some general editing made.	Matthew Chung
C	2015-12-15	3-yearly regular review with the title of the standard changed from “Electrical Earthing Standard” to “Electrical Earthing Standard for Communications and Controls Systems”.	Ricko Lor
D	2018-11-1	3-yearly regular review with some general editing made for Clause 4.2, 5.1.2, 5.3.1 and 5.4.2	Ricko Lor

## Summary of Applicable Railway Lines

**Check this box for common standards and leave blank to all railway lines below.**

Please check the appropriate box(es) preceding the railway lines to which this standard shall apply; provide comments and/or any particulars / exceptions if applicable:

<u>Railway Line</u>	<u>Abbreviation</u>	<u>Comment</u>
<input checked="" type="checkbox"/> Operating Railway	OPR	_____
<input type="checkbox"/> East Rail Lines:	ERL	_____
<input type="checkbox"/> East Rail Line	EAL	_____
<input type="checkbox"/> Ma On Shan Line	MOL	_____
<input type="checkbox"/> Airport Express, Tung Chung & Disneyland Resort Lines:	AT&D	_____
<input type="checkbox"/> Airport Express Line	AEL	_____
<input type="checkbox"/> Disneyland Resort Line	DRL	_____
<input type="checkbox"/> Tung Chung Line	TCL	_____
<input type="checkbox"/> Light Rail	LRL	_____
<input type="checkbox"/> Urban Lines:	URL	_____
<input type="checkbox"/> Island Line	ISL	_____
<input type="checkbox"/> Kwun Tong Line	KTL	_____
<input type="checkbox"/> Tseung Kwan O Line	TKL	_____
<input type="checkbox"/> Tsuen Wan Line	TWL	_____
<input type="checkbox"/> West Rail Line	WRL	_____

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## 1. SCOPE AND PURPOSE

This standard is to ensure that all electrical installations associated with Control & Communications equipment within the MTR are safe for operation by reducing the possibility of electrical shock to people.

This standard applies to all electrical equipment of Control & Communications systems except those items of portable equipment (such as power tools, test/measurement instruments, and the like) which are double insulated and where the manufacturer recommends that the equipment is not earthed.

## 2. DEFINITIONS

### 2.1 Primary Earthing Bar

A solid metal conductor having a maximum resistance of  $0.12 \text{ m}\Omega/\text{m}$  such as 150 mm<sup>2</sup> copper bar.

### 2.2 Primary Earthing Conductor

A conductor with a maximum resistance of  $0.5 \text{ m}\Omega/\text{m}$  such as 35 mm<sup>2</sup> copper cable.

## 3. SAFETY CONSIDERATIONS

Electrical equipment is earthed, among other reasons, to reduce the possibility of electrical shock to people. Hence compliance with this standard is not only a contractual obligation but a safety responsibility as well.

## 4. GENERAL

- 4.1 There shall be effective and rapid operation of protective equipment, where appropriate, in the event of either an earth fault in an electrical supply system, or in response to a lightning strike, which might otherwise damage equipment or cause fire, or both.
- 4.2 Electrical interference shall be minimised, provided that this does not jeopardise **the equipment safety**.
- 4.3 The complete earthing system shall comply with the requirements of the latest edition of Code of Practice for the Electricity (Wiring) Regulations by Electrical and Mechanical Services Department, BS 7430 and the Supply Rules of Hong Kong Electric and China Light and Power. Where the requirements or recommendations of the Supply Rules, Code of Practice for the Electricity (Wiring) Regulations and BS 7430 differ, then the Supply Rules shall take precedence.
- 4.4 Cabling (except leaky coaxial cables) with terminations contained within one substation, ancillary building, station or equipotential area shall have their armour and screen earthed at each end.
- 4.5 Where this cannot be achieved, or in situations as directed by the Engineer, cabling shall have its sheath, screens or armour earthed at only one end or alternatively shall be earthed at both ends but the earth continuity shall be broken at some point along the route of the cable. In such situations all unterminated ends shall be insulated from earth and a label drawing attention to the earth isolation or break in conductivity and Approved by the Engineer shall be attached.
- 4.6 Earthed components of cabling routed from one equipotential area to another shall be rated to carry currents which may arise from power faults at either equipotential area.

## 5. EARTHING FOR SAFETY

- 5.1 Protective Conductor Materials
  - 5.1.1 All protective conductors shall be of high conductivity hard drawn copper, manufactured in accordance with BS EN 13601 for bar and BS EN 13602 for cables.
  - 5.1.2 Earthing bars shall be flat copper bar of high conductivity **and the associate copper tape shall be with LS0H sheath**. Fixtures to buildings shall be by means of copper or brass clamps with brass screws and non-fibrous wall plugs.
  - 5.1.3 No earth stud or bolt shall have a cross-sectional area at the base of the threads less than 15 mm<sup>2</sup>.

5.1.4 The minimum size of protective conductor shall be defined as in the latest edition of the Code of Practice for the Electricity (Wiring) Regulations.

5.2 Method of Earthing

5.2.1 All exposed conductive parts of the installation other than those forming part of any electrical circuit, shall be connected on to the existing earthing system in the station.

5.2.2 Each local earth system shall be linked to all main earth points within the site.

5.2.3 Each local earth system shall be connected to the main earth at a minimum of two independent points using a primary earthing bar or a primary earthing conductor as appropriate.

5.2.4 Conductors fixed in locations visible from the public areas of Stations shall be run vertically and/or horizontally (but not diagonally). Changes in the plane of the conductors shall be right-angles joints. No folding of the conductor shall take place.

5.2.5 Those items of equipment installed outside the confines of the station shall be isolated from the station earth and connected to a specially provided earth in a manner to be Approved by the Engineer.

5.2.6 Small distribution boards, small motors and other apparatus having ratings below 5kw may be connected to other earthed apparatus by the sheaths and armour of their connecting cables or by conduits, provided that the total resistance to the nearest principle earthing conductor in no case exceeds 0.5 ohms and that the cable sheaths, armour or conduit can safely carry the maximum available earth current for 3 seconds without damage.

5.2.7 The primary earthing bar shall not be drilled except at termination points.

5.2.8 Joints and connections to the earthing system shall be so effected as to avoid more than a 1% reduction of the current carrying capacity.

5.2.9 Earthing connections for all items of equipment shall be made between the equipment and the distribution board feeding it.

5.2.10 Where conductors come into fortuitous contact with metalwork at or near earth potential they shall be either bonded solely or shall be insulated to withstand an alternating potential difference of 500V r.m.s.

### 5.3 Bonding

- 5.3.1 Bonding of exposed conducting parts shall be provided and comply with BS 7671 **and the Code of Practice for the Electricity (Wiring) Regulations by Electrical and Mechanical Services Department.**
- 5.3.2 The total length of any bonding conductor shall not exceed 30 metres between two exposed conductive parts located within 2 metres of each other.
- 5.3.3 The bonding connection shall be welded, brazed or bolted. The material used in bolted applications shall not create electrolytic corrosion.
- 5.3.4 The diameter of holes drilled in bars shall be less than a quarter of the bar's width.
- 5.3.5 A serrated locking washer shall be used with each bolt.
- 5.3.6 A welded or brazed connection shall have a joint whose resistance does not exceed that of two metres of the conductor.
- 5.3.7 Every other type of joint shall have a resistance not exceeding that of five metres of the conductor.

### 5.4 Earthing of Cables, Cubicles and Equipment Cabinets

- 5.4.1 Particular care shall be taken on cable termination boxes to ensure that the cable sheath and armour is bonded to the frame so as to maintain undiminished conductivity through the cable termination gland. If the bonding is inadequate to the extent that the conductivity is diminished, then a special copper connection shall be made between the apparatus frame, cubicles & equipment cabinet frame and the cable sheath and armour.
- 5.4.2 The sheath and armouring of all armoured cables shall be connected to the main earthing system at both ends **or otherwise refers to the Clause 4.5.**
- 5.4.3 All connections between earth conductors and apparatus shall be by bolts or studs so arranged that the resistance between the apparatus, cubicles & equipment cabinet and the earth conductor shall not exceed  $0.1 \Omega$ .

## 6. EARTHING FOR EMI SCREENING

### 6.1 EMI Earth Resistance

- 6.1.1 Earthing systems provided for EMI reasons shall have a total resistance to earth of not less than  $1.0 \Omega$ .

## 6.2 Screening Grid

- 6.2.1 Where screening grids are required they shall be made from copper or steel sheet. Holes may be punched in the sheet to reduce the weight of the installation.
- 6.2.2 If holes are punched in the metal sheets of the screening grid, then these shall be no larger than one quarter of the wavelength of the highest frequency against which the screening grid is to be effective (the required effectiveness of the screening grid shall be determined as indicated in S/CC-gen/DS/05(99)).
- 6.2.3 The sheets constituting the screening grid shall be joined together every 25 cm in a manner identical to that for joining the screening grid to the drain conductor.

## 6.3 Drain Conductor

- 6.3.1 The drain conductor connecting the screening grid to the primary earth shall be as short as practicable.
- 6.3.2 The drain conductor shall be made from solid copper with a cross-sectional perimeter of at least 60 mm or from copper braid at least 20 mm wide.
- 6.3.3 The drain conductor shall be attached to the screening grid at only one point.
- 6.3.4 Attachment to the screening grid shall be by means of copper clamps with copper bolts.
- 6.3.5 The screening conductor of any cable shall be connected to either the screening grid where the cable passes through the grid or to the primary earth conductor.
- 6.3.6 No part of a screening or similar conductor shall protrude into the screened area.

## 7. EARTHING FOR LIGHTENING PROTECTION OF EQUIPMENT

- 7.1 Equipment directly connected to cabling running in exposed above ground areas shall, where directed by the Engineer, be protected from the effects of lightning strikes by a connection to a lightning arrestor at the point of cable entry. The lightning arrestor shall be connected to an earth termination.
- 7.2 The earth termination shall be custom designed and installed independently from any other earthing system.
- 7.3 The design shall be submitted to the Engineer for Approval.

## 8. REFERENCES

- 8.1 MTR Operations Engineering Standards
  - 8.1.1 Railway Terminology
  - 8.1.2 S/CC-gen/DS/05(99) Design Standard Electromagnetic Compatibility and Non-ionizing Radiation
- 8.2 British Standards
  - 8.2.1 BS EN 13601 Copper and copper alloys. Copper rod, bar and wire for general electrical purposes
  - 8.2.2 BS EN 13602 Copper and copper alloys -Drawn, round copper wire for the manufacture of electrical conductors
  - 8.2.3 BS 7430 Code of Practice for Earthing
  - 8.2.4 BS 7671 Requirements for Electrical Installations

Issue : 1

Contract C3855-22E

Rev. : 0 01/02/2023

Provision of In-Train Remote CCTV System  
and Train Car Loading Indicator for M-Trains  
Particular Specification

**Appendix K EMC and Non-ionising Radiation**

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# Operations Engineering Standard

S/CC-gen/DS/05(99)

Former number: S/C&C/DS/007(2)

**Title:**

Design Standard - Electromagnetic Compatibility and Non-Ionizing Radiation

**Revision:** D

**Date:** 2017-12-18

Safety related standard

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This standard is mandatory and applied from the date of issue.

## ENDORSEMENT & AUTHORIZATION

**Approved by standards owner:**

Thomas Lam

Date:

27-2-2018

Communications & Network Engineering Manager

**Endorsed by (for safety related standard only):**

N/A

Date:

Chairman – Technical Standards Sub-committee

**Authorized for issue by:**

Michael Leung

Date:

27.2.2018

Acting DGM – Technical & Asset Engineering



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## Revision Record

This standard will be updated when necessary by issuing a complete document. Amendments to the former issue will be summarized in the revision record below. The latest revision of this standard is mandatory and applied immediately from the authorized date for issue unless otherwise stated in the document.

Rev	Date	Amendment	Writer
A	2009-06-18	Rationalized to cope with post merger MTR system. Also updated for new EMC Directive 2004/108/EC.	Thomas Lam
B	2012-09-21	3-yearly regular review and confirmed that the standard remains valid.	Thomas Lam
C	2016-01-06	3-yearly regular review with the Electromagnetic Compatibility (EMC) requirement included in 4G LTE and RFID frequency band.	Michael Chan
D	2017-12-18	<ul style="list-style-type: none"><li>- EMC Directive was updated to version 2014/30/EU.</li><li>- Removed outdated standards EN 50081-1 and EN 50082-2.</li><li>- Replaced outdated standards EN 50061 with EN 45502-2-1.</li><li>- <b>Revised the test requirements for RF radiated emission and Cardiac Pacemakers Safety were revised.</b></li><li>- Revised the table of Permissible radiated emission and its notes in Section 5.2.</li><li>- Renamed OFTA to be OFCA which is the current name</li><li>- Added abbreviations for clarity</li><li>- Replaced EN 55022 with EN 55032</li><li>- Replaced ITU-T K.18 with ITU-T K.68 which is more appropriate for trackside cables</li></ul>	Michael Chan

## Summary of Applicable Railway Lines

Check this box for common standards and leave blank to all railway lines below.

Please check the appropriate box(es) preceding the railway lines to which this standard shall apply; provide comments and/or any particulars / exceptions if applicable:

Railway Line	Abbreviation	Comment
<input checked="" type="checkbox"/> Operating Railway	OPR	_____
<input type="checkbox"/> East Rail Lines:	ERL	_____
<input type="checkbox"/> East Rail Line	EAL	_____
<input type="checkbox"/> Ma On Shan Line	MOL	_____
<input type="checkbox"/> Airport Express, Tung Chung & Disneyland Resort Lines:	AT&D	_____
<input type="checkbox"/> Airport Express Line	AEL	_____
<input type="checkbox"/> Disneyland Resort Line	DRL	_____
<input type="checkbox"/> Tung Chung Line	TCL	_____
<input type="checkbox"/> Light Rail	LR	_____
<input type="checkbox"/> Urban Lines:	URL	_____
<input type="checkbox"/> Island Line	ISL	_____
<input type="checkbox"/> Kwun Tong Line	KTL	_____
<input type="checkbox"/> Tseung Kwan O Line	TKL	_____
<input type="checkbox"/> Tsuen Wan Line	TWL	_____
<input type="checkbox"/> West Rail Line	WRL	_____

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## 1. Scope and Purpose

The purpose of this document is to specify the generic limits and test standards for the Electromagnetic Compatibility (EMC) in relation to continuous and transient radiated disturbances. In addition, the document provides limits and reference on the protection against non-ionizing radiation.

The emission limits are specified so as to ensure a low level of Electromagnetic (EM) emission which will cause no disturbance to operation of the existing systems and minimal health hazard to human beings. The immunity requirements are specified so as to ensure the robustness of a system under Electromagnetic Interference (EMI).

This standard applies to all general control and communications products intended to operate in MTR areas including stations, tunnels, depots, offices and ancillary buildings. Where specific system and equipment are to be considered in specific location, such as signalling and trainborne equipment, the EMC requirements shall be defined according to the actual site conditions and the relevant EMI limits.

## 2. Definitions and Abbreviations

### 2.1 Definitions

Definitions of terms are given in the EMC Directive 2014/30/EU and in CISPR Publication. The definitions stated in the EMC Directive 2014/30/EU for EMC take precedence.

### 2.2 Abbreviations

<b>AC or ac</b>	<b>Alternating Current</b>
CCITT	The International Telegraph and Telephone Consultative Committee (now known as ITU-T)
CCTV	Closed Circuit Television
CDMA	Code-division Multiple Access
CE	By affixing the CE marking to a product, a manufacturer declares that the product meets all the legal requirements for CE marking and can be sold throughout the European Economic Area (EEA). Reference: EMC Directives 2014/30/EU.
CENELEC	European Committee for Electrotechnical Standardization
CISPR	International Special Committee on Radio Interference
<b>DC or dc</b>	<b>Direct Current</b>
EFT	Electrical Fast Transients
EM	Electromagnetic
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EN	European Norm
ESD	Electrostatic Discharge
GSM	Global System for Mobile Telecommunication
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IEC	International Electrotechnical Commission
IEV	International Electrotechnical Vocabulary
ITU	International Telecommunications Union
ITU-T	ITU Telecommunications Standardization Sector
MTR	Mass Transit Railway
MTRCL	Mass Transit Railway Corporation Limited
<b>OFCA</b>	<b>Office of the Communications Authority</b>
RIA	Railway Industry Association
RF	Radio Frequency
RFCI	Radio Frequency Conducted Immunity
RFRI	Radio Frequency Radiated Immunity
<b>RMS or rms</b>	<b>Root-Mean-Square</b>
TDMA	Time-division Multiple Access
UPS	Uninterruptible Power Supply

### 3. Safety Considerations

- 3.1 In order to maintain a high reliability of equipment, especially in some safety related devices (e.g. smoke sensors, heat sensors), any EM emission shall not affect the operation of any safety related and safety critical systems in the MTR environment.
- 3.2 In order to provide a safe and healthy environment for the passengers and MTR employees/contractors, design of any system shall follow the relevant Code of Practice issued by Office of the **Communications Authority (OFCA)**.
- 3.3 Failure to comply with the specified requirements of this standard may result in degrading the system performance and safety of passengers and MTR employees/contractors.

#### **4. Design Requirements**

- 4.1 Any system design shall utilize the frequency bands in an effective way and shall avoid the use of frequencies which have already been occupied by various signalling, control and communication systems in the MTR environment.
- 4.2 Suitable design techniques and construction methods shall be employed to minimise the effects of the EMI.
- 4.3 All commercial off-the-shelf products shall conform to the EMC Directives 2014/30/EU.

## 5. Emission Limits

All equipment shall not generate any EMI that affects the operation of other equipment in the MTR environment.

### 5.1 Emission Limits and Test Requirements

All equipment for operating in the MTR environment shall comply with the emission and test requirements in Table 1:

Description	Specification	Additional or Special Test Requirements
RF Radiated Emissions	EN 61000-6-3 and EN 55032 Class B	<ol style="list-style-type: none"><li>For the frequencies listed in Table 2, the permissible radiated emission shall be according to the limits given in Table 2.</li><li>Different internal frequencies of the equipment-under-test have different measurement ranges. Please refer to EN61000-6-3/EN61000-6-4 for details.”</li></ol>
RF Conducted Emissions	EN 61000-6-3 and EN 55032 Class B	None
Cardiac Pacemakers Safety	EN 45502-2-1	<p>Ref.: EN 45502-2-1 Section 27.6</p> <ol style="list-style-type: none"><li>The static magnetic field is to be measured at a distance of less than 0.5 m from the Equipment Under Test.</li><li>The maximum magnetic flux density is less than 1mT and 0.1mT respectively for static and alternate emissions.</li></ol>

Table 1 - Emission Limits and Test Requirements

## 5.2 Permissible Radiated Emissions at Specific Frequencies

The radiated emission measured at a distance of 1 m in any direction from any component of the supplied equipment shall not be greater than the field strength for frequency bands as shown in Table 2, except the equipment designated to use the bands listed in the table. The measurement shall be taken with the bandwidth specified in Table 2 for the corresponding frequency bands.

