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Specialist Theatre Systems Performance Specification

Document Title	Performance Specification
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Project	Witney Corn Exchange
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Creation Date	23 rd June 2021
Our Reference	WTC-DBD-ZZ-ZZ-SH-Y-82050
No. of Pages	29
Revision	C03

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Table of Contents

1. FOREWARD	4
1.1 TENDER DATA	4
1.2 CROSS REFERENCES	4
1.3 PRICING	4
1.4 TENDER RETURNS	4
1.5 TENDER EVALUATION	5
2. PRELIMINARIES	7
2.1 INTRODUCTION.....	7
2.2 TERMS.....	7
2.3 CONTRACT DETAILS.....	8
2.4 INSURANCE COVER.....	8
2.5 SCOPE OF WORK	8
2.6 STANDARDS	9
2.7 MATERIALS.....	10
2.8 SYSTEM PROGRAMMING	10
2.9 SITE ATTENDANCES	10
2.10 HEALTH AND SAFETY AT WORK.....	10
2.11 OPERATION AND MAINTENANCE MANUALS	11
2.12 INSTRUCTION AND OPERATION	11
2.13 COMMISSIONING	11
2.14 DEFECTS LIABILITY.....	12
3. PERFORMANCE SPECIFICATION	13
3.1 PRODUCTION LIGHTING.....	13
3.1.1 INTERNALLY WIRED BARS	13
3.1.2 SIGNAGE	13
3.1.3 PRODUCTION LIGHTING BOXES	14
3.1.4 PRODUCTION LIGHTING POWER DISTRIBUTION	14
3.1.5 DMX DISTRIBUTION	15
3.1.6 LIGHTING CONTROL CONSOLE	15
3.1.7 LUMINAIRES	16
3.2 AUDIO AND VIDEO SYSTEMS	16
3.2.1 MAIN LOUDSPEAKERS	16
3.2.2 SUB-BASS LOUDSPEAKERS - OPTIONAL	17
3.2.3 SURROUND LOUDSPEAKERS - OPTIONAL	17
3.2.4 AMPLIFIERS	18
3.2.5 DIGITAL SIGNAL PROCESSOR	18
3.2.6 SURROUND SOUND PROCESSOR - OPTIONAL	19
3.2.7 SOUND MIXER	19
3.2.8 PROJECTOR - OPTIONAL	20
3.2.9 PROJECTION SCREEN - OPTIONAL	20
3.2.10 AV CONTROL SYSTEM	21
3.2.11 BLU-RAY PLAYER - OPTIONAL	22
3.2.12 FACILITY PANELS	22
3.2.13 SOUND & COMMUNICATIONS EQUIPMENT RACK	23
3.3 COMMUNICATIONS SYSTEMS	24
3.3.1 INTERCOM/TALKBACK SYSTEM	24
3.3.2 PAGING AND SHOW RELAY SYSTEM	24
3.3.3 ASSISTED LISTENING SYSTEM	25
3.4 STAGE ENGINEERING	25
3.4.1 CURTAIN TRACKS	25
3.4.2 CURTAINS	26

Performance Specification

3.4.3	FRONT BORDER	26
3.4.4	LEG CURTAINS	27
3.5	INSTALLATION AND PROJECT MANAGEMENT	27
3.6	SPECIFICATIONS, SCHEDULES, MATRICES & PRICING SCHEDULE	28
3.7	DRAWINGS - PLANS.....	28
3.8	DRAWINGS - SECTIONS	28
3.9	DRAWINGS – FACILITY PANELS	28
3.10	DRAWINGS – SCHEMATICS	28
APPENDIX A GENERAL STANDARDS OF WORKMANSHIP.....		29

Performance Specification

1. Foreward

1.1 Tender Data

This Document, the Performance Specification for the specialist theatre systems details the employer's requirements for the supply and installation of these systems.

The details within this document must be read in conjunction with the accompanying drawings and schedules.

1.2 Cross References

The bill of quantities is to be completed as part of the tender response. This provides itemised details relating to the equipment specified in this document, the associated schedules and the drawing set.

1.3 Pricing

The bill of quantities pricing schedule shall be completed in full including the sections for installation and preliminaries.

Owing to the specialist nature of this project, companies who intend to bid are required to identify the resources they intend to apply to the project. This should include the project and site management resource and design engineering resource.

Prices must be inclusive of all duties and taxes (excluding VAT) and the cost for shipping to the project site.

Tenders should include allowances for all attendances, travel and associated costs incurred during the execution of the work.

All costs relating to the preparation of the tender shall be carried solely by the Tenderer, including attendance in any mid or post tender meetings as required.

Note, it is the bidder's responsibility to ensure that all pricing sub totals are verified as correct. Microsoft Excel should not be relied on for this purpose.

The system design is at RIBA Stage 4, however as is typical in projects of this nature, further design development will be required prior to the successful contractor reaching site. Bidders will be expected to have allowed for significant levels of design coordination. It is also to be noted that no additional costs will be borne by the project other than that of the tender sum for this discrete package of works, so any allowances required to ensure this is adhered to will be required.

1.4 Tender Returns

All returns shall be submitted as instructed in this document and any accompanying request for tender.

Tenders that omit any part of the works covered in the pricing schedule and specification will be deemed non-compliant.

All confidential material supplied must be clearly identified as so.

Performance Specification

Any offer received assumes that the bidder has read all of the tender documents, that they have included everything necessary to provide complete and working systems and that the labour is inclusive of all resources required to deliver the complete operation package of works.

Please ensure you include the following with your tender submission:

- Confirmation that your bid fully complies with the specification and if not, please detail any deviation(s).
- Completed bill of quantities
- Literature on all equipment offered where not specified or offered as an alternative.
- Completed summary of tender as on 1st page of bill of quantities.
- Organisation chart and resource schedule
- Sample Method Statement and Risk Assessment
- Insurance details

The Client does not undertake that the lowest or any tender shall be accepted, nor shall any expenses incurred by the tenderer be reimbursed.

1.5 Tender Evaluation

Tenders will be evaluated to determine the most economically advantageous taking into consideration the following award criteria:

Award Criteria	Maximum Score	Weighting
QUALITY ASSESSMENT		
	Total marks available: 100	60%
	The breakdown is as follows:	
Quality of Tender Submission	30	
Compliance with Specification	20	
Warranty Support Contract	20	
Organisation Chart and Resource Schedule	20	
Method Statement & Risk Assessment	10	
QUANTITATIVE (PRICE) ASSESSMENT		
	Total marks available: 100	40%
Total price in summary of tender	100	

Quality Assessment:

The quality section will be scored as follows:

Score	Explanation of reasons for award
10	Excellent – submission exactly as required
7	Very Good – submission as required with some omissions
5	Good – submission generally good
3	Satisfactory – submission just meets the requirements
1	Poor – information not provided or inadequate
0	Very Poor - information not provided

Performance Specification

2. Preliminaries

2.1 Introduction

The Corn Exchange is a grade II listed building in the heart of Witney, providing a social and creative resource for the people of Witney and visitors.

It was built by the private 'Corn Exchange Company' in 1863, replacing a 16th Century building used in the 1850's as a corn returns office. From the outset, it was used for social events and meetings as well as corn dealings and housed several clubs and societies.

The main hall currently has no permanently installed technical theatre systems or seating so the proposal is to install these systems to enable the venue to be utilised by local theatre and music groups and small scale touring productions.



This specification is for the supply and installation of specialist theatre systems to include production lighting, sound and communications systems and stage engineering.

2.2 Terms

The following terms are used in this specification:

Specialist Theatre Contractor (STC)

The Company carrying out the works detailed in this specification

Consultant

Drama by Design

The Client

Witney Town Council

Performance Specification

2.3 Contract Details

This Contract is for the supply and installation of specialist theatre systems.

The successful tenderer shall be appointed via a direct order from the Client with contract details to be agreed with the Client.

The STC shall allow for liaising with the Consultant and Client team to ensure completion of his works by the date for completion.

It shall be assumed that any tender submission fully complies with this specification unless clearly stated otherwise.

Where relevant an example of the type of equipment preferred for a particular item is indicated. This is not intended to be a definitive requirement, any equal approved product offering similar facilities and quality shall be considered subject to approval by the Consultant.

2.4 Insurance Cover

The following minimum levels of insurance cover shall be required:

Public Liability	£10 Million
Employers Liability	£10 Million
Professional Indemnity	£2 Million

Professional Indemnity cover must include the works detailed in this specification.

This is a pass/fail question; any tenderer not having the requested insurance cover shall be rejected. Copies of insurance certificates shall be included with the tender.

2.5 Scope of Work

There are no other works taking place in the space at the same time, with the exception of the seating which is covered by a separate tender. The STC therefore needs to include for all works necessary to provide complete and working systems. This includes supply and installation of all containment (black finish in main hall space for all containment and fixings), mains and ELV cabling for the specialist theatre installation including mounting of back boxes for the facility panels and production lighting boxes.

Power supplies to all equipment are existing via a distribution board, fused spur, isolator or socket. It is the responsibility of the STC to check the size and location of all power supplied and ensure they are adequate for their needs.

The STC shall make the connection to the existing supplies and provide any necessary sub-circuit fusing or distribution.

The STC shall be responsible for checking all site dimensions and dimensions of all equipment to be manufactured.

The STC shall produce a full set of drawings for approval prior to manufacture. It is anticipated that the following drawings shall be provided:

- Schematics for all systems

Performance Specification

- Layout drawings showing locations of all equipment
- Drawings of all facility panel, production lighting box front panels and lighting bars
- Proposed fixing detail for lighting bars
- Cable schedules
- Rack layouts

This list is not exhaustive and other drawings may be required or requested as part of the design process or as detailed later in this specification. All drawings are to be approved by the Consultant prior to manufacture.

The STC shall include all items necessary to provide complete working systems, irrespective of whether they are detailed in this specification, extras shall not be considered at a later date after the successful tenderer has been appointed due to a lack of information.

2.6 Standards

All equipment supplied shall comply with all appropriate UK and EC standards and, where applicable, carry a CE mark.

All work carried out shall comply with relevant UK and EC codes and regulations for Health and Safety including fire protection, Construction Design and Management Regulations (CDM), IEE electrical wiring regulations, building regulations and Local Authority Building Control.

All designs of equipment and systems shall adhere to:

- The relevant BS, EN, IEC and ISO standards to include:
 - BS 7905-1:2001, Lifting equipment for performance, broadcast and similar applications. Specification for the design and manufacture of above stage equipment (excluding trusses and towers)
 - BS 7906-1:2005, Use of lifting equipment for performance, broadcast and similar applications. Code of practice for installation, use and removal of above stage equipment (excluding trusses and towers)
 - BS 6399 Design loading for buildings
 - BS 6259:2015 Code of Practice for the design, planning and installation of sound systems
 - BS 5950 The structural use of steelwork in buildings
 - BS 4360 Specification of weldable structural steel
 - EN 10147 Galvanised structural steel
 - BS 5867 Part 2 types A & B standard for fire retardancy for curtains.
 - BS 8300:2009 Design of buildings and their approaches to meet the needs of disabled people.
 - BS 5882, Part 1 & 2 and Ignition Source 5 Furniture and Furnishings Fire Safety Regulations
 - BS 8300:2009 Design of buildings and their approaches to meet the needs of disabled people.
 - BS 5588-6:1991 Fire precautions in the design, construction and use of buildings. Code of practice for places of assembly
- Building Regulations (including Approved Document Part M) and Local Authority Building Control requirements
- Construction Design and Management (CDM) Regulations 2015

Alternative equipment and finishes to those specified shall be considered by the Client/Consultant, but requests must be submitted and approval received in writing. Substitutions which have not been notified at tender stage may not be considered.

Performance Specification

2.7 Materials

All equipment and materials supplied shall be new as specified or equal and approved and shall not be varied in any way without the written permission of the Consultant.

The STC shall produce, on request by the Consultant, copies of delivery notes from their suppliers as proof that the goods are in all respects new and as specified.

The Consultant or his representatives shall have the right to reject any equipment or materials he may deem to be unfit and to have any works taken down, removed or undone shall he consider they are not executed in a workmanlike manner or using improper materials.