Permissible Radiated Emission				
Item	Radio Equipment Susceptible to Interference from the Supplied Equipment	Frequency Range (MHz)	Measurement Bandwidth (KHz)	Max. Level (dB $\mu$ V/m) (Note 1)
1.	Hand Portable Radio (FOT and HTD)	165-171	12.5	6.4
2	Train Mobile and Hand Portable Radio (EAL)	195- 198	12.5	6.4
3.	Fire Services Department Digital Trunked Radio System (DTRS)	390-400	25	13.7
4.	Criminal Investigation Department Radio	380-400	25	13.7
5.	Hong Kong Police Radio (CC3)	420-430	25	14.9
6.	MTR TETRA (Radio)	851-863	25	20.2
7.	Mobile Telephone (See Note 5)	825-837.5 (uplink)	1,000	-92 dBm (Note 3)
		870-882.5 (downlink)	1,000	-90 dBm (Note 3)
8.	Mobile Telephone (See Note 5)	885-915 (uplink)	1,000	-92 dBm (Note 3)
		930-960 (downlink)	1,000	-90 dBm (Note 3)
9.	Mobile Telephone (See Note 5)	1710-1785 (uplink)	1,000	-92 dBm (Note 3)
		1805-1880 (downlink)	1,000	-90 dBm (Note 3)
10.	Mobile Telephone (See Note 5)	1920-1980 (uplink)	1,000	-94 dBm (Note 3)
		2110-2170 (downlink)	1,000	-94 dBm (Note 3)
11.	Mobile Telephone (See Note 5)	2300-2390	1,000	-94 dBm (Note 3)
12	Mobile Telephone (See Note 5)	2500-2570 (uplink)	1,000	-94 dBm (Note 3)
		2620-2690 (downlink)	1,000	-94 dBm (Note 3)

Permissible Radiated Emission				
Item	Radio Equipment Susceptible to Interference from the Supplied Equipment	Frequency Range (MHz)	Measurement Bandwidth (KHz)	Max. Level (dB $\mu$ V/m) (Note 1)
13.	Wireless LAN Equipment (2.4G) (See Note 5)	2400-2483.5	1,000	-97 dBm (Note 3)
14.	Wireless LAN Equipment (5G) (See Note 5)	5150-5350 5470-5850	1,000	-93 dBm (Note 3)
15.	In-Cab CCTV Beacon Equipment (Note 2)	5828	1,000	-43 dBm (Note 4)
16.	In-Cab CCTV Video Equipment (Note 2)	12765-12961	1,000	-65 dBm (Note 4)
17.	RFID	433-434.79 865-868 920-925	200	-46 dBm (Note 3)

Table 2 - MTRCL Radio systems and Permissible Radiated Emission

Note:

- (1) Maximum Allowable Radiated Emission from the Supplied Equipment in dB ( $\mu$ V/m) (Quasi-peak) at 1m unless otherwise stated
- (2) Applicable to trackside and trainborne equipment only.
- (3) The value is adjusted for measurement with a 0dBd gain antenna at 1m apart.
- (4) The measurement shall be taken at 2m (instead of 1m). The value is adjusted for measurement with a 20dBi gain horn antenna at 2m apart.
- (5) The narrowband noise can be ignored if its 3dB-bandwidth is less than 180kHz and it exists in a frequency band for 3G/4G/LTE/Wi-Fi communications.

## 6. Susceptibility/Immunity Requirement

### 6.1 General Susceptibility/Immunity

The equipment for operating in the MTR environment will be susceptible to the EMI generated by other nearby equipment. It shall comply with the susceptibility/immunity and test requirements in Table 3:

Description	Specification	Test Standard	Remarks
RF Radiated Immunity (RFRI) for General Equipment	EN 61000-6-2	EN 61000-4-3	Specific requirements: 10 V/m in the frequency band from 500 MHz to 2.7 GHz 20 V/m in the frequency band from 0.15 MHz to 500 MHz
RF Radiated Immunity (RFRI) for Trackside Equipment	EN 61000-6-2	EN 61000-4-3	10 V/m in the frequency band from 30 MHz to 3 GHz (Trackside only)

Description	Specification	Test Standard	Remarks
RF Conducted Immunity (RFCI)	EN 61000-6-2	EN 61000-4-6	0.15 MHz to 80 MHz
Power Frequency Magnetic Field Immunity (Applicable to distribution networks at 50Hz and 60Hz)	EN 61000-6-2	EN 61000-4-8	Class 4 test level, 30 A/m in continuous field, 300 A/m in short duration (for 3 seconds)
DC Magnetic Field Immunity	300 µT for 2 minutes	None	No visible and functional degradation on the equipment under the specified field strength
Train Signalling System	5 KHz to 500 KHz, 78 dBµA/m (7943µA/m)	None	No visible and functional degradation on the equipment under the specified field strength (Trackside only)

Table 3 - General Susceptibility/Immunity and Test Requirements

## 6.2 Pulsed/Transient EMI Immunity

The equipment for operating in the MTR environment will be susceptible to the pulse mode or transient interference generated by other nearby equipment. It shall comply with the susceptibility/immunity and test requirement in Table 4:

Description	Specification	Test Standard	Remarks
Electrostatic Discharge Immunity (ESD)	EN 61000-6-2	EN 61000-4-2	6,000 V Contact 8,000 V Air Discharge
Electrical Fast Transients /Burst Immunity (EFT)	EN 61000-6-2	EN 61000-4-4	+/- 2,000 V peak
Electrical Surges	EN 55014-2 / EN 61000-6-2	EN 61000-4-5	1,000 V for Differential Mode 2,000 V for Common Mode
Electric Power Supply Voltage Dips	EN 61000-4-11	EN 61000-4-11	30% reduction for 10 ms, and 60% reduction for 100 ms
Electric Power Supply Voltage Interruption	EN 61000-4-11	EN 61000-4-11	> 95% reduction for 5000 ms

Table 4 - Pulsed/Transient EMI Immunity and Test Requirements

The pass criteria of the **immunity** tests shall be defined according to the particular application and system requirements. The typical pass criteria can be any one or any combination of the following conditions:

- On completion of the test, no damage to the Equipment Under Test (EUT).
- On completion of the test, the EUT will function correctly after a reset or re-powered up.
- During the test and after completion of the test, no interruption and disturbance to the function and operation of the EUT.

### 6.3 Major Sources of Interference in MTR Environment

The following systems are the major sources of interference to be considered:

- a) The power distribution system (240Vac, 50 Hz)
- b) The traction system (1500Vdc overhead catenary with running rail traction return)
- c) Trainborne power and motoring systems
- d) High speed processor-driven systems
- e) Power standby equipment e.g. UPS
- f) Various radio systems and wireless LAN equipment as shown in Table 2
- g) **Mobile phones**
- h) **The traction system (25KV ac overhead catenary)**

## 7. Induced EMI Limits

Any signal and control cables shall be properly screened and earthed to prevent noise and/or electric shock from exceeding the levels defined by the ITU-T.

Description	Specification	Test Requirements
Induced EMI	ITU-T Recommendation K.68 " Operator responsibilities in the management of electromagnetic interference by power systems on telecommunication systems "	Maximum levels of induced voltage are: <ul style="list-style-type: none"><li>- 60V in longitudinal voltage to earth (continuous <b>in normal conditions</b>)</li><li>- 430V in longitudinal voltage to earth (fault conditions)</li><li>- <b>0.5mV</b> psophometrically weighted transverse voltage</li></ul>

Table 5 - Maximum voltage levels of induced EMI

## 8. Protection Against Non-Ionizing Radiation

### 8.1 Non-Ionizing Radiation

Electromagnetic radiation that has enough energy to move atoms in a molecule around or cause them to vibrate, but not enough to change them chemically, is referred to as “Non-ionizing Radiation”.

With the fast growing use of mobile phones, radios and wireless equipment, the concerns on non-ionizing radiation hazard have not only been arisen from the equipment providers/owners, but also from the general public. In order to address these concerns, the design and implementation teams shall observe the relevant guidelines and provide proper measures for the protection against non-ionizing radiation.

### 8.2 OFCA's Code of Practice

When planning and installing radio equipment, the responsible parties shall ensure that the radio equipment and its installation comply with the “Code of Practice for the Protection of Workers and Members of Public Against Non-Ionizing Radiation Hazards from Radio Transmitting Equipment” published by the **OFCA**.

### 8.3 Limits on Non-Ionizing Radiation

As referred by the **OFCA**'s Code of Practice, the health protection standards are laid down in the “Guidelines for Limiting Exposure to Time-varying Electric, Magnetic, and Electromagnetic Fields (up to 300 GHz)” published by ICNIRP in 1998 (the ICNIRP Guidelines). For easy reference, the non-ionizing radiation limits of the ICNIRP Guidelines are extracted to Table 6 and Table 7 below. The responsible parties shall ensure that the electric and magnetic fields as well as the power density radiated from the equipment (usually antennae) do not cause exposure to occupational personnel and members of the general public in excess of the limits specified in Table 6 and Table 7 respectively.

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Equivalent Plane Wave Power Density ( $S_{eq}$ ) ( $\text{W}/\text{m}^2$ )
0.065 ~ 1	610	1.6/f	-
> 1 ~ 10	610/f	1.6/f	-
> 10 ~ 400	61	0.16	10
> 400 ~ 2,000	$3\sqrt{f}$	$0.008\sqrt{f}$	$f/40$
> 2,000 ~ 300,000	137	0.36	50

Table 6 - Reference levels for occupational exposure to time-vary electric and magnetic fields (unperturbed rms values)

Note: The occupationally exposed population consists of adults who are generally exposed under known conditions and are trained to be aware of potential risk and to take appropriate precaution.

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Equivalent Plane Wave Power Density ( $S_{eq}$ ) (W/m <sup>2</sup> )
0.15 ~ 1	87	0.73/f	-
> 1 ~ 10	$87/\sqrt{f}$	0.73/f	-
> 10 ~ 400	28	0.073	2
> 400 ~ 2,000	$1.375\sqrt{f}$	$0.0037\sqrt{f}$	$f/200$
> 2,000 ~ 300,000	61	0.16	10

Table 7 Reference levels for general exposure to time-vary electric and magnetic fields (unperturbed rms values)

## 9. References

### 9.1 Applicable Documents

#### 9.1.1 European Standards on EMC/EMI

##### [1] EMC Directive 2014/30/EU

Directive 2014/30/EU of The European Parliament and of The Council on the harmonisation of the laws of the Member States relating to electromagnetic compatibility.

##### [2] EN 55014-2

1997 Electromagnetic Compatibility: Requirement for Household Appliances, Electric Tools and Small Apparatus Part 2. Immunity-Product Family Standard (S)

##### [3] EN 55032

EMC of multimedia equipment – Emission Requirements (CISPR 32:2015)

##### [4] EN 61000-4-1

Test and Measurement Technique. Section 1: Overview of Immunity Tests

##### [5] EN 61000-4-2

Test and Measurement Technique. Section 2: Electrostatic Discharge Immunity Test

##### [6] EN 61000-4-3

Test and Measurement Technique. Section 3: Radiated, Radio-frequency, Electromagnetic Field Immunity Test

##### [7] EN 61000-4-4

Test and Measurement Technique. Section 4: Fast Transients/Burst Immunity Test

##### [8] EN 61000-4-5

Test and Measurement Technique. Section 5: Surges Immunity Test

##### [9] EN 61000-4-6

Test and Measurement Technique. Section 6: Immunity to Conducted Disturbance, Induced by Radio Frequency Field

##### [10] EN 61000-4-8

Test and Measurement Technique. Section 8: Power Frequency Field Immunity Test

##### [11] EN 61000-4-11

Test and Measurement Technique. Section 11: Voltage dips, Short Interruptions and Voltage Variation Immunity Tests (applicable to all equipment except Rolling Stock and Power Supply & Overhead Line)

[12] EN 61000-6-2 Generic standards – Emission standard for residential, commercial and light-industrial environments

[13] EN 61000-6-3 Generic standards – Immunity for industrial environments

#### 9.1.2 Other Related Standards on EMC/EMI and Safety

[14] ITU-T **K.68** Recommendation K.68, "Operator responsibilities in the management of electromagnetic interference by power systems on telecommunication systems".

#### 9.1.3 Standards on Non-ionizing Radiation Safety

[15] Code of Practice for the Protection of Workers and Members of the Public Against Non-Ionizing Radiation Hazards from Radio Transmitting Equipment, **OFCA**, May 2000

[16] Guidelines for Limiting Exposure to Time-varying Electric, Magnetic, and Electromagnetic Fields (up to 300 GHz), ICNIRP, 1998

#### 9.1.4 Other Related Standards on EMI Safety

[17] EN 45502-2-1 Active implantable medical devices - Particular requirements for active implantable medical devices intended to treat bradyarrhythmia (Cardiac Pacemaker)

## 9.2 Reference Documents

### 9.2.1 European Standard for Railway

- [18] EN 50121-1 Railway Applications - EMC Part 1: General
- [19] EN 50121-3-2 Railway Applications - EMC Part 3-2: Rolling Stock - Apparatus
- [20] EN 50121-4 Railway Applications - EMC Part 4: Emission and Immunity of the Signalling and Telecommunication Apparatus
- [21] EN 50121-5 Railway Applications - EMC Part 5: Fixed Power Supply Installations (applicable to Power Supply and Overhead Line contracts)

### 9.2.2 Others

- [22] EN55020 Immunity Requirements for Broadcast Receivers and Associated Equipment (applicable to Telecommunication equipment)
- [23] IEC61000-5-2 EMC Part 5: Installation and Mitigation Guidelines -Section 2: Earthing and Cabling (1997)
- [24] 3GPP TS36.113 LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) and repeater Electromagnetic Compatibility (EMC)

Issue : 1

Contract C3855-22E

Rev. : 0 01/02/2023

Provision of In-Train Remote CCTV System  
and Train Car Loading Indicator for M-Trains  
Particular Specification

**Appendix L Site Safety Cycle and Other Safety Requirements**

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## **Site Safety Cycle and Other Safety Requirements**

1. The Contractor shall implement Site Safety Cycle below:

1.1 Daily Cycle

- (a) Pre-Work Exercise and Safety (PES) meeting;
- (b) Hazard Identification and Activity (HIA) meeting;
- (c) Pre-work safety checks;
- (d) Safety inspection by site agent or his/ her representatives;
- (e) Guidance and supervision during work;
- (f) Safety co-ordination meeting;
- (g) Daily cleaning and tidying up of the Site; and
- (h) Checking of the Site after each day's work.

1.2 Weekly Cycle

- (a) Weekly safety walk by site agent and Registered Safety Officer in company with the Engineer or his/her representative;
- (b) Weekly co-ordination meeting with site agent and the Engineer or his/her representative; and
- (c) Weekly overall cleaning and tidying up of the site.

1.3 Monthly Cycle

- (a) Site safety management committee meeting (including pre-meeting inspection); and
- (b) Site safety committee meeting.

2. Safety supervisor shall coordinate and supervise the working parties and to implement the Site Safety Cycle.

3. The Contractor's project manager shall possess:

- (a) A Degree in Engineering discipline with minimum 3 years relevant working experience; or
- (b) A Higher Certificate / Diploma in Engineering discipline with minimum 5 years relevant working experience and
- (c) Attended safety management training organized by Occupational Safety & Health Council or equivalent.

4. Independent review on method statements shall be carried out by the Contractor's Registered Safety Officer (RSO) for contracts which have RSO in place.

5. Method statements shall be submitted for the Engineer's approval with key safety points written in both English and Chinese.

6. The Contractor shall keep controlled copies of method statements and other safety related documents on site in a designated file.

7. The Contractor shall display safety information such as publications and posters by appropriate means to suit the site environment.
8. The Contractor's Competent Person shall attend refresher session on hazards related to operating railway in every 6 months. Such refresher session shall be conducted by the Contractor's RSO.
9. The Contractor working in TWD and CWD shall require to read and acknowledge safety awareness and depot hazard log. The Employer shall interrupt and dismiss the works carried out by the Contractor at any time when the Contractor does not meet the safety standard as required "Safety Requirements and Information for Contractors" in the GS.

Issue : 1

Rev. : 0 01/02/2023

Contract C3855-22E  
Provision of In-Train Remote CCTV System  
and Train Car Loading Indicator for M-Trains  
Particular Specification

**Appendix M      Maintainability and Testability Engineering Standard**

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# Operations Engineering Standard

S/CC-gen/DS/06(99)

Former number: S/C&C/DS/008(2)

**Title:**

Maintainability and Testability Standard

**Revision:** D

**Date:** 2019-02-01

Safety related standard

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This standard is mandatory and applied from the date of issue.

## ENDORSEMENT & AUTHORIZATION

Approved by standards owner:

Thomas Lam

Communications & Network Engineering Manager

Date: 27 March 2019

Endorsed by (for safety related standard only):

N/A

Chairman – Technical Standards Sub-committee

Date: \_\_\_\_\_

Authorized for issue by:

Michael Leung

Deputy General Manager-Technical & Asset Engineering

Date: 3.4.2019



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## Revision Record

This standard will be updated when necessary by issuing a complete document. Amendments to the former issue will be summarized in the revision record below. The latest revision of this standard is mandatory and applied immediately from the authorized date for issue unless otherwise stated in the document.

Rev	Date	Amendment	Writer
A	2009-07-03	Rationalized to cope with post merger MTR system.	Thomas Lam
B	2012-09-21	3-yearly regular review and confirmed that the standard remains valid	Thomas Lam
C	2015-12-23	3-yearly regular review and confirmed that the standard remains valid	Terry Zhao
D	2019-02-01	3-yearly regular review and confirmed that the standard remains valid	Terry Zhao

## Summary of Applicable Railway Lines

**Check this box for common standards and leave blank to all railway lines below.**

Please check the appropriate box(es) preceding the railway lines to which this standard shall apply; provide comments and/or any particulars / exceptions if applicable:

Railway Line	Abbreviation	Comment
<input checked="" type="checkbox"/> Operating Railway	OPR	_____
<input type="checkbox"/> East Rail Lines:	ERL	_____
<input type="checkbox"/> East Rail Line	EAL	_____
<input type="checkbox"/> Ma On Shan Line	MOL	_____
<input type="checkbox"/> Airport Express, Tung Chung & Disneyland Resort Lines:	AT&D	_____
<input type="checkbox"/> Airport Express Line	AEL	_____
<input type="checkbox"/> Disneyland Resort Line	DRL	_____
<input type="checkbox"/> Tung Chung Line	TCL	_____
<input type="checkbox"/> Light Rail	LRL	_____
<input type="checkbox"/> Urban Lines:	URL	_____
<input type="checkbox"/> Island Line	ISL	_____
<input type="checkbox"/> Kwun Tong Line	KTL	_____
<input type="checkbox"/> Tseung Kwan O Line	TKL	_____
<input type="checkbox"/> Tsuen Wan Line	TWL	_____
<input type="checkbox"/> West Rail Line	WRL	_____

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## 1. Scope and Purpose

This standard is the prime management document for the control and implementation of the system maintainability and testability programme and has been prepared using BS5760 and MIL-STD-785B as guide-lines. Safety, Reliability and Availability are also key elements of the Maintainability and Testability standard, so for completeness, this standard should be read in conjunction with the System Safety Engineering Standard (S/CC-gen/DS/09(99)) and Reliability and Availability Engineering Standard (S/CC-gen/DS/08(99)). This standard is applicable to all phases of the project, as a reference standard that describes the means by which system maintainability and testability will be specified by the designers.

## 2. Definitions

Definitions of terms are given in the Corporation's "Railway Terminology".

The following definitions are applicable to the reliability programme.

### 2.1 Reliability

The ability of an item to perform a required function under stated conditions for a stated period of time.

### 2.2 Basic Reliability

The probability of failure-free performance under stated conditions. This term, also referred to as "logistic reliability", covers all failures within a system or equipment which require a maintenance action.

### 2.3 System Reliability

The ability of a system to perform its specified functions under specified conditions and for a specified period of time. This is also referred to as "mission reliability".

### 2.4 Availability

The ability of an item (under combined aspects of its reliability, maintainability and maintenance support) to perform its required functions at a stated instant of time or over a stated period of time

### 2.5 Maintainability

The ability of an item, under stated conditions of use, to be retained in, or restored to, a state in which it can perform its required functions, when maintenance is performed under stated conditions and using prescribed procedures and resources

## 2.6 Failure Analysis

Subsequent to a failure, the logical systematic examination of an item, its construction, application, and documentation to identify the failure mode and determine the failure mechanism and its basic cause

## 2.7 Reliability Growth

The improvement in a reliability parameter caused by the successful correction of deficiencies in an item's design or manufacture.

## 2.8 Corrective Action

A documented design, process, procedure or materials change implemented and validated to correct the cause of a failure or design deficiency.

## 2.9 Stress Screening

A series of tests conducted under environmental stresses to disclose weak parts and workmanship defects for correction.

## 2.10 Failure Reporting and Corrective Action (FRACAS)

FRACAS is a process to continuously improve the reliability of a product. It furnishes:

- a) Failure reporting to establish a historical database
- b) Failure analysis that may be used to determine the cause of a failure
- c) Documentation of corrective actions to minimise the occurrence of particular failure causes

## 2.11 Derating

Either: using an item in such a way that applied stresses are below rated values OR the lowering of the rating of an item in one stress field to allow an increase in another.

## 2.12 Failure Modes Effect (and Criticality) Analysis

A procedure by which each potential failure mode in a system is analysed to determine the results or effects thereof on the system

## 2.13 Components Parts List

A list of the component parts that comprise the system

## 2.14 Corrective Maintenance

All actions performed as a result of a failure, to restore an item to a specified condition.

2.15 Mean Time Between Failures

A basic measure of reliability for repairable items. The mean number of life units during which all parts of the item perform within their specified limit, during a particular measurement interval under stated conditioned.

2.16 Mean Time To Repair

A basic measure of maintainability, the sum of the corrective maintenance times at any specific level of repair, divided by the total number of failures within an item repaired at that level, during a particular interval under stated conditions.

2.17 Growth Testing

A series of tests conducted to disclose deficiencies and to verify that corrective actions will prevent recurrence in the operational inventory.

2.18 Failure / Fault

The failure mechanism specified in the Failure Mode, Effects and Criticality Analysis.

2.19 Product

A product is an item of equipment. It is usually identified as being housed in a single case. A product is composed of components and modules.

2.20 Module

A module is a major physical subset of a product. A module may be a circuit board or a mechanical assembly. A module is composed of individual components.

2.21 Abbreviations

Abbreviations used in this document are defined as follows:

BIST	Built In Software Test
BIT	Built In Test
BITE	Built In Test Equipment
ESS	Environmental Stress Screening
FBD	Functional Block Diagram
FC	Failure Catalogue
FMECA	Failure Modes, Effects and Criticality Analysis
FRACAS	Failure Recording, Analysis and Corrective Action System
LOF	List Of Functions
M&T	Maintainability & Testability
MTBF	Mean Time Between Failures
MTTR	Mean Time To Repair
MTTT	Mean Time To Test

PAT	Product Acceptance Test
RBD	Reliability Block Diagram
RCIL	Reliability Critical Items List
RDT	Reliability Demonstration Test
RGT	Reliability Growth Test
SAT	System Acceptance Test
STF	System Test Facility

### **3. Safety Considerations**

There is no special safety considerations applying to the activities described in this standard.

### **4. Maintainability & Testability Programme Management**

#### **4.1 Maintainability and Testability Organisation**

The Contractor shall specify the maintainability and testability organisation for the project and provide details of the key personnel in the Maintainability Plan.

#### **4.2 Resources**

**4.2.1** The Contractor shall allocate sufficient resources to the Maintainability and Testability programme to ensure that the programme is completed to time and budget. Additional resources may be allocated from time to time as the Maintainability and Testability programme workload and skill level requirements demand.

**4.2.2** The Contractor shall be responsible for ensuring that the personnel are suitably qualified and/or experienced in the required Maintainability and Testability engineering skills.

#### **4.3 Maintainability and Testability Programme Monitoring**

##### **4.3.1 Design Reviews**

The Contractor shall be responsible for ensuring that Maintainability and Testability Engineer or a nominated representative attends each design review, so that all concerned with the overall programme can be informed on the Maintainability and Testability aspects of the system and equipment and of any agreed corrective actions.

##### **4.3.2 Maintainability and Testability Reviews**

**4.3.2.1** The purpose of this activity shall be to monitor and control the design process in order to achieve the

specified level of Maintainability and Testability, taking into consideration operational requirements and the optimising of life cycle costs.

4.3.2.2 The Contractor shall ensure that the information generated in these appraisals is used in the Maintainability and Testability analyses, and in preparation of the Maintainability and Testability Reports.

4.3.2.3 At commencement of the Contract, a meeting will be held to determine the extent of activities to be covered by the Maintainability Plan. Those activities will be either those listed in the checklist in Appendix 1 or an agreed subset thereof.

4.3.2.4 Throughout the design and development of the equipment the Contractor shall monitor the design and check for compliance against the agreed Maintainability and Testability Check Lists.

4.3.2.5 The Contractor shall conduct formal assessments at regular periods, related to critical stages of the System, Product and Module development.

#### 4.3.3 Progress Reviews

4.3.3.1 Progress on the Maintainability and Testability programme shall be monitored by the Contractor as part of the progress monitoring and reporting process for the overall project programme.

4.3.3.2 The Contractor shall provide inputs to the system progress reports as required.

#### 4.3.4 Resolution of Problems

4.3.4.1 In a situation where the design is in conflict with the Maintainability and Testability requirements, the Contractor shall complete a trade-off study in favour of Maintainability and Testability.

4.3.4.2 The Contractor shall document all such trade-off studies and eventual resolutions and submit them for the Approval of the Engineer.

#### 4.3.5 Monitoring and Control of Sub-Contractors and Suppliers

4.3.5.1 The Contractor shall provide appropriate surveillance of Subcontractor's/Vendors Maintainability and Testability programmes so that timely management action can be

taken as the need arises and programme progress is ascertained.

- 4.3.5.2 In order to facilitate this task, each product or module specification submitted by the Contractor to a supplier or vendor shall be accompanied with an equipment specific maintainability and testability requirements document. This document shall identify the Maintainability and Testability tasks each supplier must undertake and the manner in which they shall be performed.
- 4.3.5.3 Each Maintainability and Testability Requirements document shall be derived from this standard and tailored to meet the specific functional and non-functional requirements.

#### 4.3.6 Configuration Control

All documentation produced by the Contractor as part of the maintainability and testability programme shall be subject to configuration control in accordance with the Particular Specification.

#### 4.3.7 Failure Reporting and Corrective Action (FRACAS)

- 4.3.7.1 The Contractor shall operate a Fault Reporting and Corrective Action System (FRACAS) Procedure throughout the commissioning and testing phases of the programme.
- 4.3.7.2 The Contractor's FRACAS procedure shall be submitted to the Engineer for Approval.
- 4.3.7.3 The Contractor shall ensure the successful implementation of the system and ensure that all design and component changes made as a result of the FRACAS are fed directly into the reliability and maintainability analysis tasks.
- 4.3.7.4 In order to ensure that as much pertinent data is assessed during the analysis process, the Contractor shall utilise as much failure data as possible from similar equipment operating in the field. The field data shall be collated and merged with the data accumulated with the FRACAS procedure in order to determine any occurrence of failure trends.

## 5. Maintainability and Testability Engineering Tasks

### 5.1 Maintainability and Testability Programme Plan

- 5.1.1 The Contractor shall submit a Maintainability and Testability programme plan, produced in accordance with MIL-HDBK-470A and MIL-HDBK-2165, to the Engineer for Approval.
- 5.1.2 The Plan shall reference each section of this standard and define clearly how the requirements contained within each section of this document and the Particular Specification shall be met.
- 5.1.3 The Contractor shall reference all standards and software packages used to perform each task with their respective version numbers.
- 5.1.4 All deviations or non-conformities with this standard shall be clearly stated with a proposal for alternative methods.
- 5.1.5 The programme plan shall include the Maintainability and Testability project plan detailing timescales and resources.

### 5.2 Maintainability and Testability Concepts

#### 5.2.1 Maintainability Concept

5.2.1.1 A maintainability concept shall be defined by the Contractor, in accordance with MIL-HDBK-470A, for the system and the products. This concept shall define the criteria covering repair philosophies, maintenance support levels, personnel factors, maintenance time constraints, spares allocation, etc. as stipulated in the Particular Specification. The concept shall:

- (a) provide the basis for the establishment of maintainability requirements for the system/products/modules to be designed and developed.
- (b) provide the basis for the establishment of requirements for supporting the system/products/modules after they have been developed.

5.2.1.2 The Contractor shall develop the maintainability concept during the conceptual phase of the project prior to the start of actual equipment design. Initiation of concept development at this stage will tend to ensure that all functions of design and support are integrated and oriented to the same concept.

5.2.1.3 The Contractor shall apportion each of the identified maintenance tasks to each product and then break them

down into their constituent parts and identify in a logical progression the means by which those tasks are to be carried out.

### 5.2.2 Testability Concept

- 5.2.2.1 Testability is now the prime element of Maintainability, and without it the repair and recovery of modern electronic equipment has become impossible. Testability is thus an important element of the system that shall be addressed at the start of the project.
- 5.2.2.2 The Contractor shall define an integrated test concept for the system using MIL-HDBK-2165 as a guide.
- 5.2.2.3 This concept shall define the testability requirements as stipulated in the particular Specification, test criteria, test strategy, levels of testing and the test equipment required to support such testing.
- 5.2.2.4 The Contractor shall use the test concept as an input to the following activities:
- (a) BIT concept definition
  - (b) BIT requirements definition
  - (c) Module/Product/System test requirements definition
  - (d) Test equipment requirements definition

### 5.2.3 BIT Concept

- 5.2.3.1 During the system level definition phase the Contractor shall formulate a BIT concept using MIL-HDBK-2165 as a guide.
- 5.2.3.2 The Contractor shall ensure that the concept identifies the following:
- (a) Define an overall BIT strategy for the System, Products and Modules,
  - (b) Identify the modes of BIT operation (i.e. Power-On, Continuous and Initiated BIT),
  - (c) Define the BIT facility, hard- and/or software, to be implemented for each function,
  - (d) Define BIT action and output on detection of fault,
  - (e) Consider impact of proposed BIT malfunction or failure,

- (f) Define the BIT failure logging functions,
- (g) Define the System, Product and Module test connector requirements,
- (h) Define the Module to Product BIT interface,
- (i) Define the Product to System BIT interface,
- (j) Define the Product/System to System Test Facility (STF) test interface

### 5.3 Maintainability and Testability Design Practices

- 5.3.1 The Contractor is responsible for ensuring that all design and development engineers are aware of the standard maintainability and testability design practices.
- 5.3.2 The Contractor shall be responsible for the Maintainability and Testability Design of the equipment.
- 5.3.3 The equipment shall be designed and developed to meet the requirements of the Particular Specification with the aim of minimizing maintenance cost, equipment downtime, servicing and the life cycle cost.
- 5.3.4 The Contractor shall ensure that the maintenance time required for "firstline" (in the normal operation environment) and "second line" (in the repair shops) is minimised. The requirements for training, spares, test equipment and skill level of personnel shall be kept to the lowest level possible through design for maintainability and testability techniques.

### 5.4 Maintainability and Testability Design Criteria

- 5.4.1 The Contractor shall, in close collaboration with the design team, establish a list of maintainability and testability design features that shall be incorporated in the equipment.
- 5.4.2 This list of maintainability and testability features shall ensure that the system provides sufficient fault monitoring, fault diagnosis and ease of repair such that the maintainability and testability requirements can be fulfilled.
- 5.4.3 The criteria shall include but not be limited to:
  - a) Reduction in complexity of overall maintenance tasks;
  - b) Minimisation of the requirements for routine maintenance;
  - c) Planning for routine maintenance to avoid the operational periods;
  - d) Minimising the number of sub-assemblies to reduce spares requirement, maintenance procedures and resultant costs;

- e) Provision of maintenance aids to minimise the maintenance personnel requirements. Maintenance aids include BIT, BITE, BIST, system level diagnostics, test points and fault indicators;
- f) Provision of safeguards or protection to minimise potential maintenance errors;
- g) Identification of development tools to prove attainment of maintainability targets;
- h) Identification of standards to be applied by the project for maintenance aids, tools and documentation;
- i) Guidance to the design team to ensure ease of access for both preventative and corrective maintenance purposes;
- j) Guidance to the design team to minimise the number of adjustments necessary to equipment during test and set up;
- k) Develop the equipment test and set up procedures;
- l) Guidance to the design team to ensure minimal equipment restart times;
- m) Minimise the number of hardware units that are heavy and require special handling;
- n) Ensure that the equipment is modular in construction;
- o) Develop the maintainability procedures for each maintenance task, their scheduling and where conducted;
- p) Minimise the use of STF and special tools, especially at first line maintenance;
- q) Ensure sufficient item identification.

#### 5.4.4 Evaluation of Previous Experience, methods, problems

##### 5.4.4.1 BIT False Alarms

The impact of false alarms caused by BIT is serious, as it results in excessive maintenance costs, a severe lack of confidence in BIT and consequently a significant disruption of the BIT based maintenance concept.

5.4.4.2 The Contractor shall ensure that the following approaches are pursued to ensure that BIT false alarms are kept to an acceptable limit:

- (a) Dedicated BIT hardware is avoided wherever possible.
- (b) Where it is necessary to provide dedicated BIT hardware it is required that the reliability of the hardware is high in relation to the function under test.
- (c) BIT functions are made testable. BIT functions themselves are proven as part of the normal BIT

modes. When an error is indicated by a BIT function, the error indication is verified by testing the BIT function before further action is taken.

- (d) All BIT tolerances are made adjustable. Tolerances of BIT routines, i.e. counter upper and lower limits, shall be programmable in software.
- (e) During continuous BIT, all BIT signal monitoring and software test results shall be filtered to prevent intermittent errors causing a direct NOGO indication.

#### 5.4.4.3 Failed on -line but Retest OK

To reduce the occurrence of "Failed on-line but retest OK" problems the Contractor shall consider the following solutions during the design:

- (a) clean function partitioning
- (b) improved fault detection coverage in the test equipment
- (c) testing based on common BIT software routines, which shall be used for;
- (d) first line BIT
- (e) second line BIT
- (f) System acceptance test
- (g) Product acceptance test
- (h) Module testing
- (i) ESS
- (j) RDT
- (k) RGT

#### 5.4.4.4

The test coverage at each different stage of testing shall be an improvement on the previous stage of testing. i.e. the same BIT modules used for testing during first line BIT shall be used for all the other stages of testing.

#### 5.4.4.5 Common Test Libraries

- (a) The Contractor shall ensure that the Products use common self-test programs for their processing parts, i.e. RAM, EEPROM, Microprocessor, thus permitting the use of similar test routines for each product's processing modules and VLSI devices.
- (b) Where possible, these test libraries shall be

derived from existing projects where similar tests are used which have been checked and demonstrated, thus increasing the confidence of the tests performance.

#### 5.4.4.6 VLSI Built In Self Test (BIST)

All VLSI devices, (i.e. serial controllers, processor peripheral devices) shall be selected with self-test being an important component selection criteria. Experience has shown that the incorporation of BIST circuitry into VLSI devices enhances the Built In Test (BIT) test coverage and provides test facilities which can be used at all levels of test, from device to system.

#### 5.4.5 Maintainability and Testability Design Check List

The M & T Design Check List agreed at the beginning of the Contract, shall be used by the Contractor to monitor and control the M & T design through out the development phase of the project.

### 5.5 Maintainability and Testability Design

#### 5.5.1 Module Testability Design

5.5.1.1 The general approach to testability within the system is to design-in the capability to allow the use of module level in-circuit and/or functional testing and to ease the commissioning and production unit test phases.

5.5.1.2 During the design and development of each module, the Contractor shall consider the following testability design aspects, as a minimum:

- (a) Implementation of function level BIT hardware and firmware
- (b) Use of onboard Module BIT to assist the Module testing on ATE
- (c) Partitioning of functions for testability
- (d) Provision of controllability and visibility through the access of test points
- (e) Provision of facility to program any EPROM/EEPROM whilst onboard through Module or Product test connectors
- (f) Availability of models for automatic test program generation and fault simulation
- (g) Identification of any special ATE adapter requirements

5.5.1.3 The Contractor shall record the BIT / testability circuitry and the test connectors on the Module's circuit diagrams, which must be approved by the Contractor's Maintainability and Testability Engineer before being submitted to the Engineer.

## 5.5.2 Test Specification

5.5.2.1 Test Specifications shall be generated by the Contractor to provide the information needed to allow them to provide the necessary hardware and software facilities for testing the system, products and modules in the most efficient way.

5.5.2.2 A preliminary document shall be produced by the Contractor early in the development phase to define the hardware facilities (i.e. BIT circuitry, visual indications, test interfaces, test connectors and test signals etc.) required in order to comply with the test concept which shall support the following levels of testing:

- (a) Built In Test (BIT)
- (b) Product Acceptance Test (PAT)
- (c) System Integration Testing
- (d) System Acceptance Test (SAT)
- (e) Site Testing
- (f) Environmental Stress Screening (ESS)
- (g) Reliability Demonstration Testing (RDT)
- (h) Reliability Growth Testing (RGT)

5.5.2.3 The Contractor shall update the Test Specification(s) once the hardware design is Approved and has reached a stable condition and shall include a BIT description, a detailed test specification requirement and test sequence for all tests to be performed during each of the test levels defined above.

5.5.2.4 The Contractor shall define each test in detail, including at least the following information:

- (a) Test reference number
- (b) Test name
- (c) Test mode(s)
- (d) Functions tested
- (e) Description of test
- (f) Test procedure
- (g) Filtering information

- (h) Pass / Fail criteria
- (i) Failure response
- (j) Diagnostic information

### 5.5.3 Acceptance Test Procedures

#### 5.5.3.1 Product Acceptance Test (PAT) Procedure

The aim of the Product Acceptance Test (PAT) procedure shall be to test the equipment for serviceability.

5.5.3.2 The Contractor shall conduct the PAT procedure on each Product prior to its shipment from the factory.

- (a) Each PAT procedure shall be made up of five independent test sections as follows:
  - (i) Physical Test  
A check of the physical characteristics of the Product, e.g. dimensions, weight, build standard, configuration control, labelling.
  - (ii) Electrical Test  
A check of the electrical characteristics of the Product, e.g. bonding resistance, isolation resistance, ground connections.
  - (iii) Hardware Functional Test  
A full test of each hardware function performed by the Product, e.g. power supply tolerance, input/output interfaces, memory.
  - (iv) Performance Test  
A performance check of the Product functioning in a 'real world' situation with all interfaces and internal functions working together in parallel.
  - (v) Configuration Test  
A check of the product configuration shall be made in order to verify that it is agreement with the intended system configuration.

#### 5.5.3.3 System Acceptance Test (SAT) Procedure

A System Acceptance Test (SAT) procedure shall be defined by the Contractor for the complete system. Its purpose shall be to check that the system configuration is correct, all the required functions are present and

functioning correctly and that the system performance is adequate.