All equipment and materials shall be suitably protected prior to delivery to site. Any items damaged in transit shall be replaced without charge.

The STC shall include for all costs of shipping all equipment and materials to site and shall make appropriate arrangements for the acceptance, handling, protection and storage of such equipment and materials.

2.8 System Programming

The STC shall perform all software programming required to provide complete and working systems as detailed in this specification, including all control logic, control system and graphic user interface programming.

The STC shall allow for re-programming of all control systems for a period of 3 months after project completion to meet the requirements of the users as requested by the Client/Consultant up to a maximum of 3 times.

All software programs shall be the property of the Client. On completion, a copy of all software programs shall be provided to the Client and/or Consultant.

2.9 Site Attendances

The STC shall allow for providing his own access equipment, unloading and hoisting facilities and protection when installed where appropriate.

The STC shall provide his own skips for rubbish where necessary and ensure that all relevant waste management regulations are complied with.

Space for the STC's huts and storage compounds may be provided subject to agreement with the Client. The STC must, however, provide all necessary huts and compounds for any required storage of their materials and any specialist tools and equipment.

The STC shall submit with their tender a summary of all health, safety and welfare facilities and/or other site attendances required.

2.10 Health and Safety at Work

The STC shall carry out the project with due regard to the Construction (Design & Management) Regulations 2015 and shall comply with all applicable Health, Safety and Welfare regulations as well as the Working Rule Agreement governing the hours of working for any industry for work people, including any amendments and/or additions and the Client's Health and Safety Plan and Site Rules.

All site operatives must have taken an appropriate health and safety test and carry the relevant Construction Skills Certification Scheme card.

Performance Specification

The STC shall allow for providing health and safety documentation with method statements and risk assessments relating specifically to this project and for liaising with the CDM co-ordinator on all aspects of site health and safety.

2.11 Operation and Maintenance Manuals

Upon practical completion, the STC shall supply Operation and Maintenance Manuals in electronic format.

The manual shall contain the following sections:

- Detailed index
- Description of works undertaken
- Basic operating instructions for each item of equipment
- Detailed operating instructions for each system detailing how to operate the system from power on
- Basic maintenance instructions for each item of equipment
- Manufacturer's manuals for each item of equipment
- Test results including fire certificates for all fabrics used
- As fitted drawings
- Connector pin outs and cables used
- Health and safety information for each item of equipment
- Health and safety information specific to the installed systems and site
- Warranty details including out of hours' contact

Manufacturer's standard data sheets and manuals shall not be acceptable, but shall be included.

The manual shall incorporate as fitted drawings and test results/certificates for all systems installed.

The manuals shall be provided to the Consultant for approval, after which they shall be issued to the Client. Manuals must be available at time of project completion, handover and training.

2.12 Instruction and Operation

The STC shall include in his tender for instructing the Client's representative in the correct operation and maintenance of all systems.

This shall include instruction on each overall system and the way the equipment interacts as well as operation and maintenance of each individual item of equipment.

A minimum of one full days training shall be provided, which may be split over two separate sessions at the client's discretion. The STC shall also be available to provide ongoing telephone support and advice during the 12-month warranty period.

2.13 Commissioning

The STC shall make a complete check of all systems prior to commissioning. At this point witness testing by the Client/Consultant shall take place, any faults arising shall then be fixed within an agreed time scale and then subjected to re-testing. Re-inspection shall take the same form as the final inspection. Any further re-inspections shall be at the cost of the STC who will be responsible for all costs and expenses.

All electrical testing shall comply with Guidance Note 3 to BS7671 and an NIC EIC or ECA completion certificate incorporating all the test results shall be provided.

All lifting equipment shall be tested in accordance with the Lifting Operations and Lifting Equipment Regulations 1998 (LOLER) and appropriate certification provided.

2.14 Defects Liability

A 12-month onsite warranty covering both installation and equipment shall be provided for the completed installation from the date of practical completion. Practical completion shall be taken as the point at which all snags are complete and the Consultant has signed off the installation. The terms and conditions of the proposed onsite warranty shall be provided with the tender return to include times support is available, response times and call-out times.

A visit of not less than one day shall be allowed for at the end of the defects liability period to check all systems with the Consultant to ensure they are still in full working order. Any faults detailed by the Consultant shall be rectified within an agreed time period.

3. Performance Specification

This document provides a detailed specification for the various systems to be installed in each of the spaces. The exact requirements for each space are detailed on the enclosed drawings and bill of quantities.

Certain items are to be priced as options, these are shown in *italics* in this document and in the BoQ.

3.1 Production Lighting

3.1.1 Internally Wired Bars

- 3.1.1.1 Bars shall be constructed from 48.3 mm outside diameter aluminium lighting barrel with black 16A socket outlets housed in either square ABS or Metalclad boxes rigidly fixed to the bar.
- 3.1.1.2 16A socket outlets shall be evenly spaced along the bar length.
- 3.1.1.3 Each bar shall incorporate a DMX outlet to allow control of the relay power control unit detailed later and the luminaires on the bars.
- 3.1.1.4 DMX outlets shall utilise 5-pin XLR female sockets to be fed from the DMX distribution system detailed later.
- 3.1.1.5 All outlets (16A and DMX) shall be clearly labelled with either separate black labels attached with nuts and bolts with white filled engraving to identify the circuit number or the panel shall be engraved and filled white.
- 3.1.1.6 All 16A socket outlets shall be black finish.
- 3.1.1.7 Bars shall be powder coated black.
- 3.1.1.8 The bars shall be fixed at intervals of no more than 2m.
- 3.1.1.9 Fixing method is to be confirmed with the structural engineer and Consultant.
- 3.1.1.10 Bars shall be fixed to the top chord of the roof trusses as detailed on the enclosed structural engineers drawing. No fixings shall be attached to the internal members or bottom chords of the roof trusses.
- 3.1.1.11 All fixings shall be black finish.
- 3.1.1.12 All bar fixings shall have a minimum safe working load (SWL) of 50kg.
- 3.1.1.13 A termination box shall be fitted at one end of the bars where the incoming wiring shall be terminated, DIN rail style terminals shall be used inside this box to provide a safe, durable and reliable connection.
- 3.1.1.14 These terminals shall be large enough to accommodate the size and quantity of cables required to connect to them.
- 3.1.1.15 The termination box shall incorporate two Neutrik PowerCON connectors, one for the supply to the bar to be connected to the relay power control unit input and the second for the supply to the bar sockets to be connected to the relay power control unit output.
- 3.1.1.16 The bars shall be fed from the existing 32A TP&N supply in the control room via a distribution board supplied and installed by the STC.
- 3.1.1.17 All containment and mains cabling for the internally wired bars shall be supplied, installed, terminated and tested by the STC.
- 3.1.1.18 Containment in the hall shall be black finish.
- 3.1.1.19 Cable/containment route is generally through the hall at high level dropping to low level where necessary.
- 3.1.1.20 Containment route, type and finish to be agreed with the Consultant prior to installation.
- 3.1.1.21 All high-level containment to be black finish.
- 3.1.1.22 Any data cabling shall be supplied and installed by the STC from to the DMX distribution system in the sound and communications rack detailed later to the bars.
- 3.1.1.23 Bar dimensions shall be checked on site by the STC prior to manufacture.
- 3.1.1.24 The STC shall allow for load testing the bars to 1.2x the designed load and a test certificate shall be supplied as part of the O & M manuals.

3.1.2 Signage

- 3.1.2.1 Two signs shall be supplied indicating the safe working load of the lighting system.

Performance Specification

- 3.1.2.2 These shall incorporate a diagram depicting the lighting bar layout and maximum load limitations.
- 3.1.2.3 They shall be wall-mounted in a protective transparent faced frame on the walls of the space so as to be plainly visible, and as not to interfere with the operation of systems.
- 3.1.2.4 The signs shall indicate the safe working load (SWL) of the entire system and of the individual suspensions and give the SWL under various distribution arrangements such as point load and uniformly distributed load.
- 3.1.2.5 Signage shall be clear and legible both in construction and grammar.
- 3.1.2.6 It shall be durable and laminated on to Foamex boards before being securely mounted on the wall.
- 3.1.2.7 Sign shall be fixed at a height of not less than 2100mm and not more than 2500mm above floor level measured to the base of the sign.
- 3.1.2.8 Final positioning and designs for the signs are to be submitted to the Consultant for approval prior to manufacture and installation.

3.1.3 Production Lighting Boxes

- 3.1.3.1 Production lighting socket outlet boxes shall be installed around the space as shown on the enclosed drawings.
- 3.1.3.2 The boxes shall be a minimum of 120mm deep manufactured from 18swg sheet steel, welded where necessary.
- 3.1.3.3 Welds shall all be ground smooth and all sharp edges shall be rounded off.
- 3.1.3.4 Finish of front panels shall be black with 20% gloss.
- 3.1.3.5 Front panels shall be earth bonded to the back box and to the incoming earth conductor.
- 3.1.3.6 Each box shall incorporate a DMX outlet to allow control of the relay power control unit detailed later and the luminaires connected to the box.
- 3.1.3.7 DMX outlets shall utilise 5-pin XLR female sockets to be fed from the DMX distribution system detailed later.
- 3.1.3.8 All socket outlets (16A and DMX) shall be labelled with either separate black labels attached with nuts and bolts with white filled engraving to identify the circuit number or the panel shall be engraved and filled white.
- 3.1.3.9 All 16A socket outlets shall be black finish.
- 3.1.3.10 The outlet boxes shall be clearly labelled with the box number.
- 3.1.3.11 Sockets shall be wired to internal DIN rail mounted terminals for connection to the cables from the patch system to provide a safe, durable and reliable connection.
- 3.1.3.12 The terminals shall be large enough to accommodate the size and quantity of cables required to connect to them.
- 3.1.3.13 The terminals shall be labelled with the circuit number.
- 3.1.3.14 The production lighting boxes shall incorporate a power control relay as detailed later.
- 3.1.3.15 The relays shall be fed from the existing 32A TP&N supply in the control room via a distribution board supplied and installed by the STC.
- 3.1.3.16 The 16A sockets in the production lighting boxes shall be fed from the relay power control units.
- 3.1.3.17 All containment and mains cabling for the internally wired bars shall be supplied, installed, terminated and tested by the STC.
- 3.1.3.18 Containment in the hall shall be black finish.
- 3.1.3.19 Any data cabling shall be supplied and installed by the STC from to the DMX distribution system in the sound and communications rack detailed later to the bars.
- 3.1.3.20 All internal cabling shall be neatly loomed.

3.1.4 Production Lighting Power Distribution

- 3.1.4.1 A DMX controlled relay shall be supplied for each internally wired lighting bar and each production lighting socket outlet box.
- 3.1.4.2 The relays shall be convection-cooled and operate without cooling fans.
- 3.1.4.3 The relay case shall include an integral moulded safety connection point.
- 3.1.4.4 Power-input and -output connectors shall be arranged at 45-degree angle to the pipe for ease of connection.

Performance Specification

- 3.1.4.5 The relays shall be two-pole with a maximum supported load of 16A.
- 3.1.4.6 The relays shall support voltage input and performing switching at 85-250 V at 47-63 Hz.
- 3.1.4.7 Power input and output connectors shall be Neutrik PowerCON.
- 3.1.4.8 Minimum 2500 V isolation shall be provided between control and power components.
- 3.1.4.9 Switching shall occur at zero cross to reduce the arcing effects of capacitive and inductive loads.
- 3.1.4.10 Relays shall support DMX512A input and output via five-pin XLR connectors.
- 3.1.4.11 The relays shall support user configuration over RDM.
- 3.1.4.12 Relays shall incorporate an auto mode which shall switch the relays on automatically when a DMX/RDM signal is detected and switch the relays off automatically following a user-configurable delay when signal is no longer detected.
- 3.1.4.13 An RDM mode shall switch the relays on via RDM command and switch the relay off via RDM command or power cycle.
- 3.1.4.14 When multiple relays are connected in a system, they shall automatically turn on at slightly different times to reduce inrush current. The delay shall be user configurable.
- 3.1.4.15 The lighting bar relays shall be rigidly attached to the lighting bars.
- 3.1.4.16 A secondary safety bond shall be supplied to attach to the relays and around the lighting bars.
- 3.1.4.17 Production lighting box relays shall be mounted inside the boxes.
- 3.1.4.18 Power to the relays shall be via the existing 32A TP&N supply in the control room.
- 3.1.4.19 The output of the relays shall be connected to the lighting bar or box 16A sockets.
- 3.1.4.20 The DMX input of the relays shall be wired to the DMX distribution system detailed later.