## 5.6 Maintainability and Testability Assessment and Analysis

### 5.6.1 List of Functions (LOF) Document

- 5.6.1.1 A LOF document shall be generated by the Contractor using MILSTD-1629A as a guide, for use in the preparation of the FMECA and the Failure Catalogue and shall be used as a means of describing the complete equipment hardware in terms of its lowest level functional blocks (at least down to functional blocks within a single module).
- 5.6.1.2 In order to compile the LOF, the Contractor shall conduct a functional analysis of the product / module and present this in the form of a Functional Block Diagram (FBD).
- 5.6.1.3 The diagram shall clearly define the functions performed by the product / module, their interactions and their external interfaces, with a dedicated number assigned to each functional block.
- 5.6.1.4 The LOF document shall contain the following data:
- (a) Function Number
  - (b) Function Name
  - (c) Description of the Function
  - (d) Functional Block Diagram with the signal flow shown
  - (e) Circuit diagram with each functional block clearly marked
- 5.6.1.5 The LOF document shall be produced by the Contractor before the System FMECA and Testability Design Analysis and updated to reflect the final equipment status.

### 5.6.2 Failure Catalogue

- 5.6.2.1 The Failure Catalogue (FC) shall be the basis for the evaluation of the failure detection and isolation capabilities.
- 5.6.2.2 The FC shall be produced by the Contractor based upon the component level FMECA failure modes. It shall be established for each module and product (the product failure catalogue being a collection of module level failure catalogues).
- 5.6.2.3 In order to describe the system level failures a

corresponding FC shall be prepared by the Contractor at system level, based on the system level FMECA failure modes.

- 5.6.2.4 The FC shall address each level of testing, Module, Product and System, to evaluate the capability of detection and isolation of all system failures.
- 5.6.2.5 The FC shall be conducted in accordance with MIL-STD-1629A, which provides the guidelines to conducting the FMECA's and FC's.
- 5.6.2.6 The final FC's shall be used by the Contractor as an input to the Testability Design Analysis and the Maintainability and Testability demonstration.
- 5.6.2.7 The final FC shall be based on the updated List of Functions, and FMECA prepared against the latest equipment design.

#### 5.6.3 Testability Design Analysis

- 5.6.3.1 This analysis shall determine if the general and specific Testability requirements are fulfilled based on equipment design information.
- 5.6.3.2 The results of the Testability Design Analysis shall indicate if the chosen equipment architecture, the partitioning of functions on Modules, the BIT concept, the allocation of test points at Module and Product level and the STF concept shall allow the overall design to meet the quantitative testability requirements.
- 5.6.3.3 The Contractor shall conduct this analysis using MIL-HDBK-2165 Tasks 202 and 203 as guides.
- 5.6.3.4 The ability to detect, and localise, faults listed in the Failure Catalogue shall be theoretically analysed by the Contractor and used as the measure for the test coverage of BIT and STF.
- 5.6.3.5 A quantification of the levels of failure detection, and location to the Module, achieved by all test modes shall be provided by the Contractor using faults from the Failure Catalogue as a measure. This BIT evaluation shall be based on the combination of a theoretical analysis of the BIT hardware and Software, and the results of simulating actual faults listed in the Failure Catalogue within the latest standard equipment.

5.6.3.6 In addition to the BIT evaluation, the capabilities of the STF audits tests shall be quantified by the Contractor. The following data shall be presented as a minimum:

Module(s)

- (a) BIT failure detection capability (each BIT Mode)
- (b) BIT contribution to Module failure rate
- (c) False alarm rate

Product(s) / System

- (a) BIT failure detection capability (each BIT Mode)
- (b) BIT contribution to Product / System failure rate
- (c) False alarm rate
- (d) BIT failure isolation capability to Module / Product level
- (e) BIT test time (each BIT mode)
- (f) BIT fault detection and isolation time (each BIT mode)
- (g) BIT and STF failure detection capability
- (h) BIT and STF failure isolation capability to Module

Product level

- (i) BIT and STF test time
- (j) BIT and STF fault detection and isolation time

## 5.6.4 Maintainability Prediction

5.6.4.1 Maintainability Prediction shall be carried out by the Contractor for both "first line" and "second line" repairs/replacements to provide a prediction of the times to conduct each maintenance task identified in the maintainability concept. These predictions can be considered to be an iterative process.

5.6.4.2 These predictions shall meet the minimum requirements stipulated in the Particular Specification.

5.6.4.3 The maintainability predictions shall reflect the changes in the overall System design as they happen and form part of the tradeoff studies. This shall ensure that sufficient emphasis is placed on meeting the MTTR/MTTT requirements for the System.

5.6.4.4 The following maintenance tasks times shall be predicted by the Contractor as a minimum:

First Line  
System

- (a) Mean Time To Repair (MTTR) System with BIT, by Product replacement

- (b) Mean Time To Repair (MTTR) System with BIT and STF, by Product replacement
- (c) Mean Time To Test (MTTT) System with BIT
- (d) Mean Time To Test (MTTT) System with BIT and STF, Product(s)

Product(s)

- (a) Mean Time To Remove and Replace Product
- (b) Mean Time To Remove and Replace Module (if required)
- (c) Mean Time To Repair (MTTR) Product with BIT , by Module replacement (if required)
- (d) Mean Time To Repair (MTTR) Product with BIT and STF, by Module replacement (if required)
- (e) Mean Time To Test (MTTT) Product with BIT
- (f) Mean Time To Test (MTTT) Product with BIT and STF

Second Line

- (a) Mean Time To Remove and Replace Module
- (b) Mean Time To Repair (MTTR) Product with BIT , by Module replacement
- (c) Mean Time To Repair (MTTR) Product with BIT and STF, by Module replacement
- (d) Mean Time To Test (MTTT) Product with BIT
- (e) Mean Time To Test (MTTT) Product with BIT and STF

5.6.4.5 The Mean Time Between Failures (MTBF) shall come from the Reliability Prediction (see S/C&C/DS/011).

5.6.4.6 An estimate shall be made of the Mean Time Between Removals based upon false alarms and operating factors.

5.6.4.7 These predictions shall be produced either by analysis, synthesis of standard times available from the field or production, or by direct measurement on actual equipment. MIL-HDBK-472 shall be used as a guideline in performing the prediction and the analysis techniques and results shall be presented within the Maintainability Analysis.

## 5.6.5 Maintainability Evaluation

5.6.5.1 A maintainability evaluation shall be carried out by the Contractor for each Product and for the complete System as soon as possible after representative equipment is available. This practical "hands-on" evaluation shall be performed in accordance with MIL-

HDBK-471 and used to check the actual hardware against the maintainability check list and shall ensure that nothing has been over looked during the design phase.

5.6.5.2 The Contractor shall feed the results of this evaluation back into the maintainability predictions and reported in the maintainability analysis. Any non-compliance with the maintainability requirements shall result in a review to decide on the possible corrective actions required.

#### 5.6.6 Maintainability and Testability Analysis Report

5.6.6.1 This report shall contain the results and status of the maintainability and testability work which has been carried out on the project.

5.6.6.2 The Contractor shall issue two reports, a preliminary and a final report. The preliminary report shall be issued after the initial testability design analysis and maintainability predictions. The final report shall be issued after the performance of the maintainability and testability demonstration.

5.6.6.3 The following design information shall be contained in the analysis reports:

- (a) The maintainability concept
- (b) The maintainability activities
- (c) Maintainability predictions
- (d) Tool requirement(s)
- (e) Test equipment requirement(s)
- (f) Personnel requirements
- (g) Handling requirements
- (h) Calibration requirements
- (i) Equipment Life
- (j) M & T Checklist (completed)

#### 5.7 Video Maintainability and Testability Verification and Tests

##### 5.7.1 Maintainability and Testability Evaluation and Demonstration Procedure

5.7.1.1 The performance of M&T demonstrations shall form part of the verification and acceptance test of the maintainability and testability facilities and shall demonstrate the exactness of the information contained in the failure catalogue, testability design analysis and maintainability analysis.

5.7.1.2 In preparation for the M&T demonstrations, the Contractor shall prepare a System M & T Evaluation and Demonstration Procedure, in accordance with MIL-HDBK-471 and MIL-HDBK-2165.

5.7.1.3 This procedure shall contain the following details of the tasks to be performed during the M&T Demonstration:

- (a) Demonstration objectives.
- (b) Demonstration methodology.
- (c) Method and criteria of data recording and analysis.
- (d) Method of reporting results of the demonstration, including format of the report.
- (e) Principle conditions of demonstration such as personnel and equipment requirements.
- (f) Levels of maintenance to be demonstrated.
- (g) Items to be demonstrated.
- (h) Analytical methods and calculation procedures.
- (i) Fault selection method.

#### 5.7.2 Fault Simulation List

Two Fault Simulation Lists shall be prepared by the Contractor for the M&T Demonstrations:

5.7.2.1 During each Product M&T Demonstration approximately 10% of the failures from each Module Failure Catalogue, or 30 failures, whichever is the lowest, shall be reproduced in the Product for evaluation of the BIT's and STF's capability in failure detection and localisation.

5.7.2.2 This failure population shall be provided in the Product Fault Simulation List which details how the faults will be physically implemented in the Product to produce the required failures.

5.7.2.3 The failure population for the product Fault Simulation List shall be selected by the Contractor.

5.7.2.4 During the System M&T Demonstration approximately 10% of the failures from the System Failure Catalogue shall be reproduced in the System for evaluation of the BIT's capability in failure detection and localisation.

5.7.2.5 This failure population shall be provided in the System Fault Simulation List which details how the faults will be physically implemented in the System to produce the required failures.

5.7.2.6 The failure population for the system fault simulation list shall be selected by the Contractor.

### 5.7.3 Maintainability and Testability Demonstration

- 5.7.3.1 A series of M&T Demonstrations shall be performed by the Contractor in order to provide assurance that the specified M&T qualitative and quantitative requirements have been met and to validate the correctness of the Failure Catalogue, Testability Design Analysis and Maintainability Analysis.
- 5.7.3.2 The M&T Demonstrations shall be performed by the Contractor utilising equipment representative of the final equipment standard.
- 5.7.3.3 As an input requirement to the M&T demonstrations it shall be presupposed that the information contained in the failure catalogue, testability design analysis and maintainability analysis meet at least the maintainability and testability requirements of the System and Product requirements specifications.
- 5.7.3.4 The Contractor shall perform two types of demonstration:
- (a) First line maintenance shall be demonstrated (the repair of the System through failed Product location using BIT, and Product replacement).
  - (b) Second line maintenance shall be demonstrated (the repair of a Product through failed Module location, using BIT only and the combination of BIT and STF, and Module replacement).
- 5.7.3.5 AM&T Demonstration report shall be prepared by the Contractor after each demonstration.
- 5.7.3.6 The report shall state the objectives of the demonstration, conditions, results achieved, any problems encountered and corresponding corrective actions being taken or proposed.
- 5.7.3.7 If the M&T Demonstration results show a compliance with the requirements then further testing shall be considered unnecessary and the M&T verification phase shall be complete. A noncompliance will mean further testing and possible system redesign by the Contractor in order to comply with the System requirements stipulated in the Particular Specification.
- 5.7.3.8 Full details of the objectives and procedure shall be contained in the Maintainability and Testability Evaluation and Demonstration Procedure.

## 5.8 System Test Facility (STF) Definition

### 5.8.1 Development

- 5.8.1.1 A System Test Facility (STF) shall be developed by the Contractor to be used to integrate and test the System and Product(s).
- 5.8.1.2 It shall automatically execute the functional testing part of the Product Acceptance Test (PAT) procedure(s) and support the System Acceptance Test (SAT) procedure and Product and System integration activities.
- 5.8.1.3 The same STF shall also be used for the Purchaser's acceptance test for the equipment before delivery.
- 5.8.1.4 A STF functional and non-functional requirement specification shall be prepared by the Contractor based on the requirements defined in the System and Product Test Specification.

### 5.8.2 Documentation

The following documents shall be produced by the Contractor as a minimum:

- (a) STF functional and non-functional requirements specification
- (b) STF description of function and performance
- (c) STF build details and design data
- (d) STF User Manual
- (e) STF Calibration Procedure, including maintenance concept
- (f) STF Spares List

## 6. References

### MTRCL References

S/CC-gen/DS/08(99) Reliability and Availability Engineering Standard

### British Standards

BS5760 Reliability of Systems, Equipments and Components - Guide to reliability testing. Design of test cycles.

### Military Standards and Handbooks

MIL-STD-785B Reliability Programme for Systems and Equipment Development and Production

MIL-STD-1629A Procedures for Performing A Failure Mode, Effects & Criticality Analysis

MIL-HDBK-470A Designing and Developing Maintainable Products and Systems, Vol. 1

MIL-HDBK-471 Maintainability Verification/Demonstration/Evaluation.

MIL-HDBK-2165 Testability Program for Electronic Systems and Equipment

MIL-HDBK-472 Maintainability Prediction

Unless specified in this document, the maintainability and testability programme shall use the edition current at the commencement of the relevant task.

## Appendix 1 - Maintainability Plan Check List

### Glossary of Terms, Definitions and Abbreviations

- All terms, definitions and abbreviations given in the Plan are compatible with MTRC understanding and common usage.
- Stated or implied assumptions are correct and comply with MTRCL operational practices and maintenance policies.
- Definitions of first, second and third line maintenance are as specified in the PS OR are in agreement with the maintenance policy for the equipment.
- Terminology used in the Plan is defined and consistent with MTRCL practices
- Formulate used are based on correct assumptions; are correct for the application and mathematically correct.

### Format and Structure

- The Plan is generally in the format specified in the PS.
- The Plan contains cross references to the Contractor's Project Quality Plan and PS for traceability.
- All the Reliability requirements of the GS (GS8.3.1) have been adequately dealt with in the Plan.
- Every item of equipment is covered by the Plan.
- The Plan covers all stages of the Contract from Preliminary Design to the end of the Period of Maintenance.
- The quantitative maintainability targets (Mean Time To Repair, Mean Time To Restore, Manning Index etc.) indicated in the PS have been correctly incorporated in the Plan OR suitable targets have been set.
- The Plan identifies which equipment is existing and will remain unmodified, which equipment is existing but will be modified for the particular project and which equipment is new.
- The Plan covers second sourcing of components.
- The Plan indicates what maintenance records are to be kept up until the end of the Period of Maintenance.

### Maintainability Programme Management Organisation

- The Plan indicates the resources, reporting structure, roles and responsibilities of all Contractor and Subcontractor personnel to be engaged in maintainability activities.
- The level of resources assigned to maintainability activities as indicated in the Plan seem adequate.
- The skill level and experience of the people assigned to tasks is an acceptable match to that task.

### Programme Monitoring

#### **Review Process**

- The Plan shows that adequate reviews are going to be held at suitable points in the product development process.
  - The reviews will ensure that the project meets the maintainability requirements.
  - The reviews will ensure that the project meets the cost and timescale requirements.

### **Resolution of Problems**

- The Plan identifies a clear method of problem resolution which is acceptable to MTRCL.
  - The problems will be advised to MTRCL.
  - MTRCL will be consulted as to the resultant course of action.
- The Plan indicates a Failure Reporting, Analysis and Corrective Action System (FRACAS) to improve the maintainability of a product.
  - The FRACAS is closed loop throughout the testing, commissioning and operational phases.

### **Monitoring of Subcontractors/Suppliers**

- The Plan covers not only the Contractor but any Subcontractors and Suppliers as well.
  - The same standards and progress monitoring mechanisms applicable to the Contractor will also be applicable to the Subcontractor.
  - Quality standards and delivery arrangements relating to Suppliers will be monitored and controlled.

### **Maintainability Programme**

- The Plan defines an acceptable and credible set of maintainability activities along with their deliverables.
- The Plan defines OR refers to a timescale for the maintainability activities.
- The maintainability programme shows realistic durations for activities in relation to the level and experience of resources allocated to those tasks.

### **Configuration Management**

- The Plan shows that configuration management procedures are (will be) put in place.
  - The configuration management procedures cover all phases and deliverables of the maintainability programme.

### Maintainability and Testability Concepts

#### **Maintainability Concept**

- The Plan is in accordance with MTRCL proposed Maintenance Policy for the equipment/system.
- The Plan identifies an acceptable level of skilled assumed to be possessed by the Maintenance Staff.

#### **Testability Concept**

- The Plan identifies the use of Built In Test.
- The Plan identifies the sub-system test requirements
- The Plan identifies the test equipment requirements.

#### **Built In Test (BIT) Concept**

- The provision and use of Built In Test (BIT) for aiding diagnostics and maintenance is indicated in the Plan.
  - The Plan defines the strategy for BIT action and output
  - The Plan defines the strategy for BIT failure logging functions
  - The Plan defines the strategy for test connections/harnesses/jigs
  - The Plan defines requirements for Automatic Test Equipment which match or closely approximate MTRCL policy and expectations
  - It is clear from the Plan that any restrictions or limitations for equipment use that are a result of the action of BIT will be agreed with MTRCL before design is finished.