Example: ETC ColorSource Relay equal approved

3.1.5 DMX Distribution

- 3.1.5.1 DMX outlets are included on the internally wired bars and production lighting socket outlet boxes for connecting intelligent lighting fixtures and other equipment requiring DMX control via the power control relays detailed earlier.
- 3.1.5.2 These shall be separately wired back to the sound and communications rack backstage detailed later and terminated into a 5-pin XLR DMX patch bay.
- 3.1.5.3 All cabling and containment to be supplied and installed by the STC.
- 3.1.5.4 Containment in the hall shall be black finish.
- 3.1.5.5 A DMX/RDM splitter unit shall be provided to enable the output of the lighting control console to be distributed to the DMX outlets.
- 3.1.5.6 All ports shall be individually isolated and well protected against transient over voltages.
- 3.1.5.7 The splitters shall be visible to RDM controllers, offering a better overview of the installation and assisting with trouble shooting.
- 3.1.5.8 It shall have 10 no. 5-pin DMX outputs with built-in line termination.
- 3.1.5.9 Sufficient DMX patch cables shall be provided to connect all the splitter inputs and outputs.
- 3.1.5.10 All DMX distribution equipment shall be RDM compliant.

Example: Swisson XSR-5R-5R equal approved

3.1.6 Lighting Control Console

- 3.1.6.1 A computerised lighting control console shall be supplied.
- 3.1.6.2 The lighting control console shall be a microprocessor-based system specifically designed to provide complete control of stage, studio, and entertainment lighting systems.
- 3.1.6.3 It shall provide control of 512 DMX addresses on a maximum of 80 control channels/devices.
- 3.1.6.4 It shall be possible to record a maximum of 999 cues contained in non-volatile electronic memory.
- 3.1.6.5 20 faders shall provide access to individual intensity channels, intensity for devices as well as playbacks.
- 3.1.6.6 A built-in fixture library (upgradeable via USB) shall be provided.
- 3.1.6.7 The control surface shall incorporate 4 user-definable master faders, 5 user-definable buttons for common commands and an intuitive 7" integrated multi-touch display.
- 3.1.6.8 Six softkey buttons shall be provided, five of which may be configured by the user.

Performance Specification

- 3.1.6.9 Console shall be equipped with an on-board help system.
- 3.1.6.10 Console shall not require the use of an external monitor for normal use, however a 19" 1080p wide screen LCD monitor shall be provided with the console.
- 3.1.6.11 Console software upgrades shall be made by the user via an integral USB drive. Changing internal components shall not be required.
- 3.1.6.12 The console shall provide a USB port allowing show data to be saved for archival or transfer to other consoles or a personal computer.
- 3.1.6.13 User recordable colour, position and beam pallettes shall be provided for fast fixture editing.
- 3.1.6.14 The console shall provide intuitive colour control of LED luminaires
- 3.1.6.15 It shall be possible to discover and configure RDM devices connected to the console.
- 3.1.6.16 The console shall be connected to the DMX input sockets on the facility panels via the DMX patch bays and splitters.
- 3.1.6.17 It shall be provided with 2m mains and DMX cables and a dust cover.
- 3.1.6.18 The STC shall allow for setting up the console to control the DMX equipment being provided.

Example: ETC ColorSource 20AV Console equal approved

3.1.7 Luminaires

- 3.1.7.1 LED luminaires shall be supplied and installed.
- 3.1.7.2 All luminaires shall be finished in satin black.
- 3.1.7.3 They shall be RDM enabled, provide a flat, even field of light and be quiet in operation utilising low noise fans.
- 3.1.7.4 They shall feature a four-colour (RGB + lime) mixing system providing bright, vibrant colours and perfectly-mixed pastels.
- 3.1.7.5 Luminaires shall incorporate 4 user selectable dimming modes.
- 3.1.7.6 PowerCON input and output sockets and 5-pin XLR DMX input and output sockets shall be provided on each luminaire.
- 3.1.7.7 Life expectancy of the LED source shall be a minimum of 50,000 hours.
- 3.1.7.8 Sources shall have a high CRI to ensure natural lighting of faces and objects.
- 3.1.7.9 Light output shall be flicker free.
- 3.1.7.10 The luminaires shall be supplied with hook clamps to enable them to be suspended from the lighting bars.
- 3.1.7.11 In addition, a secondary means of suspension shall be provided for the luminaires consisting of a suitable rated safety bond linking the luminaire yoke to the internally wired bar above.
- 3.1.7.12 The STC shall allow for unpacking all luminaires, assembling and fitting plugs where necessary, attaching the luminaires to the lighting bars in positions to be confirmed by the Consultant and setting up the lighting control console to control the luminaires.
- 3.1.7.13 All luminaires shall be supplied complete with 5m DMX cable and 1.5m mains cable with fitted 16A plug top.
- 3.1.7.14 An additional 5 no. 5m DMX cables and 5 no. 5m PowerCON to PowerCON cables shall be supplied.

Example: Prolights LED equal approved

3.2 Audio and Video Systems

3.2.1 Main Loudspeakers

- 3.2.1.1 Main loudspeakers shall be provided as shown on the enclosed drawings and bill of quantities.
- 3.2.1.2 The loudspeakers shall be a passive, two-way system.
- 3.2.1.3 Transducers shall consist of a reflex-loaded 12" low frequency driver and a 1.7" diaphragm/1" exit compression driver mounted on a high frequency horn which shall be user-rotatable to enable vertical or horizontal orientation of the enclosure.
- 3.2.1.4 Horizontal dispersion shall be 80° and vertical dispersion shall be 50°.
- 3.2.1.5 The on-axis frequency response shall be a minimum of 62Hz-20kHz +/- 3dB and the loudspeaker shall produce a maximum SPL of 128dB peak calculated at 1 metre.

Performance Specification

- 3.2.1.6 Power handling shall be 300W AES, 1200W peak.
- 3.2.1.7 Rated impedance shall be 8 ohms.
- 3.2.1.8 The rear connector panel shall be fitted with two NL4 type connectors.
- 3.2.1.9 Low and high frequency sections shall be integrated by an internal 2.3kHz passive network.
- 3.2.1.10 The symmetrical, multi-angle enclosure shall be made from plywood and finished with a black textured paint.
- 3.2.1.11 The enclosure shall be fitted with a pole-mount socket and M8 threaded inserts to accommodate eyebolt suspension and a wall bracket.
- 3.2.1.12 The drivers shall be protected by a perforated steel grille with scrim cloth backing.
- 3.2.1.13 The front of the loudspeaker cabinets shall be protected by a tough rigid metal grill backed by an acoustically transparent fabric.
- 3.2.1.14 The left and right loudspeakers shall be mounted on the side walls of the auditorium utilising proprietary wall mounting brackets.
- 3.2.1.15 The brackets shall allow the loudspeakers to be angled in both the horizontal and vertical planes for optimum alignment.
- 3.2.1.16 *An optional price shall be provided for a centre speaker mounted under the Unistrut support channels detailed later utilising a proprietary hanging yoke bracket allowing for adjustment in both the vertical and horizontal planes.*
- 3.2.1.17 The loudspeakers shall be connected to amplifiers via the facility panels and patch bays detailed later.
- 3.2.1.18 Suitable length Speakon cables shall be provided with the loudspeakers to connect them to the facility panels.
- 3.2.1.19 A safety bond shall be supplied with the loudspeakers to provide a secondary means of suspension between the speakers and a secondary fixing point on the wall or overhead steelwork.
- 3.2.1.20 The STC shall allow for aligning the loudspeakers to ensure even coverage of the whole space.

Example: Martin Audio Blackline X12 equal approved

3.2.2 **Sub-Bass Loudspeakers - optional**

- 3.2.2.1 *An optional price shall be provided for sub-bass loudspeakers; these shall be portable and located on the floor when required.*
- 3.2.2.2 *The loudspeakers shall be a compact subwoofer consisting of one 15" reflex-loaded, long-excursion, low frequency transducer.*
- 3.2.2.3 *The on-axis frequency response shall be a minimum of 45Hz-150kHz +/- 3dB and the loudspeaker shall produce a maximum SPL of 135dB peak calculated at 1 metre.*
- 3.2.2.4 *Power handling shall be 500W AES, 2000W peak.*
- 3.2.2.5 *Rated impedance shall be 8 ohms.*
- 3.2.2.6 *The rear connector panel shall be fitted with three NL4 type connectors.*
- 3.2.2.7 *The enclosure shall be made from plywood and finished with a black textured paint.*
- 3.2.2.8 *The enclosure shall be fitted with a pole-mount socket and M10 threaded inserts for eyebolt suspension.*
- 3.2.2.9 *Provision shall be made for the fitment of castors and the drivers shall be protected by a perforated steel grille.*
- 3.2.2.10 *The speakers shall be connected to the facility panels around the stage detailed later.*
- 3.2.2.11 *A 5m Speakon to Speakon cable shall be provided with each speaker to connect it to the facility panels.*

Example: Martin Audio Blackline X115 equal approved

3.2.3 **Surround Loudspeakers - optional**

- 3.2.3.1 *An optional price shall be provided for left, right and rear surround loudspeakers.*
- 3.2.3.2 *They shall feature a high-power, long-throw 8" low-frequency transducer coupled with a 1" soft dome tweeter.*
- 3.2.3.3 *The loudspeaker's MDF enclosure shall feature a 15° down angle baffle and easily accessible*

Performance Specification

terminals on the top of the enclosure.

- 3.2.3.4 *Horizontal dispersion shall be 130° and vertical dispersion shall be 110°.*
- 3.2.3.5 *Frequency response shall be a minimum of 54Hz-20kHz -10dB and the loudspeaker shall produce a maximum SPL of 118dB peak calculated at 1 metre.*
- 3.2.3.6 *Power rating shall be the 125-watt continuous.*
- 3.2.3.7 *A sophisticated crossover with protection circuitry shall provide absolute reliability.*
- 3.2.3.8 *Enclosure finish shall be black with a black grille.*
- 3.2.3.9 *Pre-installed speaker-side hardware shall allow fast single-installer mounting.*
- 3.2.3.10 *Mounting brackets shall support down-angles of either 15° (standard) or 23° (optional). The speakers shall be mounted on the walls as shown on the enclosed drawings and wired to amplifiers in the sound and communications rack detailed later.*
- 3.2.3.11 *The STC shall allow for supply and installation of cabling and containment from the amplifiers to the speakers.*

Example: QSC SR-8101 equal approved

3.2.4 Amplifiers

- 3.2.4.1 Amplifiers shall be provided to power the loudspeakers – one amplifier for the main loudspeakers, all others priced as options.
- 3.2.4.2 They shall use premium toroidal power transformers for reliable "mid-weight" performance.
- 3.2.4.3 A variable-speed fan shall move air crosswise through the amplifier, drawing cool air in over the power transformer, through the fan, and then over the heat sink.
- 3.2.4.4 Built-in protection shall be provided to automatically protect the amplifiers and loudspeakers from damage due to temperature rise or overdrive without shutting down the show.
- 3.2.4.5 Detented gain controls shall be provided for precise setting and matching of sensitivity.
- 3.2.4.6 Front panel LEDs shall monitor power, signal and clipping.
- 3.2.4.7 Inputs shall be via XLR, 1/4" TRS and phono input connectors.
- 3.2.4.8 Outputs shall be via 1/4" (TS) plugs, Speakon or binding posts
- 3.2.4.9 Power levels of the amplifiers shall be matched to the loudspeakers.
- 3.2.4.10 The amplifiers shall be mounted in the sound and communications rack backstage detailed later.
- 3.2.4.11 All controls shall be clearly labelled with their function utilising securely fixed engraved labels.
- 3.2.4.12 The outputs of the amplifiers shall be wired to the speaker patch panels detailed later.
- 3.2.4.13 The amplifier inputs shall be wired to the audio patch bays detailed later.