## Maintainability and Testability Design Practices

### **Maintainability and Testability Design Criteria**

- The Plan aims to reduce the overall maintenance task
- The Plan aims to minimise the need for routine maintenance
- The Plan indicates how routine maintenance can be scheduled to avoid the operational period
- The Plan indicates how the number of sub-assemblies, spares and maintenance procedures and maintenance cost are to be minimised
- The Plan indicates how maintenance aids will be used to minimise the need for maintenance personnel
  - The proposed maintenance aids include system level diagnostics, provision of test points and fault indicators
- The Plan indicates how safeguards will be provided to minimise the possibilities of potential maintenance errors
- The Plan indicates any special maintenance tools that will be developed to facilitate the attainment of the maintenance targets
- The Plan will indicate how the number of adjustments necessary to equipment during test and set up will be minimised
- The Plan indicates how equipment power-up times will be minimised.
- The Plan will indicate how the number of heavy units and the maximum weight of such units will be minimised
- The Plan indicates the use of modular construction
- The strategies proposed in the Plan for design for replacement and maintenance seem achievable and adequate
- Acceptable methods of ensuring ease of access to installed equipment have been identified in the Plan
- Acceptable methods of ensuring ease of access within equipment cases/housings have been identified in the Plan
- Acceptable proposals for equipment connections and terminations have been adequately identified in the Plan
- The Plan indicates that the possibility of incorrect connections will be adequately guarded against
- The Plan indicates that critical modules with a high failure rate will be given special attention
- The Plan indicates that equipment in locations which are difficult to access will be given special attention
- The Plan indicates that equipment in locations which have special environmental considerations will be given special attention
- The Plan covers long term strategies to deal with replacement component and component obsolescence

### **BIT False alarm**

In order to minimise the rate of BIT false alarms, the Plan indicates how:

- BIT hardware will be minimised
- BIT functions will be made testable
- All BIT tolerances will be made adjustable
- Continuous BIT signal monitoring and software test results will be filtered

## **Maintainability and Testability Design**

- The Plan indicates how the equipment will be designed/modified to minimise the maintenance cost, equipment down-time and whole-of-life costs
- The Plan indicates how the need for special tools and test equipment will be minimised
- Any need for on-line replacement of modules has been correctly reflected in the Plan

### **Test Specifications**

- The level of BIT coverage indicated in the Plan is as per the PS OR is suitable for the application
- The Plan indicates acceptable targets for acceptance and integration testing
- The Plan identifies any site testing that may be necessary

### **Test Procedures**

- The Plan shows that preventative maintenance instructions will be provided
- The Plan shows that corrective maintenance instructions will be developed making optimum use of fault finding flow charts and decision trees

## Maintainability and Testability Assessment and Analysis

### **List of Functions Document**

- The Plan indicates that a “List of Functions” document will be produced
  - The List of Functions document will be used in the development of BIT and corrective maintenance actions

### **Failure Catalogue**

- The Plan indicates that a “Failure Catalogue” document will be produced
  - The Failure Catalogue document will be used in evaluating the failure detection and isolation capabilities
  - The Failure Catalogue document will itemise each failure mode and assess the systems capability of detecting and isolating the cause of failures

### **Testability Design Analysis**

- The Plan indicates that Testability Design Analysis will be performed
  - The Testability Design Analysis will be conducted at the module and system level
  - The Testability Design Analysis will assess failure detection capability
  - The Testability Design Analysis will assess BIT contribution to module/system failure rates
  - The Testability Design Analysis will assess BIT isolation capability
  - The Testability Design Analysis will assess BIT test time
  - The Testability Design Analysis will assess BIT fault detection and isolation times
  - The Testability Design Analysis preferably will be based on MIL-HDBK-2165

### **Maintainability Prediction**

- The Plan indicates the strategy for Maintainability Predictions (preferably MIL-HDBK-472)
- The Plan indicates that Mean Time To Restore will be assessed
- The Plan indicates that Mean Time to Repair (second and third line) will be assessed
  - The spares provision specified in the PS OR a provision based on equipment reliability, population, time to repair/replace and probability of outstocking has been incorporated in the Plan. This will be incorporated in the predictions
- The Plan indicates that Mean Time To Test will be assessed

### **Maintainability Evaluation**

- The Plan indicates the strategy for practical Maintainability Evaluations

### Maintainability and Testability Verification Tests

### **Maintainability and Testability Evaluation and Demonstration Procedure**

- The Plan indicates that a demonstration procedure for evaluation of the failure Catalogue. Testability Design Analysis and maintainability Analysis will be produced for MTRCL Approval

### **Fault Simulation List**

- The Plan indicates that a fault Simulation list containing the failure to be reproduced during the tests will be developed and Approved by MTRCL

### **Maintainability and Testability Demonstration**

- The Plan indicates the strategy for providing credible and measurable demonstrations of the Maintainability Targets
- The Plan defines a list of maintainability data to be collected during the Period of Maintenance and the method of analysis applied to that data

Issue : 1

Contract C3855-22E

Rev. : 0 01/02/2023

Provision of In-Train Remote CCTV System  
and Train Car Loading Indicator for M-Trains  
Particular Specification

**Appendix N Reliability and Availability Engineering Standard**

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# Operations Engineering Standard

S/CC-gen/DS/08(99)

Former number: S/C&C/DS/011(2)

**Title:**

Reliability and Availability Engineering Standard

**Revision:** C

**Date:** 2015-12-23

Safety related standard

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This standard is mandatory and applied from the date of issue.

## ENDORSEMENT & AUTHORIZATION

Approved by standards owner:

Thomas Lam

Date: 12-1-2016

Communications & Network Engineering Manager

Endorsed by (for safety related standard only):

N/A

Chairman - Technical Standards Sub-committee

Date: \_\_\_\_\_

Authorized for issue by:

Philip Wong

General Manager-Technical & Engineering Services

Date: 22 Jan 2016



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## Revision Record

This standard will be updated when necessary by issuing a complete document. Amendments to the former issue will be summarized in the revision record below. The latest revision of this standard is mandatory and applied immediately from the authorized date for issue unless otherwise stated in the document.

Rev	Date	Amendment	Writer
A	2009-07-03	Rationalized to cope with post merger MTR system.	Thomas Lam
B	2012-09-21	3-yearly regular review and confirmed that the standard remains valid.	Thomas Lam
C	2015-12-23	3-yearly regular review and confirmed that the standard remains valid.	Harry Chan

## Summary of Applicable Railway Lines

Check this box for common standards and leave blank to all railway lines below.

Please check the appropriate box(es) preceding the railway lines to which this standard shall apply; provide comments and/or any particulars / exceptions if applicable:

Railway Line	Abbreviation	Comment
<input checked="" type="checkbox"/> Operating Railway	OPR	_____
<input type="checkbox"/> East Rail Lines:	ERL	_____
<input type="checkbox"/> East Rail Line	EAL	_____
<input type="checkbox"/> Ma On Shan Line	MOL	_____
Airport Express, Tung Chung & Disneyland Resort Lines:	AT&D	_____
<input type="checkbox"/> Airport Express Line	AEL	_____
<input type="checkbox"/> Disneyland Resort Line	DRL	_____
<input type="checkbox"/> Tung Chung Line	TCL	_____
<input type="checkbox"/> Light Rail	LRL	_____
<input type="checkbox"/> Urban Lines:	URL	_____
<input type="checkbox"/> Island Line	ISL	_____
<input type="checkbox"/> Kwun Tong Line	KTL	_____
<input type="checkbox"/> Tseung Kwan O Line	TKL	_____
<input type="checkbox"/> Tsuen Wan Line	TWL	_____
<input type="checkbox"/> West Rail Line	WRL	_____

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## 1. Scope and Purpose

This standard is the prime management document for the control and implementation of the system reliability and availability programme and has been prepared using BS5760 and MIL-STD-785 as guide-lines. Safety, Maintainability and Testability are also key elements of the Reliability and Availability Standard, so for completeness, this Standard should be read in conjunction with the System Safety Engineering Standard (S/CC-gen/DS/09) and Maintainability and Testability Standard (S/CC-gen/DS/06). This standard is applicable to all phases of the project, as a reference standard that describes the means by which system reliability and availability will be specified by the designers.

## 2. Definitions

Definitions of terms are given in the Corporation's "Railway Terminology".

### 2.1 Reliability

The ability of an item to perform a required function under stated conditions for a stated period of time.

### 2.2 Basic Reliability

The probability of failure-free performance under stated conditions. This term, also referred to as "logistic reliability", covers all failures within a system or equipment which require a maintenance action.

### 2.3 System Reliability

The ability of a system to perform its specified functions under specified conditions and for a specified period of time. This is also referred to as "mission reliability".

### 2.4 Availability

The ability of an item (under combined aspects of its reliability, maintainability and maintenance support) to perform its required functions at a stated instant of time or over a stated period of time.

### 2.5 Maintainability

The ability of an item, under stated conditions of use, to be retained in, or restored to, a state in which it can perform its required functions, when maintenance is performed under stated conditions and using prescribed procedures and resources.

### 2.6 Failure Analysis

Subsequent to a failure, the logical systematic examination of an item, its construction, application, and documentation to identify the failure mode and determine the failure mechanism and its basic cause.

2.7 Reliability Growth

The improvement in a reliability parameter caused by the successful correction of deficiencies in an item's design or manufacture.

2.8 Corrective Action

A documented design, process, procedure or materials change implemented and validated to correct the cause of a failure or design deficiency.

2.9 Stress Screening

A series of tests conducted under environmental stresses to disclose weak parts and workmanship defects for correction.

2.10 Derating

Either: using an item in such a way that applied stresses are below rated values OR the lowering of the rating of an item in one stress field to allow an increase in another.

2.11 Failure Modes Effect (and Criticality) Analysis

A procedure by which each potential failure mode in a system is analysed to determine the results or effects thereof on the system.

2.12 Components Parts List

A list of the component parts that comprise the system.

2.13 Corrective Maintenance

All actions performed as a result of a failure, to restore an item to a specified condition.

2.14 Mean Time Between Failures

A basic measure of reliability for repairable items. The mean number of life units during which all parts of the item perform within their specified limit, during a particular measurement interval under stated conditions.

2.15 Mean Time To Repair

A basic measure of maintainability, the sum of the corrective maintenance times at any specific level of repair, divided by the total number of failures within an item repaired at that level, during a particular interval under stated conditions.

2.16 Growth Testing

A series of tests conducted to disclose deficiencies and to verify that corrective actions will prevent recurrence in the operational inventory.

## 2.17 Failure / Fault

The failure mechanism specified in the Failure Mode, Effects and Criticality Analysis.

## 2.18 Failure Reporting and Corrective Action

Failure Reporting and Corrective Action (FRACAS) is a process to continuously improve the reliability of a product. It furnishes:

- a) Failure reporting to establish a historical database.
- b) Failure analysis that may be used to determine the cause of a failure.
- c) Documentation of corrective actions to minimise the occurrence of particular failure causes

## 2.19 Critical Item

A item is defined as critical when:

- a) The failure of which could critically affect the system safety, cause the system to become unavailable or unable to achieve mission objectives, or cause extensive/expensive maintenance and repair;
- b) The failure of which would prevent the acquisition of data to evaluate system safety, availability, mission success or the need for maintenance / repair;
- c) That which has stringent performance requirement(s) in its intended application relative to state of the art technology for the item;
- d) The sole failure of which causes system failure;
- e) That which is stressed in excess of the specified derating criteria;
- f) That which has a known operating life, shelf life or environmental exposure such as vibration, thermal, propellant or a limitation which warrants controlled surveillance under specified conditions;
- g) That which is known to require special handling, transportation, storage or test precautions;
- h) That which is difficult to procure or manufacture relative to state of the art technologies;
- i) That which has exhibited an unsatisfactory operating history;
- j) That which does not have sufficient history of its own, or similarity to other items having demonstrated high reliability, to provide confidence in its reliability;
- k) That which has past history, nature, function, or processing with a deficiency warranting total traceability;
- l) That which is used in large quantities (typically where the quantity of that particular component exceeds 10% of the total number of components on a module);

## 2.20 Product

A product is an item of equipment. It is usually identified as being housed in a single case. A product is composed of components and modules.

#### 2.21 Module

A module is a major physical subset of a product. A module may be a circuit board or a mechanical assembly. A module is composed of individual components.

#### 2.22 Abbreviations

Abbreviations used in this document are defined as follows:

CPL	Component Parts List
EOLA	Environmental and Operational Load Analysis
ESS	Environmental Stress Screening
FBD	Functional Block Diagram
FMEA	Failure Modes, Effects and Criticality Analysis
FRACAS	Failure Recording, Analysis and Corrective Action System
MTBF	Mean Time Between Failures
RBD	Reliability Block Diagram
RCIL	Reliability Critical Items List
RDT	Reliability Demonstration Test
RGT	Reliability Growth Test

### 3. Safety Considerations

There is no special safety considerations applying to the activities described in this standard.

### 4. Reliability and Maintainability Programme Management

#### 4.1 Reliability and Availability Organisation

The Contractor shall specify the reliability and availability organisation for the project and provide details of the key personnel in the Reliability Plan.

#### 4.2 Resources

4.2.1 The Contractor shall allocate sufficient resources to the reliability and availability programme to ensure that the programme is completed to time and budget. Additional resources may be allocated from time to time as the Reliability and Availability programme workload and skill level requirements demand.

4.2.2 The Contractor shall be responsible for ensuring that the personnel are suitably qualified and/or experienced in the required Reliability and Availability engineering skills.

#### 4.3 Reliability and Availability Programme Monitoring

##### 4.3.1 Design Reviews

The Contractor shall be responsible for ensuring that a Reliability Engineer or a nominated representative attends each design review, so that all concerned with the overall programme can be informed on the Reliability and Availability aspects of the system and equipment and of any agreed corrective actions.

##### 4.3.2 Availability and Reliability Reviews

4.3.2.1 (The purpose of this activity shall be to monitor and control the design process in order to achieve the specified level of Reliability and Availability, taking into consideration operational requirements and the optimising of life cycle costs.

4.3.2.2 The Contractor shall ensure that the information generated in these appraisals is used in the Reliability and Availability analyses, and in preparation of the Reliability and Availability Reports.

4.3.2.3 At commencement of the Contract, a meeting will be held to determine the extent of activities to be covered by the Reliability Plan. Those activities will be either those listed in the checklist in Appendix 1 or an agreed subset thereof.

4.3.2.4 Throughout the design and development of the equipment the Contractor shall monitor the design and check for compliance against the agreed Reliability and Availability Check Lists.

4.3.2.5 The Contractor shall conduct formal assessments at regular periods, related to critical stages of the System, Product and Module development.

##### 4.3.3 Progress Reviews

4.3.3.1 Progress on the Reliability and Availability programme shall be monitored by the Contractor as part of the progress monitoring and reporting process for the overall project programme.

4.3.3.2 The Contractor shall provide inputs to the system progress reports as required.

##### 4.3.4 Resolution of Problems

4.3.4.1 In a situation where the design is in conflict with the Reliability and Availability requirements, the

Contractor shall complete a trade-off study in favour of Reliability and Availability.

- 4.3.4.2 The Contractor shall document all such trade-off studies and eventual resolutions and submit them for the Approval of the Engineer.

4.3.5 Monitoring and Control of Sub-Contractors and Suppliers

- 4.3.5.1 It shall be the responsibility of the Contractor to provide appropriate surveillance of Subcontractor's/Vendors Reliability and Availability programmes so that timely management action can be taken as the need arises and programme progress is ascertained.

- 4.3.5.2 In order to facilitate this task, each product or module specification submitted by the Contractor to a supplier or vendor shall be accompanied with an equipment specific Reliability and Availability Requirements document. This document shall identify the Reliability and Availability tasks each supplier must undertake and the manner in which they shall be performed.

- 4.3.5.3 Each Reliability and Availability Requirements document shall be derived from this standard tailored to meet the specific functional and non-functional requirements.

4.3.6 Configuration Control

All documentation produced by the Contractor as part of the reliability and availability programme shall be subject to configuration control in accordance with the Particular Specification.

4.3.7 Failure Reporting, Analysis and Corrective Action System (FRACAS)

- 4.3.7.1 The Contractor shall operate a Fault Reporting and Corrective Action System (FRACAS) Procedure throughout the commissioning and testing phases of the programme.

- 4.3.7.2 The Contractors FRACAS procedure shall be submitted to the Engineer for Approval.

- 4.3.7.3 The Contractor shall ensure the successful implementation of the system and ensure that all design and component changes made as a result of the FRACAS are fed directly into the reliability and maintainability analysis tasks.

4.3.7.4 In order to ensure that as much pertinent data is assessed during the analysis process, the Contractor shall utilise as much failure data as possible from similar equipment operating in the field. The field data will be collated and merged with the data accumulated with the FRACAS procedure in order to determine any occurrence of failure trends.

## 5. Reliability and Availability Engineering Tasks

### 5.1 Reliability and Availability Programme Plan

- 5.1.1 The Contractor shall submit a Reliability and Availability programme plan, produced in accordance with MIL-STD-785, to the Engineer for Approval.
- 5.1.2 The Plan shall reference each section of this standard and define clearly how the requirements contained within each section of this document and the Particular Specification shall be met.
- 5.1.3 The Contractor shall reference all standards and software packages used to perform each task with their respective version numbers.
- 5.1.4 All deviations or non-conformities with this standard shall be clearly stated with a proposal for alternative methods.
- 5.1.5 The programme plan shall include the reliability and availability project plan detailing timescales and resources.

### 5.2 Reliability Analyses

It is important to understand that reliability analyses (in conjunction with the safety, maintainability and testability analyses) are iterative. Because each of the tasks that form the reliability analyses are inter-related it is essential that tight configuration control of each reliability analysis document is established and then maintained.

#### 5.2.1 Reliability Modelling

5.2.1.1 Reliability modelling techniques shall be used to characterise a system's design as a mathematical expression or computer simulation for the purpose of quantifying the systems mission, safety or logistic reliability. Modelling shall be used to:

- (a) Apportion the system reliability requirements to the lower levels to allow the product and module reliability requirements to be specified;
- (b) Perform trade-off between the performance characteristics (e.g. performance, reliability, maintainability) in order to achieve the most

desirable balance among the parameters;

- (c) Determine levels of redundancy for failure tolerant critical systems;
- (d) Highlight problem areas in the design which limit the ability of the design to meet the requirements.

5.2.1.2 The Contractor shall conduct the reliability modelling using task 201 of MIL-STD-785, as a guide.

5.2.1.3 The model shall utilise the interactions between the modules, their failure rates, duty cycles, mission time, standby factor and mission profile.

5.2.1.4 If deemed necessary, the Contractor shall conduct the reliability modelling at module and component level.

## 5.2.2 Reliability Apportionment

5.2.2.1 The Contractor shall apportion the basic and system reliability requirements to each of the products that comprise the system using task 202 of MIL-STD-785 as a guide.

5.2.2.2 The reliability apportionment process is a live activity, hence the Contractor shall subject the apportionment to constant revision until the design stabilises.

5.2.2.3 The apportionment process shall utilise the following factors, as a minimum:

- (a) Circuit complexity;
- (b) Quantity of components;
- (c) Device types;
- (d) Quality levels;
- (e) Operating conditions;
- (f) History of similar or identical equipment.

## 5.2.3 Parts and Materials Selection Process

5.2.3.1 The Contractor shall ensure that the Reliability Engineer has an active involvement with the design team in the parts and materials selection process.

5.2.3.2 The process shall use task 207 of MIL-STD-785 and MILHDBK-338 as guides, and involve assessing each component part against the following criteria:

- (a) Component history;
- (b) Level of screening;
- (c) Suitability of intended environment;

- (d) Suitability of intended operation;
- (e) Expected life of the component or part;
- (f) Software aspects (Whether a component can accommodate the application software);
- (g) Component availability (Sourcing);
- (h) Compatibility of materials.

#### 5.2.4 Components Parts List

5.2.4.1 The components selected for each module shall be presented in the form of a component parts list (CPL). The CPL shall contain the following information as a minimum:

- (a) Device type;
- (b) Manufacturer and supplier;
- (c) Component specification;
- (d) Component description;
- (e) Component identification and circuit reference number
- (f) Quantity;
- (g) Remarks - Any relevant comments that the designer wishes to make.

5.2.4.2 The Contractor shall ensure that the CPL is updated as changes in the design occur, thus it provides the latest available information for each module design.

#### 5.2.5 Reliability Predictions

5.2.5.1 Reliability predictions are performed to determine whether the reliability requirements can be achieved by the proposed design. The predictions shall also identify those components or functions of the system or equipment which are critical to the reliability of the system and which may require further work to eliminate or reduce their criticality.

5.2.5.2 It should be noted that reliability predictions only provide estimates of the level of reliability that is likely to be achieved by a design under certain specified conditions, usually an average of the range of conditions normally encountered. Reliability predictions shall be used to compare alternative designs, and to identify the critical areas of a design in relation to the overall reliability.

##### 5.2.5.3 Basic Reliability Predictions

- (a) The predicted basic reliability of the system shall not be less than the minimum requirement

stated in the Particular Specification.

- (b) The Contractor shall perform basic reliability predictions for electronic equipment using task 201 of MIL-STD-785, and the reliability models and data contained in the failure rate database MIL-HDBK-217.
- (c) The Contractor shall perform reliability predictions of non-electronic parts data using published data or in-service reliability data.
- (e) The Contractor shall utilise alternative sources of failure data, such as manufacturers or field data, provided the data has integrity and the samples are statistically significant.
- (e) The Contractor shall ensure that the justification for using alternative data is fully documented.
- (f) Initial estimates of reliability predictions for each of the modules resident in the system shall be carried out using the parts count method of MIL-HDBK-217.
- (g) The Parts Count prediction shall assume the environmental conditions stated in the Particular Specification
- (h) As detailed design information becomes available, the Contractor shall update the parts count prediction by a parts stress prediction performed in full accordance with MIL-HDBK-217.
- (i) The Parts Stress prediction shall assume the environmental conditions stated in the Particular Specification
- (j) The Parts Stress prediction shall assume the nominal ambient operating temperatures local to the product (or module) under consideration, as defined in the particular Specification.
- (k) For initial parts stress predictions the Contractor may use default thermal and electrical data.
- (l) As the environmental and operational load analysis is undertaken, the Contractor shall replace the default values with the actual electrical and thermal stresses of the components
- (m) The Contractor shall perform continual assessments of these predictions to reflect the changes made to the design of each module.
- (n) The results of the basic reliability shall be considered when any trade-off studies are conducted and a noncompliance with the basic

reliability requirements shall mean further analysis and possible redesign to ensure that the system meets that requirement.