Example: QSC GX5 and GX7 equal approved

3.2.5 Digital Signal Processor

- 3.2.5.1 A Dante® enabled digital signal processor (DSP) shall be supplied and installed in the sound and communications rack to provide control and signal routing for the sound system.
- 3.2.5.2 The DSP shall be used for routing signals from the theatre audio mixer, input plates and other audio sources to the correct amplifiers and for configuring the system for optimum performance and protection and for routing signals.
- 3.2.5.3 Wherever possible audio signals shall be distributed utilising a Dante® network.
- 3.2.5.4 The DSP shall have 6 analogue mic/line inputs and 4 analogue line outputs (*with the option of 12 inputs and 8 outputs if the full sound system is selected*) plus a minimum of 32 inputs and 16 outputs utilising Dante® audio networking.
- 3.2.5.5 Networking shall be via 1000 Base-T RJ45 utilising CAT6 cable.
- 3.2.5.6 A designer software application shall be provided that operates on a Windows computer running Windows® 7 or higher operating system.
- 3.2.5.7 The DSP shall incorporate a minimum of 6 channels of acoustic echo cancellation (AEC).
- 3.2.5.8 A powerful 64-bit floating point DSP engine shall be utilised to provide very wide dynamic range and reduce the potential for clipping.
- 3.2.5.9 It shall utilise studio grade 24-bit audio converters with 48 kHz sampling to maintain audio signal transparency.
- 3.2.5.10 A range of powerful, easy-to-configure tools shall be provided to control level, dynamics, filters,

Performance Specification

- delay, ducking, loudness, and feedback suppression.
- 3.2.5.11 All program memory shall be non-volatile and provide program security should power fail.
 - 3.2.5.12 The DSP shall be controlled via the AV control system detailed later.
 - 3.2.5.13 All inputs and outputs to the DSP shall be routed via the audio patch bays detailed later with normal routing automatically routed through the patch panel without the need to insert a patch cord (normalled).
 - 3.2.5.14 The signal processor shall be linked to the fire alarm system so that in the event of an alarm situation the sound system shall be automatically muted.
 - 3.2.5.15 The STC shall allow for full programming of the signal processor at time of commissioning to the Consultants requirements with up to three later revisions if required.

Example: Extron DMP64 Plus AT (*DMX128 as option*) equal approved

3.2.6 Surround Sound Processor - optional

- 3.2.6.1 *An optional price shall be provided for a surround sound processor/pre-amplifier.*
- 3.2.6.2 *It shall feature six HDMI inputs, component/composite ins/outs, XLR balanced and RCA unbalanced Dolby 7.1 pre-outs and RS-232C control.*
- 3.2.6.3 *An HDMI output shall be provided.*
- 3.2.6.4 *It shall feature Bluetooth 4.0 connectivity.*
- 3.2.6.5 *An FM tuner shall be provided with 20-channel memory.*
- 3.2.6.6 *The unit shall be compatible with multi-channel formats including TrueHD/Dolby Digital Plus/Dolby Digital/ DTS-HD/MasterAudio/DTS ES.*
- 3.2.6.7 *It shall be HDCP-compatible.*
- 3.2.6.8 *The surround sound processor shall be installed in the sound and communications rack and connected to the AV switcher output and audio DSP input.*
- 3.2.6.9 *It shall be controlled via the AV control system detailed later.*

Example: Denon DN-700AVP equal approved

3.2.7 Sound Mixer

- 3.2.7.1 A flexible digital mixing system shall be provided with signal processing and audio in a rack mounting processor unit and separate plug-in control surface.
- 3.2.7.2 It shall have 16 mono mic/line inputs each with a dedicated motorised fader, 3 stereo inputs and 12 mix outputs.
- 3.2.7.3 The analogue signal shall be captured by high-class, low latency 24bit analogue to digital converters matched to 24bit digital to analogue converters to deliver the required high-quality output.
- 3.2.7.4 The preamp design shall offer superb transparency, minimal distortion and an ultra-low noise floor.
- 3.2.7.5 An 800×480 integral touchscreen and its dedicated rotary encoder shall provide super-fast access to all settings and parameters.
- 3.2.7.6 Dedicated keys and screen tabs shall quickly guide the user to meter and RTA views, FX racks, channel processing, USB audio control, scenes and setup menus.
- 3.2.7.7 A set of single function physical controls shall provide instant access to gain, HPF, 4 band PEQ, gate, compressor, GEQ and pan.
- 3.2.7.8 It shall have 4 stereo effects engines returned to the mix on dedicated return channels, providing as a minimum reverb, gated reverbs, delays, modulators, flangers.
- 3.2.7.9 It shall come with an iPad app providing a simple interface for non-technical users to control the essential parameters of mixer.
- 3.2.7.10 The mixer processor shall be mounted in the sound and communications rack with network audio connections to the facility panels via the data sockets on the facility panels for connection of the mixer control surface.
- 3.2.7.11 The processor shall incorporate 16 microphone/line inputs and 8 outputs which shall be connected to the facility panel microphone and audio tie line sockets and digital signal processor

Performance Specification

inputs via the audio patch panel detailed later.