- (o) The Contractor shall produce a reliability prediction report, referencing the relevant component parts list and the environmental and operational load analysis. Any assumptions made when predicting the failure rate shall be shown along with the full justification for their use.
- (p) Where any component exhibits a high failure rate or has a limited life expectancy then the Contractor shall identify these components and log them on the reliability critical items list.

#### 5.2.5.4 Service Reliability Prediction

- (a) Using the methods defined in task 202 of MIL-STD-785 as a guide, the Contractor shall conduct a prediction of the in-service reliability using the information obtained from the following tasks:
  - (i) Reliability modelling;
  - (ii) Basic reliability predictions;
  - (iii) Maintenance requirements;
  - (iv) Service profile;
  - (v) Component duty cycles;
  - (vi) Maintainability predictions.
- (b) The predicted service reliability of the system shall not be less than the minimum requirement stated in the Particular Specification
- (c) The Contractor shall continuously update the prediction as the system design matures.
- (d) The results of the service reliability shall be considered when any trade-off studies are conducted and a noncompliance with the service reliability requirements shall mean further analysis and possible redesign to ensure that the system meets that requirement.
- (e) The results of this prediction shall be included in the report produced as part of the basic reliability prediction task.

#### 5.2.6 Environmental and Operational Load Analysis (EOLA)

- 5.2.6.1 Throughout the design phase, the Contractor shall perform an EOLA on each module resident in the system. The analysis shall involve predicting and assessing the thermal and electrical stresses exhibited

by each component.

5.2.6.2 The analysis shall assume worst case stress operating conditions at the worst case ambient operating temperature defined in the Particular Specification

5.2.6.3 Where components have a safety critical function or are subject to high stresses then the Contractor shall ensure that the components undergo practical thermal and electrical measurements in a representative environment in order to verify the predicted stressing levels. The thermal and electrical parameters assessed shall include (where applicable):

- (a) Voltage
- (b) Current
- (c) Power
- (d) Case Temperature
- (e) Junction Temperature

5.2.6.4 The Contractor shall present the results of the EOLA, with the component manufacturers maximum rated data and the derating criteria.

5.2.6.5 The data shall be assessed by the Contractor who shall identify the components stressed in excess of the manufacturers maximum rated criteria and implement corrective action for such components.

5.2.6.6 Components that exceed the derating criteria shall be placed on the reliability critical items list where they in turn shall be considered for replacement.

5.2.6.7 For the purpose of conducting the basic reliability predictions, the Contractor shall rework results of the EOLA to identify the stresses exhibited by the components when operating at the nominal ambient temperature defined in the Particular Specification.

#### 5.2.7 Electronic Component Derating

5.2.7.1 Derating is the limiting of a component maximum operating stress to a percentage of its rated value, with the aim of enhancing reliability.

5.2.7.2 The derating policy for the project shall be defined by the Contractor and be submitted to the Engineer for Approval. The policy shall provide specific derating guidelines for each type of component in terms of electrical and thermal stresses.

#### 5.2.8 Component Parts/Circuit Tolerance Analysis

5.2.8.1 A tolerance analysis of electrical and electronic component parts and circuits shall be performed by the Contractor on those equipments, functions or modules which are identified as critical to the reliability or safety of the system, sub-system or equipment.

5.2.8.2 The analysis shall examine the effects of component parts/circuit tolerances and parasitic parameters over a range of temperatures, and shall assume the worst-case credible combination of conditions and tolerances applicable to the item under analysis.

5.2.8.3 The analysis shall use MIL-STD-882B as a guide.

#### 5.2.9 Failure Mode, Effects (and Criticality) Analysis

5.2.9.1 The purpose of the task shall be to identify all single point failure modes resident in the system and then determine the effects those failure modes have on the operation of the system in terms of reliability and in some cases availability.

5.2.9.2 A component level Failure Mode, Effects (and Criticality) Analysis shall be performed by the Contractor in accordance with the MIL-STD-1629A.

5.2.9.3 The analyses shall be performed concurrently with the design process so that the design reflects the analysis, conclusions and resultant recommendations.

5.2.9.4 The results and current status of the FME(C)A shall be presented by the Contractor at all design reviews and shall be used as inputs to design trade-off, safety reviews and maintainability reviews in order to control system design weaknesses.

#### 5.2.10 Reliability Critical Items List

5.2.10.1 Throughout the design phase a Reliability Critical Items List shall be produced by the Contractor in accordance with task 208 of MIL-STD-785.

5.2.10.2 The Contractor shall be responsible for the constant evaluation of that list and in conjunction with the design team ensure that the numbers of critical items are kept to a minimum through module redesign or component replacement.

5.2.10.3 The list shall be prepared using the results of each of the aforementioned reliability analysis.

#### 5.2.11 Trade off Studies

- 5.2.11.1 Design trade off studies shall be carried out by the Contractor as an activity within the natural process of design. The design team may require to evaluate the effects of using various possible design solutions at the system or module levels.
- 5.2.11.2 The repetitive nature of the work requires a close collaboration between the safety and reliability project team and the design team. The process may involve trading off cost, performance, reliability, maintainability, safety and availability. The object of the study is to produce a system that exhibits the required performance in a cost effective manner.

### 5.3 Reliability Testing

#### 5.3.1 Reliability Growth Testing (Test, Analyse and Fix)

- 5.3.1.1 Reliability growth testing (RGT) consists of extended life testing of equipment under specified environmental conditions to disclose design deficiencies in the equipment and to verify that corrective actions will prevent recurrence in operational use.
- 5.3.1.2 A full Reliability Growth Test shall be conducted by the Contractor on all equipments.
- 5.3.1.3 The Contractor shall produce a Reliability Growth Test procedure using MIL-HDBK-189 as a guide and submit this to the Engineer for Approval.
- 5.3.1.4 All failures occurring during this period shall be recorded using the Contractors FRACAS Procedure. Any corrective actions undertaken during this period may encompass redesign, part and material change or changes in the design and manufacturing processes.

#### 5.3.2 Environmental Stress Screening

- 5.3.2.1 Environmental stress screening consists of a series of tests applied to components or equipments conducted under environmental stresses to disclose weak parts and workmanship defects for correction prior to the acceptance of the component or equipment for use. To provide an optimum screening programme, it is essential to subject the products to a screen that is strong enough to force any resident latent defects but does not however excessively age or destroy the product.

- 5.3.2.2 The Contractor shall perform ESS on each of the

individual development products prior to commissioning and testing of the final system.

- 5.3.2.3 The development testing and ESS carried out on the development products shall be used to optimise and specify the ESS required for those products committed to production.
- 5.3.2.4 An individual screening procedure shall be developed by the Contractor for each product, using task 301 of MIL-STD-785, and MIL-HDBK-344 as guides.
- 5.3.2.5 The ESS Procedures shall be submitted to the Engineer for Approval.
- 5.3.2.6 All failures that occur during the screening shall be logged as part of the Contractors FRACAS Procedure and the respective corrective action undertaken.

### 5.3.3 Reliability Demonstration Test

- 5.3.3.1 An in-service reliability demonstration test is required to demonstrate that the specified basic and service reliability requirements for the system have been met.
- 5.3.3.2 The test will be carried out by the Engineer in accordance with the requirements stipulated in the Particular Specification.
- 5.3.3.3 Prior to the start of the test the system shall have been subject to the design changes made as a result of the Reliability Growth Test and undergone full environmental stress screening in accordance with the respective procedures.
- 5.3.3.4 The Contractor shall produce a Reliability Demonstration Test Procedure in accordance with MIL-HDBK-781 which shall be submitted to the Engineer for Approval.

### 5.4 Availability Analysis

- 5.4.1 The predicted availability for safety critical functions shall not be less than the minimum requirement specified in the Particular Specification.
- 5.4.2 The predicted availability for non-safety critical functions shall not be less than the minimum requirement specified in the Particular Specification
- 5.4.3 The reliability model shall be used to predict the availability of the system using task 201 of MIL-STD-785 as a guide.

- 5.4.4 The model shall use the information obtained from the system reliability predictions and maintainability calculations.
- 5.4.5 This process is iterative, such that any changes to the model and its supporting data shall be incorporated. If it is deemed necessary by the Contractor, the availability model shall be conducted at card and component level.
- 5.4.6 The results of the availability modelling shall be considered when any trade-off studies are conducted and a non-compliance with the availability requirements shall mean further analysis and possible redesign to ensure that the system meets that requirement.

## 6. References

### MTRCL Standards

S/CC-gen/DS/09(99) System Safety Engineering Standard  
S/CC-gen/DS/06(99) Maintainability and Testability Standard

### British Standards

BS5760 Reliability of Systems, Equipments and Components. Guide to reliability testing. Design of test cycles.

### Military Standards and Handbooks

MIL-HDBK-217F	Reliability Prediction of Electronic Equipment
MIL-STD-785B	Reliability Programme for Systems and Equipment Development and Production
MIL-HDBK-338B	Electronic Reliability Design Handbook
MIL-STD-882B	System Safety Programme Requirements
MIL-STD-1629A	Procedures for Performing A Failure Mode, Effects & Criticality Analysis
MIL-HDBK-781A	Reliability Test Methods, Plans, and Environments for Engineering Development, Qualification & Production
MIL-HDBK-189	Reliability Growth Management
MIL-HDBK-344A	Environmental Stress Screening of Electronic Equipment

Unless specified in this document, the maintainability and testability programme shall use the edition current at the commencement of the relevant task.

## Appendix 1 - Maintainability Plan Check List

### Glossary of Terms, Definitions and Abbreviations

- All terms, definitions and abbreviations given in the Plan are compatible with MTRC understanding and common usage
- Stated or implied assumptions are correct and comply with MTRCL operational practices and policies
- Definitions of a logistic failure and a functional failure are as specified in the PS OR are in agreement with the anticipated operation of the equipment.
- Terminology used in the Plan is defined and consistent with MTRCL practices
- Formulations used are based on correct assumptions; are correct for the application and mathematically correct

### Format and Structure

- The Plan is generally in the format specified in the PS
- The Plan contains cross references to the Contractor's Project Quality Plan and PS for traceability
- All the Reliability requirements of the GS (GS8.3) have been adequately dealt with in the Plan
- Every item of equipment is covered by the Plan
- The Plan covers all stages of the Contract from Preliminary Design to the end of the Period of Maintenance

### Reliability Programme Management

#### **Organisation**

- The Plan indicates the resources, reporting structure, roles and responsibilities of all Contractor and Subcontractor personnel to be engaged in reliability activities
- The level of resources assigned to reliability activities as indicated in the Plan seem adequate
- The skill level and experience of the people assigned to tasks is an acceptable match to that task

### Programme Monitoring

#### **Review Process**

- The Plan shows that adequate reviews are going to be held at suitable points in the product development process
  - The reviews will ensure that the project meets the reliability requirements
  - The reviews will ensure that the project meets the cost and timescale requirements

#### **Resolution of Problems**

- The Plan identifies a clear method of problem resolution which is acceptable to MTRC
  - The Problems will be advised to MTRCL
  - MTRC will be consulted as to the resultant course of action
- The Plan indicates a Failure Reporting, Analysis and Corrective Action System (FRACAS) to improve the reliability of a product
  - The FRACAS is closed loop throughout the testing and commissioning phases

#### **Monitoring of Subcontractors/Suppliers**

- The Plan covers not only the Contractor but any Subcontractors and Suppliers as well

- The same standards and progress monitoring mechanisms applicable to the Contractor will also be applicable to the Subcontractor
- Quality standards and delivery arrangements relating to Suppliers will be monitored and controlled

### **Reliability Programme**

- The Plan defines an acceptable and credible set of reliability activities along with their deliverables
- The Plan defines OR refers to a timescale for the reliability activities
- The reliability programme shows realistic durations for activities in relation to the level and experience of resources allocated to those tasks

### **Configuration Management**

- The Plan shows that configuration management procedures are (will be) put in place
  - The configuration management procedures cover all phases and deliverables of the reliability programme

### Reliability Engineering Tasks

#### **Reliability Modelling**

- The logistic failure rate targets from the PS have been correctly indicated in the Plan
- Reliability modelling for new or modified equipment is indicated in the Plan
  - The method of logistic failure rate prediction indicated in the PS for new or modified equipment has been adopted in the Plan
  - Reliability models are based on a mathematical model of the equipment and are computerized
  - Reliability models incorporate interactions between modules
  - Reliability models incorporate component failure rates
  - Reliability models incorporate equipment duty cycles
  - Reliability models incorporate equipment usage time
  - Reliability models address both functional and hardware partitioning of the system
  - Reliability models are prepared on an approved software tool

#### **Reliability Apportionment**

- Reliability apportionment for new equipment is indicated in the Plan
  - Reliability apportionment considers circuit complexity
  - Reliability apportionment considers quality of components
  - Reliability apportionment considers device types
  - Reliability apportionment considers operating conditions
  - Reliability apportionment considers equipment accessibility
  - Reliability apportionment considers component count

### **Parts and Materials Selection Process**

- A parts and materials selection programme is indicated for new or modified equipment
  - The parts and materials selection programme indicates component history
  - The parts and materials selection programme indicates the level of screening of purchased components
  - The parts and materials selection programme indicates the suitability for intended environment
  - The parts and materials selection programme indicates component sourcing/availability (and where necessary, multiple sourcing)

- The parts and materials selection programme considers intended operation
- The parts and materials selection programme considers the expected life of parts
- The parts and materials selection programme considers compatibility of materials.

### **Reliability Predictions**

- Logistic reliability predictions are indicated for new or modified equipment
  - Logistic reliability predictions are based on the method specified in the PS OR will be based on a large enough sample of relevant data systematically collected and documented from a previous equivalent installation
  - Logistic reliability predictions are based on the operating environment specified in the PS OR on an appropriate description of the intended operating environment
  - Logistic reliability predictions are conducted using a suitable software tool
  - Logistic reliability predictions consider the operating environment ambient temperature
  - Logistic reliability predictions are compared against test data as the design develops

### **Availability Modelling**

- All the availability targets from the PS have been correctly indicated in the Plan
- Availability modelling is indicated in the Plan
  - Availability models are produced from reliability data/predictions and maintainability data
  - The Plan indicates that techniques such as construction of Reliability Block Diagrams will be used in predicting the functional availability
  - The maintainability data used in the availability models is in accordance with the maintainability information contained in the Maintainability Plan

### **Environmental and Operational Load Analysis (EOLA)**

- Environmental and Operational Load Analysis (EOLA) is indicated for new equipment or existing equipment which has been modified, rehoused or used in a different environment
  - Theoretical EOLA assumes worst case temperature, voltage, current, power and component tolerances
  - Practical environmental and operational load tests are indicated for safety critical components and high stress components

### **Component Derating**

- Component derating is indicated in the Plan for electronic components
  - Component derating criteria include electrical and thermal stresses

### **Component Parts/Circuit Tolerance Analysis**

**(for Safety Critical systems only)**

- Tolerance analysis for new or modified electrical and electronic circuits is indicated in the Plan

### **Failure Mode Effect (and Criticality) Analysis**

**("Criticality" for Safety Critical Systems only)**

- The Plan indicates that a Failure Mode Effect (and Criticality) Analysis will be conducted

- The FME(C)A will be conducted at an appropriate level (functional, block or component)

### **Fault Tree Analysis**

- The Plan indicates that a Fault Tree Analysis (FTA) will be conducted
  - The FTA will use information obtained from the FME(C)A
  - The FTA will include the effect of software failures
  - The FTA will be conducted using a suitable software tool

### **Reliability Critical Items List**

- The production of a Reliability Critical Items List (RCIL) is indicated in the Plan

### Reliability Testing

#### **Reliability Growth Testing**

- Reliability Growth Testing (RGT) of new or modified items (whether produced by the Contractor or Subcontractor) is indicated in the Plan

#### **Environmental Stress Screening**

- Environmental Stress Screening of manufactured items is indicated in the Plan

#### **Reliability Demonstration Testing**

- The methods indicated of demonstrating the reliability of the equipment/system are as specified in the PS OR will achieve a credible result based on defined, qualified and measurable events
- The Plan defines a list of reliability data to be collected during the Period of Maintenance and the method of analysis applied to that data

Issue : 1

Rev. : 0 01/02/2023

Contract C3855-22E  
Provision of In-Train Remote CCTV System  
and Train Car Loading Indicator for M-Trains  
Particular Specification

**Appendix O**  
**Material and Workmanship Standard for Rolling Stock Mechanical Equipment**

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# Operations Engineering Standard

S/RS-rse/MW/07(01)

Former number: S/ROS/MW/009(1)

**Title:**

Material and Workmanship Standard for Rolling Stock Mechanical Equipment

Revision: E

Date: 2022-01-05

Safety related standard

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This standard is mandatory and applied from the date of issue.

## ENDORSEMENT & AUTHORIZATION

Approved by standards owner:

Michael Cheung

Lead Train Services Engineering Manager

Date: 19.1.2022

Endorsed by (for safety related standard only):

N/A

Chairman – Technical Standards Sub-committee

Date: \_\_\_\_\_

Authorized for issue by:

HK Chan

General Manager -Engineering & Innovation Centre

Date: 04 FEB 2022



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## Revision Record

This standard will be updated when necessary by issuing a complete document. Amendments to the former issue will be summarized in the revision record below. The latest revision of this standard is mandatory and applied immediately from the authorized date for issue unless otherwise stated in the document.

Rev	Date	Amendment	Writer
A	2009-10-06	Rationalized to cope with post merger MTR system.	Simon Du
B	2012-11-20	3-yearly regular review and confirms that the standard remains valid.	Simon Du
C	2016-02-05	3-yearly regular review and confirms that the standard remains valid with minor updated information.	Simon Du
D	2019-06-05	3-yearly regular review and confirms that the standard remains valid with minor updated information for Portable fire extinguisher	Simon Du
E	2022-01-05	3-yearly regular review with document owner, authorizer, standard references updated and minor updated information for the limiting the use of Chloride Adhesive. SIL was included in the standard. TML was updated in Summary of Applicable Railway Lines.	Simon Du

## Summary of Applicable Railway Lines

Check this box for common standards and leave blank to all railway lines below.

Please check the appropriate box(es) preceding the railway lines to which this standard shall apply; provide comments and/or any particulars / exceptions if applicable:

Railway Line	Abbreviation	Comment
<input type="checkbox"/> Operating Railway	OPR	_____
<input type="checkbox"/> East Rail Lines:	ERL	_____
<input type="checkbox"/> East Rail Line	EAL	_____
<input type="checkbox"/> Tuen Ma Line	TML	_____
<input checked="" type="checkbox"/> Airport Express, Tung Chung & Disneyland Resort Lines:	AT&D	_____
<input type="checkbox"/> Airport Express Line	AEL	_____
<input type="checkbox"/> Disneyland Resort Line	DRL	_____
<input type="checkbox"/> Tung Chung Line	TCL	_____
<input type="checkbox"/> Light Rail	LR	_____
<input checked="" type="checkbox"/> Urban Lines:	URL	_____
<input type="checkbox"/> Island Line	ISL	_____
<input type="checkbox"/> South Island Line	SIL	_____
<input type="checkbox"/> Kwun Tong Line	KTL	_____
<input type="checkbox"/> Tseung Kwan O Line	TKL	_____
<input type="checkbox"/> Tsuen Wan Line	TWL	_____

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## 1. Scope and Purpose

- 1.1 This standard covers constructional details and installation of equipment for electric multiple units (EMU) and engineer's vehicles of Urban Lines and Lantau & Airport Railway.
- 1.2 The requirements listed in this standard may be applicable to East Rail Lines, **Tuen Ma Line** and Light Rail.

## 2. Definitions

The following terms are defined for this standard:-

- 2.1 High voltage  
In excess of 300 V, to earth.
- 2.2 Low voltage  
300 V or less, to earth.
- 2.3 Auxiliary contact  
A contact in a low voltage circuit.
- 2.4 Enclosure  
A closed space in which equipment is mounted.
- 2.5 Contact enclosure  
A small enclosure in which auxiliary contacts only are mounted.
- 2.6 Terminal  
A fixed point to which a conductor can be attached to form a connection.

## 3. Safety Considerations

There are no special safety considerations applying to the activities described in this standard.

## 4. Maintenance

- 4.1 Minimum maintenance is considered to be of great importance. Consideration shall be given to the reduction of maintenance work and to increasing the periods

between inspections and overhauls of equipment. Easy access to the equipment for maintenance purposes shall be incorporated in the design of equipment cases and layouts.

- 4.2 The Engineer may specify in detail the maintenance requirements for any item or complete equipment in the relevant Particular Specification.
- 4.3 The Contractor, when offering a design for Approval, shall state the actual and frequency of the required maintenance work, and at what frequency.

## 5. General Material and Constructional Considerations

### 5.1 General

- 5.1.1 All equipment shall be constructed in a sufficiently robust manner, and arranged so as not to suffer deterioration, wear, or damage due to vibration or shock loads encountered in traction service.
- 5.1.2 Fixings (See Clause 7 of this Standard for details) shall be adequately locked to prevent loosening in service. Fixings shall be so designed that they withstand horizontal collision shock loads of up to  $30 \text{ m/s}^2$ . Axle mounted equipment shall be able to withstand accelerations of up to  $200 \text{ m/s}^2$  in any direction.
- 5.1.3 The requirements of B.S. Code of Practice CP 1014 for Tropicalisation of Equipment shall be complied with by the Contractor. Special attention is drawn to the necessity to provide means to combat corrosion.
- 5.1.4 Equipment shall be arranged into groups where practicable (See Clause 12 of this Standard for details), the items of any one group being mounted on a common frame or the equivalent, complete with wiring, piping, etc. All such equipment shall be protected against damage caused by dirt, dust, moisture, etc.

### 5.2 General material specifications

#### 5.2.1 Ferrous materials

- (a) Steel castings shall be in accordance with BS 3100(592) of Approved grade. For bogie frames a carbon content of 0.3% shall not be exceeded. Cast iron shall be used only with the Engineer's Approval.
- (b) Stainless steels used for structural purposes shall be of an Approved composition. Chromium content shall not be less than 17% and carbon not greater than 0.12% for structural members unless otherwise agreed with the Engineer.

- (c) Steel (other than stainless steel) used in welded structures shall be corrosion and weather resistant and not inferior to BS4360.WP50. The amount of such steel shall be kept to a minimum and shall not be used at all in structural assemblies above the underframes of vehicles constructed substantially of stainless steel or aluminium, or in exposed areas of passenger compartments except where Approved.

#### 5.2.2 Aluminium based material

- (a) Aluminium alloys used for car construction shall be of an Approved composition. Frames shall be formed of extruded sections, of an alloy not inferior to BS4300/15H17, with approximately 4% zinc and 1.3% magnesium.
- (b) Light alloys for exterior panels, forgings and castings shall not be inferior to BS1470 NS5; BS1472 HF30; BS1490 LM6 respectively.
- (c) Magnesium based alloys shall not be used.

#### 5.2.3 Rubbers

- (a) Rubbers shall be of an Approved grade to perform over the temperature range at least 0°C to 50°C.
- (b) Polychloroprene is an acceptable material for all applications where electrical insulation resistance is not important, and shall be used where exposure to sunlight may occur.
- (c) For pantograph hoses a suitable grade of nylon, polychloroprene or other Approved material, having an insulation resistance over a 400 mm length of not less than 50 MΩ, shall be used.

#### 5.2.4 Glass reinforced polyester

Glass reinforced polyester may be used for non-structural parts, for covers and other applications. They shall be manufactured and moulded to an Approved process with particular regard to non-flammability. Hand laying will not be accepted for large mouldings.

#### 5.2.5 Asbestos

No asbestos or asbestos compounds shall be present in any material or equipment.

### 5.2.6 Chloride Adhesive

Use of Chloride Adhesive shall be limited to prevent any corrosion.

## 5.3 Riveting and bolting

### 5.3.1 General

- (a) This clause covers joining components by bolting, riveting or use of similar Approved fasteners.
- (b) Note that where both components are compatible grades of steel, welding (Clause 5.4 below) is the required method in the absence of alternative indications.
- (c) In all cases the bearing surfaces of the components shall be securely held in contact with each other and all fasteners shall be tight.
- (d) Exposed heads of rivets shall be free from rings, fins, pits or burrs.

### 5.3.2 Holes

- (a) Holes shall be accurately located and aligned, and where necessary reamed round to specified size and position. They shall be drilled, not punched, and of minimum size necessary. Rounding out of holes is not acceptable other than as above.
- (b) Edges of rivet holes in aluminium shall be chamfered before assembly.

### 5.3.3 Riveting of steel

- (a) Hand driven steel rivets shall be driven hot and shall completely fill the hole.
- (b) Cold rivets shall only be used where structural strength is not required.
- (c) They shall be driven using mechanical equipment.

### 5.3.4 Jointing of aluminium

- (a) Riveting of aluminium to aluminium on members requiring structural strength shall be carried out with aluminium alloy rivets, cold squeezed or by Approved steel fasteners suitably protected against corrosion.

- (b) Aluminium shall be riveted to steel by steel rivets driven hot, or by Approved steel fasteners. See Clause 5.3.5 below for corrosion protection.

### 5.3.5 Corrosion protection of metals other than stainless steel

- (a) Contacting surfaces of similar metals shall be treated with Approved anti-corrosion agent before assembly by means other than welding.
- (b) When jointing aluminium or its alloys to other metals, mating surfaces shall be treated with barium chromate anti-corrosion agent or Approved equivalent before riveting.
- (c) Special attention shall be paid to exposed parts of steel rivets or fasteners in areas that are otherwise un-painted.

## 5.4 Welding

### 5.4.1 General

- (a) Welding of stainless or high tensile steels, of aluminium or its alloys, or of components carrying structural stresses, shall be by one of the methods outlined below, as may be Approved.
- (b) In all cases complete and adequate fusion with the base material shall be obtained, without loss of structural thickness (under cutting), and the Engineer may require radiographic examination of important areas to verify this point.

### 5.4.2 Arc welding

Such welds shall be by an Approved gas shielded arc method.

### 5.4.3 Spot welding

Spot welding of components carrying structural stresses shall be performed using equipment fitted with time, current and pressure control.

### 5.4.4 Hand welding

Where hand welding of components carrying structural stresses is Approved, the Engineer reserves the right to inspect and/or approve the qualifications of the operatives. Use of hand welding of such components will only be Approved where the Engineer is satisfied alternatives are impracticable.

## 5.5 Finishes

### 5.5.1 Stainless steel and aluminium

- (a) Stainless steel, aluminium or their alloys shall not be painted except as required by the colour scheme.
- (b) Stainless steel or aluminium visible to the public shall be finished by an Approved method.

### 5.5.2 Other metals

- (a) Steel (other than stainless steel) framing structural sub-assemblies including bogies shall be sandblasted or cleaned in an Approved manner and immediately given a first coat of Zinc chromate or other Approved corrosion preventative priming paint before being concealed.
- (b) Steel parts of the bogies and underside of the vehicle, (including equipment boxes where use of steel is Approved) shall be given three coats of Approved black paint after priming.
- (c) Copper pipe work need only be painted where required for identification.

### 5.5.3 Interior finish

- (a) Panels inside the car shall have smooth easily cleanable surfaces of self-colour, and metal fittings shall have stainless steel or anodised aluminium surfaces of Approved finish. Use of Chromium plating will only be Approved where stainless steel cannot be used.
- (b) Welding shall not be carried out on parts on which surfaces have already been treated.

## 6. Interchangeability

- 6.1 Similar parts shall be interchangeable. This is particularly important in the case of covers, bearing caps and details, line replaceable units, and the like. The Engineer may require a demonstration by the Contractor to ensure that this requirement is met.
- 6.2 Where a number of non-interchangeable parts with the same mounting arrangements are used the parts themselves and their mountings shall be clearly marked to ensure that incorrect fitting does not occur. Such applications shall be for Approval and the Engineer may require non-interchangeable mountings to be

used where he considers confusion could still arise. This requirement shall also apply where an item can be reversed on its mounting.

## 7. Screw Threads and Fixings

- 7.1 Screw threads shall be I.S.O. metric preferred sizes. The following standards shall be applied where appropriate:-
- BS 3692 for hexagonal bolts, screws and nuts
  - BS 4183 for machine screws & nuts
  - BS 4174 for self tapping screws
  - BS 1574 for split cotter pins
  - BS 4929 for prevailing torque nuts
- 7.2 Screw threads smaller than M4 size shall be used only where Approved.
- 7.3 All screws, bolts, nuts and plain washers shall be suitably treated by an Approved method to avoid corrosion. Proprietary makes of high tensile or other types of screw may be used unprotected provided the Engineer is satisfied that a standard screw is not suitable and that corrosion will not be a problem and provided that the above specified screw thread requirements are adhered to.
- 7.4 Black steel spring or other lock washers shall not be used unless Approved.
- 7.5 Steel bolts shall be used in all cases including terminals, unless otherwise Approved.
- 7.6 Bolt and screw heads and nuts shall be hexagon form. Where special advantages can be shown socket head screws may be Approved by the Engineer, cheese head screws or Phillips head screws, suitably plated, may be used where high strength is not important.
- 7.7 M8 and larger screws or bolts shall not be provided with screw driver slots.
- 7.8 Special attention shall be paid to the locking of all nuts, bolts and fixings. In critical areas, such as couplers, bogie to body connections, running gear, etc, the locking shall be of a positive form which mechanically prevents rotation of the nut relative to the bolt. The acceptable form of locking is by means of a split pin and associated castle nut although the use of wire locking will be considered where the former method is not appropriate. The use of suitable tab washers is also acceptable provided they are of a type which effectively lock the bolt head and nut securely to the component.
- 7.9 In all other areas the acceptable method shall be by means of the use of an Approved form of single turn spring washer.

- 7.10 The use of nuts with nylon inserts or similar self locking nuts which can be removed and replaced for a limited numbers of occasions shall not be used unless Approved. Whatever method of locking is employed the number of loose items shall be kept to a minimum.
- 7.11 Whenever possible tapped holes shall be drilled and tapped for the full thickness of the material, blind holes being used only where unavoidable.
- 7.12 Tapped holes shall be provided with suitable thread inserts where necessary, and in all cases in Aluminium or Copper. The use of loose nuts and bolts will only be Approved where it is possible for a man to reach easily both parts of the fixing simultaneously. Tapped holes in aluminium shall, in all cases, be provided with suitable thread inserts. Items of proprietary equipment which are normally supplied without wire thread inserts may be exempted from this requirement, subject to Approval.
- 7.13 Fixings for covers which may have to be removed for maintenance shall be captive, and, where visible to the public, shall be of stainless steel or chromium plated, with heads of the Phillips recessed type.
- 7.14 Items of electrical equipment shall be fitted to panels so that all fixings can be made from the front only, except where otherwise Approved.
- 7.15 Due consideration shall be given in the design stage to the tolerance of components in order to ensure interchangeability of components. To this end the use of fitted bolts is discouraged and their use shall only be allowed subject to Approval.
- 7.16 For fixings connections which will be dismantled for maintenance, the following methods shall be used.
- Bolted connection, shall use documented torque tightening procedures which shall be submitted to Approval. Hexagon head bolts Grade 8.8 and nuts Grade 8 shall be used. Where secondary locking is required, which shall include all bogie applications, prevailing torque nuts to BS 4929 shall be used.
- Setscrews (Grade 8.8) and stud connections (Grade 8.8 studs with grade 8 prevailing torque nuts to BS 4929 may only be used where it is not possible to make a bolted connection. The use and the proposed method of locking will be subject to Approval.
- 7.17 Washers shall not be used except where the nut is tightened onto a soft surface.
- 7.18 Mating surfaces shall be machined flat and shall be clean and free from paint.
- 7.19 Where tab washers are proposed the material chosen shall be sufficiently hard to prevent settlement of the joint and consequent loss of bolt preload. Mild steel tab washers shall not be used.

## 8. Ducting

- 8.1 Ducts shall be sealed all round, including any removable lids or covers, against ingress of moisture and dirt. Lids shall be provided to enable the cables to be introduced easily into the duct. The cables and cable loom shall be cleated or otherwise secured into the duct sufficiently frequently to prevent movement.
- 8.2 Ducting with top access lids shall be avoided whenever possible and will not be accepted for under floor mounting.

## 9. Labels and Rating Plates

### 9.1 Labels - general

Engraved plastic labels shall have black letters on a white background. Alternatively, black on to white background rear indented will also be accepted.

### 9.2 Equipment labelling

- 9.2.1 All items of apparatus shall be labelled with the maker's name and the type and/or form of the piece of apparatus.
- 9.2.2 All machines shall carry a rating plate with, at least, the following information:-
  - (a) Serial number.
  - (b) Maker's type number.
  - (c) Current and voltage ratings and whether continuous or otherwise.
  - (d) Speed at rated current.
  - (e) Maximum speed.
  - (f) Field connection (series, separately-excited, etc.)
- 9.2.3 In addition a connection diagram shall be provided inside or adjacent to the terminal box, where provided. Unidirectional rotating machines shall carry an arrow showing the correct direction of rotation and, in the case of axial fans, of the air flow.
- 9.2.4 All labels, rating plates, and the arrows required for fans shall be mounted in such a position that they can be seen from the usual point of access. The labels shall be clearly stamped, cast, or engraved and securely attached to the machine.
- 9.2.5 The Engineer may require certain equipment other than machines to carry serial numbers and information on rating.

### 9.3 Position labelling

The position in which apparatus is mounted but not the apparatus itself, shall be labelled clearly with the circuit designation of the piece of apparatus there

mounted. Where a contactor, for example, is referred to as LS1, it will be sufficient to label the position with such reference. Such labels shall be clear and easy to read and securely fixed adjacent to the mounting position. Covers, arc-chutes, and similar removable interchangeable items shall not be labelled.

## 10. Pneumatic Systems

- 10.1 Stainless steel piping (BS 3605-1) shall be used on bogies. Nylon may be used in certain applications, with the Approval of the Engineer. Elsewhere, solid drawn copper pipe to BS 2871-2, half hard grade suitable for 17.5 bar working pressure shall be used. All fittings, valves and components shall be non-ferrous. All joints shall be of the capillary type, or where these are unsuitable, of an Approved form of compression fitting. The use of suitably corrosion-protected ferrous materials for reservoirs or elsewhere as Approved will be accepted.
- 10.2 All pipework shall be thoroughly blown out and cleaned before service to ensure clean, dry compressed air; and all pipes shall be adequately secured and cleated against movement.
- 10.3 Electrical equipment, door engines, and other systems where so Approved, shall be supplied from one control reservoir per car at a pressure of  $5.5\pm0.1$  bar, by means of a reducing valve and high capacity filter. The reservoir shall be fitted with a suitable automatic drain valve and shall have capacity not less than ten times the maximum air volume consumed by the equipment per minute.
- 10.4 The various parts of the whole system, including the control reservoir system and the equipment supplied, as set out above shall be subdivided into sections, each section being provided with a vented isolating cock and a strainer. Where a check valve is incorporated in the system means of venting the system shall be provided.
- 10.5 Equipment other than strainers and cutout cocks, shall be mounted on a pipe bracket or otherwise so that it may be removed for maintenance without breaking pipe joints.
- 10.6 All air cylinders (other than brake cylinders), pistons and pneumatic valves shall be of a type which does not require lubrication between overhauls.
- 10.7 An Approved type of hose, date stamped to the Corporation's standards, shall be used for all applications.
- 10.8 Diaphragms, and piston and air valve seals shall be of the non-metallic type. The use of leather as a gasket, a seal, or packing material will not be accepted. Diaphragm and seal life shall be at least 5 years. Exceptions to this requirement may be made for cutout cocks and compressor check valves, which shall operate in air temperatures of up to 150°C.

- 10.9 Drain cock handles shall point vertically downwards when the cock is closed. All other cocks shall be open when the handle is along the line of pipe, and shall either have a vertical spindle, or the handle shall fall to the open position.

## 11. Bearings and Pivots

- 11.1 All bearings and pivots shall be of ample proportions to withstand shock loads and vibration in addition to the normal static and dynamic loads.
- 11.2 Plain bearings shall be of the dry type (incorporating graphite compound, P.T.F.E. or nylon, lubricant retaining bearing metal or similar).Plain bearings or pivots requiring periodic applications of oil or grease at inspections are not allowed. Lubrication or inspection, if required at more frequent intervals than one year, will require Approval.
- 11.3 Rolling element bearings shall be of the prepacked prelubricated and sealed type and shall run between C1 major maintenance without relubrication or replacement. Care shall be taken to ensure that brinelling does not occur. Where prepacked bearings are not applicable, the arrangement shall be for Approval and the means of lubrication replenishment shall be fitted with Tecalemit Type ND6160 nipples or equivalent. Replenishment interval shall not be less than 1 year and the recommended annual replenishment quantity of grease shall be stated.

## 12. Mountings and Enclosures

### 12.1 General

All inside mounted equipment shall be arranged in self contained groups and enclosed to protect them from the effects of dirt, dust and moisture.

### 12.2 Ventilation of enclosures

12.2.1 Air inlets, outlets and vents shall be fitted with louvres or otherwise designed so that ingress of rain or rubbish is prevented, irrespective of whether the vehicle is moving or stationary and independent of the wind direction. In the case of forced ventilation the filter (if provided) or a suitable settling chamber may be relied on to remove any rain which passes the louvres provided that the complete system meets the requirement of efficient filtration. Any louvre or guard, intended to prevent the ingress of rubbish should not reduce the enclosure ventilation with guard or louvre 75% blanked off.

12.2.2 The term filter, in the context of this Clause, covers any device to remove dust, dirt, and rain drops from the air. Where filters are proposed, they shall be of the dry type and shall not require cleaning more frequently than at 12 monthly intervals under the conditions pertaining

in Hong Kong. Such cleaning shall be by knocking or blowing off the dirt. If washing of the filters is required, this shall not be at more frequent intervals than six months, and easy access for removal of the filter shall be provided.

- 12.2.3 Inertial separators are permitted for traction equipment and other 1500 V machines, and shall be maintenance free between C1 major maintenance.
- 12.2.4 Oil wetted air filters shall not be used.
- 12.2.5 For equipment cases in which they shall contain power equipment that shall possibly produce electric arcing during operation. The production of corrosive gases shall be prevented in any circumstances.

### 12.3 Mounting of groups

- 12.3.1 An equipment group may be mounted in a box or case, or on a frame or panel. The individual items of equipment shall be so arranged that they can be removed separately, or in sub-groups as appropriate. Any group mounting shall be self supporting when out of the vehicle and sufficiently strong to be lifted out complete under normal workshop conditions.
- 12.3.2 Equipment groups requiring the fitting of strengthening before lifting the group off the vehicle will not be Approved unless a significant weight saving can be demonstrated. All the equipment in one location shall be mounted in one group unless sub-division is Approved.
- 12.3.3 Anti-vibration resilient mounts shall be incorporated on the fixings of the rotating machines, cooling fan, traction or inverter inductors, transformers, etc to avoid the transmission of vibration onto the carbody or its structure.

### 12.4 Types of enclosure

- 12.4.1 Inside and underframe mounted equipment shall be in sealed enclosures. Equipment mounted in such enclosures shall be treated as mounted in clean conditions as specified in BS 2618 Clause 3. Filtration requirements are covered in Clause 12.2 above. Where enclosures, as described above cannot be adopted, ventilation of enclosures, naturally or forced air, will be considered. Equipment mounted in such enclosures shall be treated as mounted in dirty conditions as specified in BS 2618, except that enclosure pressure ventilated with filtered air shall be designated as clean areas.
- 12.4.2 In the case of machines, the machine frame forms the enclosure. Machines shall be regarded as inside mounted and shall comply with

this Clause according to the ventilation arrangements, or as may be Approved.

## 12.5 Details of enclosure

- 12.5.1 Clipped covers shall be used where regular access to equipment is necessary, and bolted covers elsewhere on the underframe. Covers shall be of reinforced moulded resin of an Approved flame retardant formulation, designed to prevent distortion and damage, and shall be fitted with lifting handles and safety chains. Clipped covers shall be provided with location guides to facilitate location and correct fitting by one man. Particular care shall be exercised in ensuring a good seal against the ingress of dust and water, for the life of the equipment. Furthermore, water shall be prevented from accumulating on seals and gaskets.
- 12.5.2 Alternatively, covers which are substantially flat may be light weight metal pressings otherwise meeting the above requirements.
- 12.5.3 In the case of body mounted equipment other than in the passenger area, suitably stiffened lift-off hinged doors may be used. Doors hung on "piano" hinges shall be used in passenger areas. Doors shall be secured by Approved locks in cabs or passenger compartments (Clause 12.7 below). Bolted doors will be considered where appropriate. The number of fixing bolts for bolted doors or covers shall be kept to a minimum.
- 12.5.4 Bolts used for hinged doors or covers shall be captive to the door or panel.
- 12.5.5 No enclosures will be allowed in or opening from passenger areas, which contain apparatus whose voltage exceeds 300 V to earth.
- 12.5.6 Enclosures in which heat or arcs may be generated shall be lined with barriers of insulating material. These materials shall also be used for vents, where required. The design of such vents in the case of heavy duty equipment shall be such that the arc has a clear path to the outside of the enclosure and such that the vents do not tend to impede the emerging gas. The materials for heat and arc barriers and similar applications are specified in Clause 9 of Material and Workmanship Standard for Rolling Stock Electrical Equipment.

## 12.6 Access to equipment

- 12.6.1 Equipment with moving parts shall be so arranged that the movement is accessible for inspection. The location of any item requiring adjustment shall be for Approval.
- 12.6.2 In the case of contactors, relays and cam-operated switch groups it shall be possible, without breaking any pipe joints, or any electrical

connections except those to the item concerned and without disturbing any other equipment, to change the following:-

- (a) All contact tips and flexible copper braids.
- (b) All arc chutes and arcing horns.
- (c) All contactors and relays.
- (d) All magnet valves.
- (e) All auxiliary contact enclosures complete (Clause 2 of this Standard).
- (f) All plug-in cards.

12.6.3 The requirement may, at the Engineer's discretion, be extended to other apparatus.

## 12.7 Openings

In the case of air inlets, outlets or vents accessible from the platforms or areas to which passengers have access, it shall not be possible to touch, or to insert any object into any moving or electrically energised equipment, including blower or fan rotors. Any such inlet, outlet or vent which is mounted other than in such an area shall be covered with a mesh or grille so that it is impossible to insert a hand or finger to a dangerous extent.

## 12.8 Roof mounted equipment

Roof mounted equipment may be mounted externally in a depressed area of the roof, or inside the roof cavity. Outside mounted equipment shall as nearly as practicable maintain the roof profile and it shall be water tested before assembly, and removed for repair if required. Great care shall be taken to avoid penetration of water, both at sealing surfaces and at fixing points.

## 12.9 Outside mounted equipment

Where outside mounted equipment on the underframe is mounted within 750 mm of the structure gauge and includes bare conductors energised at high voltage, an earthed screen (solid or mesh) shall be provided to prevent accidental contact with staff walking beside the vehicle.

## 13. Instruments

### 13.1 General

- 13.1.1 This clause covers electrical and pneumatic instruments. All electrical instruments and their accessories shall be of an Approved type, to IEC 51, with a true zero, with movements suitably damped for rail traction service and shall comply with the following requirements as appropriate. The accuracy shall be as set out in Clause 13.4 below.
- 13.1.2 Instruments shall be suitable for mounting in or on a panel vertically, or at an angle to the vertical of 30° or less. The panel may be of ferrous or other material.
- 13.1.3 Zero adjustment shall be provided on all instruments. Adjustors shall be accessible only from the rear of the instrument, and without opening the core.
- 13.1.4 All screws shall be effectively locked. Use of a locking compound will be considered.
- 13.1.5 Electrical instruments shall be suitable for a circuit working voltage of 660 V to earth and a minimum high potential test of less than 3000 V to earth.
- 13.1.6 Pneumatic instruments shall be scaled 0-14 bar for main reservoir and associated pressures and 0-8 bar for brake cylinder pressures where the maximum pressure does not exceed 6 bar. All gauges shall withstand a test pressure of 12.5 bar.

### 13.2 Driver's desk instruments

- 13.2.1 The term "Driver's Desk Instruments" includes speedometers, ammeters, pneumatic pressure gauges, etc.
- 13.2.2 Instrument cases shall be weather-proof, and of rugged construction. Small openings for ventilation in the rear of the case may be provided subject to Approval.
- 13.2.3 All instrument dials shall have a 100 mm diameter dial and 240° scale (both dimensions approx.) marked with black figures on a white or opaque dial as appropriate. The instrument glass shield shall be positively secured.
- 13.2.4 All instruments shall incorporate dials and/or pointers with luminous elements with an Approved half life, emitting no detectable radiation, and containing not more than 5 Curie of radioactive material. Approval from the Hong Kong Radiation Board to use such radioactive material is also required. The scale markings and pointer shall be clearly legible

from full daylight through to complete darkness. No significant light shall escape into the cab from the scale and none at all from elsewhere.

13.2.5 Cab desk indicator and instrument illumination shall be for Approval. The method of illumination should minimise dazzle in the tunnel environment and maximise visibility in bright sunlight. Glass covers should be of toughened and diffused type.

### 13.3 Other instruments

These shall be 75 mm dia approx. surface or flush mounted, to an Approved drawing and shall have a 100° (approx.) scale. Battery charging ammeters shall have a centre zero ±50° scale. Illumination is not required. Other requirements of Clause 13.2 above shall apply.

### 13.4 Accuracy

13.4.1 The accuracy of instrument systems (i.e. overall accuracy including accessories) from 10% to 90% f.s.d. of the instrument shall be as under:-

- (a) Desk mounted instrument systems which include speedometer generators, a.c. or d.c. current transformers or the like. ±3%
- (b) Other desk mounted instrument system: ±2%
- (c) Instrument systems other than (a) or (b) above: ±5%

13.4.2 All accessories shall be interchangeable. Accessories having means of adjustment will be considered, but, once set, it shall, for systems as set out in (b) above, be possible to fit any instrument and still obtain the above specified accuracy grade without adjustment, and the instrument resistance shall be selected accordingly.

## 14. Safety Hazards

- 14.1 The Contractor shall carry out a hazard analysis of systems or sub-systems on the vehicle to identify all conceivable malfunctions that could potentially cause a safety hazard. The Contractor shall ensure that hazards are eliminated from the design. The Corporation may require the Contractor at no extra cost to submit a hazard study of selected systems to demonstrate compliance with this clause.
- 14.2 Attention is drawn to the responsibility of the Main Contractor to ensure that design interfaces are free from potential hazards.
- 14.3 As a guide, single component failures shall not cause a hazard. Multiple failures of components of individually high-integrity design need not be considered, providing they are not the result of common-mode failures.

14.4 The systems to be considered shall include but not be limited to:

- Traction power control
- Brake system
- Door system (where applicable)
- Safety earthing

14.5 Where software driven systems are used in safety critical circuits, a fully independent non-software driven system shall provide the essential elements of fail safety in case of software errors. Reliance shall not be placed upon the use of validated software.

## 15. Fire Requirements

15.1 Passenger vehicles

15.1.1 The materials used on all rolling stock vehicles shall satisfy stringent fire specification. In general, for passenger train which requires higher resistance to fire than the other vehicles, the interior materials shall conform to EN45545 or BS 6853 category Ia or equivalent. More detailed requirements will be specified based on different locations and orientation. For other vehicles, except those suffer from high fire risks, materials to EN45545 or BS6853 category II or equivalent will be acceptable.

15.1.2 Exemption to this fire standard can be granted based on the consideration of risk and benefits consideration. Clear cost benefit clarification and the detailed fire specification for the Engineer's Approval.

15.2 Other vehicles

For other vehicles, except those suffer from high fire risks, materials shall comply to EN45545 or BS6853 category II or equivalent.

## 16. Industrial Safety Precautions for Contractor and His Subcontractor (if any)

16.1 General requirements

The Contractor and his Subcontractors shall comply with MTR Railway Safety Rules, Code of Practice (Operations Division) and the relevant statutory regulations, especially the Factories and Industrial Undertakings Ordinance, Dangerous Goods Ordinance and their subsidiary legislations.

16.2 Breach of requirements

The Contractor and his Subcontractors will be required to stop work whenever any of the requirements mentioned in these precautions is found breached and

will not be allowed to resume work until the satisfactory rectification of the unsafe condition.

#### 16.3 Site of work and routes of access

No employee of the Contractor and his Sub-contractors shall trespass into any part of the MTRC premises other than the place of work and the routes of access.

#### 16.4 Person-in-charge

The Contractor shall appoint a person-in-charge for the job to ensure that the work is done safely. He shall be present at the site at all times of work. The responsible person shall ensure that all sources of ignition are removed, all power supplies are isolated, and the worksite is in a safe condition before leaving the site.

#### 16.5 Portable fire extinguisher

At least one 4.5kg dry chemical powder portable fire extinguisher, or portable fire extinguisher of appropriate type, must be provided at each worksite. Additional fire extinguishers must be available according to the fire risk.

#### 16.6 Flammable substance

No flammable substance shall be kept at site unless prior approval has been obtained from the MTRC. However, if such material has to be used on site it shall be contained in suitable receptacles for the specific work requirement, the quantity shall be kept as low as possible in a closed metal cabinet provided by the Contractor and Approved by the MTRC, and the Contractor shall comply with very stringent safety precautions as instructed by the Engineer.

#### 16.7 Dangerous substances

All Dangerous Substances shall be properly labelled and kept in suitable containers and handled with extreme care as per statutory requirements. Storage space for dangerous substance as required by Hong Kong Government requirements will be provided by MTRC in their Dangerous Goods Stores subject to prior agreement.

#### 16.8 Welding and flame-cutting

No welding or flame-cutting will be permitted without prior authorization of the MTRC. Only one set of oxy-acetylene will be allowed at the worksite, and it shall be fitted with proper flashback arrestors. The oxygen and acetylene set shall be in good working condition and free of cracks and leaks.

#### 16.9 Painting

Painting and welding or flame-cutting will not be allowed to be done simultaneously at site and will not be allowed unless carried out in areas designated for the purpose.

#### 16.10 Guarding of machinery

All machinery in use shall be properly guarded against human bodies reaching its dangerous parts.

#### 16.11 Electricity connection

Other than a small consumption of electricity which can be safely plugged into the existing power points, the Contractor shall provide a proper temporary electrical distribution panel in good condition and equipped with a main cut-off switch, an effective over-current protection device, and an effective earth leakage circuit breaker for temporary power supply to the worksite. The Contractor will only be permitted to make connection to the MTRC power source upon satisfaction of MTRC that the temporary electrical distribution panel and the associated electrical wirings have been properly installed.

#### 16.12 Electrical tools, equipment and installation

The Contractor shall ensure that all electrical tools, equipment and temporary wirings in use are in good working condition, suitable for the type of environmental condition, and in particular, satisfy the following criteria:-

- free of frayed portions;
- free of exposed live conductors;
- free of sloppy taped joints;
- suitable for the supply voltage and loading current;
- properly protected against electrocution by earth leakage circuit breakers or by earthing;

- properly protected against mechanical damage;
- properly connected by plugs and sockets.

#### 16.13 Conveyance of bulky items

No bulky items shall be conveyed onto MTRC Premises without the prior permission from the MTRC.

#### 16.14 Dangerous tools and equipment

Dangerous tools and equipment shall not be brought onto MTRC premises, especially:-

- metal ladders;
- cartridge operated fixing tools;
- open type welding transformers;
- spray painting equipment; or
- asbestos products.

#### 16.15 Pressure receivers

All air receivers in use on site shall be in good working condition, and provided with a valid certificate to prove that they have been properly tested and examined in the past 26 months as per the Boilers and pressure Receivers Ordinance.

#### 16.16 Lifting appliance and lifting gear

All lifting appliances and gears in use at site shall be in good working condition, and the inspection and examination shall not be expired and shall comply with Factories and Industrial Undertakings (Lifting Appliances and Lifting Gear) Regulations.

#### 16.17 Scaffolding and working platform

All scaffoldings in use shall be:-

- in good working condition;
- erected by experienced persons;
- provided with proper handrails at a height of 1m from the working platform;
- suitably guarded against overturning by the erection of outriggers;
- provided with a closely planked working platform;
- kept away from moving onto the running tracks;
- displayed with warning signs on the danger of falling objects;
- kept away from causing obstruction to any passageway;
- locked at designated locations after each shift.

Safety belts, safety nets or fall arrestors shall be used by all workers when working on a scaffold in case items (c), (d) and (e) of Clause 16.17 cannot be fulfilled due to physical environmental constraints.

#### 16.18 House-keeping

Good house-keeping shall be maintained at the worksite at all times. All flammable waste and sources of ignition shall be removed, all power supplies isolated and the worksite is left in a safe condition after each workshift.

#### 16.19 Electric cables

The Contractor shall treat all electric cables or similar looking things installed on site as 'LIVE' and no work shall be carried out on or cause any damage to them.

#### 16.20 Personal protective equipment

All workmen on site shall wear the necessary personal protective equipment, i.e. safety helmets, eye goggles, ear protectors, respirators and safety belts, etc. as required by the nature of work.

#### 16.21 Smoking

The Contractor shall ensure that there is no smoking at the worksite.

#### 16.22 Work on MTRC equipment

The Contractor and its workers are not allowed to work on any MTRC equipment unless prior approval has been obtained from the Engineer.

#### 16.23 Report of accident

The Contractor shall inform the MTRC Works Manager/Depot Manager and the Engineer's Representative immediately of any accident at the worksite. The Contractor shall submit a written report in the MTRC C35 form to the Engineer's Representative within 24 hours of the occurrence of the accident.

#### 16.24 Additional safety precautions

The aforementioned safety precautions are no way exhaustive and additional ones will be imposed whenever necessary.

### 17. References

#### 17.1 Complete vehicles shall comply with International Electrotechnical Specification (IEC61133).

17.2 The offer of equipment to alternative standards may be considered, but shall be accompanied by copies of the proposed alternative standard specifications, in English, and the Engineer will advise whether they can be applied in whole or in part.

17.3 BRB/RIA Specifications referred to herein are prepared by the British Railways Board and Railway Industries Association of Great Britain, Technical and Standards Committee and are obtainable from:

The Railway Industries Association,  
56 Buckingham Gate,  
London SW1E 6AE,  
ENGLAND.

17.4 BS 6853 : 1999 Code of practice for fire precautions in the design and construction of passenger carrying trains

17.5 EN 45545 : Railway applications — Fire protection on railway vehicles

Issue : 1

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Contract C3855-22E

Provision of In-Train Remote CCTV System

and Train Car Loading Indicator for M-Trains

Particular Specification

**Appendix P**

**MTR Security Risk Evaluation Matrix**

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## 2B1. Assessing Security Risks

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### 2B1.6 Evaluation of Security Risks...continued

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**Security Risk Evaluation Matrix**

Evaluation of risk or actual incidents is made against the Security Risk Evaluation Matrix as shown in the table below:

		Consequences			
		Relatively unimportant	Moderately serious	Very serious	Extreme
Service disruption	System	--	--	--	Any
	Line	--	--	20 – 60 mins	Hours
	Station	--	20 – 60 mins	Hours	1 day
Loss of Corporation assets		<\$100,000	\$100,000 – 1,000,000	\$1,000,000 – 10,000,000	\$10,000,000+
Safety	Fatality				Any
	Major Injury <sup>#</sup>			< 5	5 or more
	Minor Injury <sup>@</sup>		< 5	5 - 50	51 or more
Normal sentence imposed to offenders committing crimes against passenger / staff / third party / Corporation		≤ 5 years imprisonment	> 5 to ≤ 10 years imprisonment	> 10 to ≤ 20 years imprisonment	> 20 years imprisonment
Non-financial impact		Minor degradation of service, impact limited to a single area of the business, management intervention required	Significant degradation of service, impact to multiple areas of business, can be managed with significant management intervention	Major degradation of service, impact to widespread areas of the business, would not threaten viability but would require significant mobilisation of resources and significant management intervention	Threatens long-term viability of the business
Likelihood					
Very high – every week (>50/yr)	SeR2	SeR2	SeR1	SeR1	
High – every month (11 - 50/yr)	SeR3	SeR2	SeR2	SeR1	
Medium – every year (1 - 10/yr)	SeR4	SeR3	SeR2	SeR2	
Low – less than yearly (<1/yr)	SeR4	SeR4	SeR3	SeR2	

**Legend:**

Colour	Legend	Action required
	SeR1	Risk must be reduced except in exceptional circumstances
	SeR2	Risk must be reduced if it is reasonably practicable to do so
	SeR3	Risk is tolerable but should be further reduced if it is cost effective to do so
	SeR4	Risk is acceptable

- # Fracture of any bone (but not a bone in the hand or foot); amputation of hand or foot, or complete severance of a finger or toe; penetrating injury or burn to an eye or loss of sight; electric shock requiring immediate medical treatment; loss of consciousness resulting from lack of oxygen; inhalation or ingestion through the skin of any substance leading to acute illness or requirement for medical treatment; medical treatment resulting from exposure to a pathogen; any other injury requiring admittance to hospital for more than 24 hours
- @ Any personal injury which is not a major injury

Issue : 1

Contract C3855-22E

Rev. : 0 01/02/2023

Provision of In-Train Remote CCTV System  
and Train Car Loading Indicator for M-Trains  
Particular Specification

**Appendix Q Schedule of Completion Obligations**

<b>Completion Obligation</b>	<b>Date for Completion</b>
Completion of the whole of the Works	30 July 2024

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