Example: Allen and Heath QU16 and AB168 equal approved

3.2.8 Projector - optional

- 3.2.8.1 *An optional price shall be provided for a WUXGA LCD projector to be supplied and installed as indicated on the drawings.*
- 3.2.8.2 *The projector shall be a 3 LCD unit and shall have a minimum output of 16,000 ANSI lumens.*
- 3.2.8.3 *It shall have a minimum resolution of 1920 x 1200 WUXGA.*
- 3.2.8.4 *Contrast ratio shall be a minimum of 10,000:1.*
- 3.2.8.5 *It shall provide 20,000 hours maintenance free operation.*
- 3.2.8.6 *Input shall be via the HDMI out socket on the facility panel above the stage area.*
- 3.2.8.7 *It shall accept resolutions up to 4K/60p which shall be converted to the 1920 x 1200 output resolution.*
- 3.2.8.8 *It shall generate no more than 38dB of noise during normal operation.*
- 3.2.8.9 *Finish shall be matt black.*
- 3.2.8.10 *The projector shall be mounted under the Unistrut support channels detailed later utilising a proprietary hanging bracket.*
- 3.2.8.11 *Suitable brackets shall be supplied and installed to ensure the projector its mounting is secure and stable, with no vibration.*
- 3.2.8.12 *Bracket shall be black finish.*
- 3.2.8.13 *A secondary means of suspension shall be provided from the projector to the overhead steelwork.*
- 3.2.8.14 *The projector shall be supplied complete with a zoom lens with motorised zoom and focus to provide full screen width on the proposed projection screen.*
- 3.2.8.15 *The projector shall incorporate electronic adjustment for keystone (± 60 degrees Vertical (Max), ± 20 degrees Horizontal (Max)), image position and image type.*
- 3.2.8.16 *The STC shall install a power supply for the projector by way of a 13A switched socket fed from the control room distribution board.*
- 3.2.8.17 *The STC shall allow for connecting to this supply including any cabling and containment required.*
- 3.2.8.18 *The projector power shall be remotely controlled from the AV control system detailed later.*
- 3.2.8.19 *It is the responsibility of the STC to ensure that the projector and screen locations are suitable to provide full screen uninterrupted coverage.*

Example: Panasonic PT-MZ16KL + ET-EMW400 lens equal approved

3.2.9 Projection Screen - optional

- 3.2.9.1 *An electrically operated roller front projection screen shall be supplied and installed in the main theatre as indicated on the enclosed drawing.*
- 3.2.9.2 *Drive mechanism shall be contained in the top box.*
- 3.2.9.3 *Screen casing shall be epoxy painted in non-reflective black.*
- 3.2.9.4 *The motor shall be fitted with adjustable limit switches to stop the motor automatically at either end of travel.*
- 3.2.9.5 *Screen size shall be wide screen 6m wide x 3.375m drop (16x9 format).*
- 3.2.9.6 *Screen surface shall be suitable for front projection with a minimum surface gain of 1.8.*
- 3.2.9.7 *The screen shall be fixed to the top chord of the roof trusses as detailed on the enclosed structural engineers drawing. No fixings shall be attached to the internal members or bottom chords of the roof trusses.*
- 3.2.9.8 *All fixings shall be black finish.*
- 3.2.9.9 *The STC shall install a power supply for the projection screen by way of a 13A switched socket or fused spur fed from the control room distribution board.*
- 3.2.9.10 *The STC shall allow for connecting to this supply including any cabling and containment required.*

Performance Specification

3.2.9.11 *Control of the screen shall be via the AV controller detailed later.*

3.2.10 AV Control System

- 3.2.10.1 An AV control system shall be provided to enable simple, intuitive control of all elements of the AV system
- 3.2.10.2 It shall consist of a seamless presentation switcher, a control processor and two button control panels.
- 3.2.10.3 The presentation switcher shall have one DisplayPort, two HDMI and one twisted pair input and support signal resolutions up to 4K/60 at 4:4:4. It shall have a loop through output that can be routed from any of the inputs, an HDMI main output and output over twisted pair data cable.
- 3.2.10.4 Image quality shall be excellent with fast and reliable switching, along with audio processing, seamless video transition effects and logo keying.
- 3.2.10.5 It shall be HDCP 2.2 compliant to ensure display of content protected 4K video media.
- 3.2.10.6 Audio DSP processing shall be 64-bit floating point to maintain very wide dynamic range and audio signal transparency to simplify gain stage management while reducing the possibility of DSP signal clipping.
- 3.2.10.7 A high-performance control processor shall be supplied to enable control of the AV system.
- 3.2.10.8 It shall use industry standard communication protocols, including HTTP (insecure), HTTPS, SSH, SFTP, SMTP, NTP, Discovery Service, DHCP, DNS, ICMP, 802.1X, and IPv4.
- 3.2.10.9 Control interfaces shall include two RS232, IR, digital I/O, relay, LAN and connection for button panels.
- 3.2.10.10 It shall provide LAN control of the switcher, audio DSP, projector (optional) and Blu-ray player (optional).
- 3.2.10.11 It shall also provide relay control of the motorised projection screen.
- 3.2.10.12 Button panels shall be provided to control the AV control processor, one at the rear of the stage and one in the control room as shown on the enclosed drawings.
- 3.2.10.13 The control panels shall incorporate fully customisable backlit buttons and a volume control knob with LED indicators that shall be programmed indicate the current volume level.
- 3.2.10.14 Control panels shall incorporate 10 programmable buttons.
- 3.2.10.15 Buttons shall be labelled with printed text to indicate their function, labelling to be agreed with the Consultant.
- 3.2.10.16 They shall be powered over the network to receive power and communication over a single Ethernet cable, eliminating the need for a local power supply.
- 3.2.10.17 The control panels shall be programmed to provide the following controls as a minimum:
- Power on/off
 - Volume via rotary pot and level indicator
 - Audio mute on/off
 - Video blank on/off (where applicable)
 - Screen up/down
 - Source select buttons
- 3.2.10.18 Design for the button panel functionality to be agreed with the Consultant prior to programming.
- 3.2.10.19 The STC shall allow for full programming of the control system at time of commissioning to the Client and/or Consultant's requirements with up to three later revisions if required.
- 3.2.10.20 Cabling for the AV control system shall be supplied and installed by the STC in containment provided by the STC.

Example: Extron IN1804 DI/DO switcher equal approved
 Extron IPCP Pro 250 control processor equal approved
 Extron MLC Plus 200 control panel equal approved

Performance Specification

3.2.11 *Blu-ray player - optional*

- 3.2.11.1 *An optional price shall be provided for supply and installation of a Blu-ray disc and media player.*
- 3.2.11.2 *It shall handle all popular optical video and audio CD playback formats.*
- 3.2.11.3 *Front-loading SD and USB ports shall deliver access to video, audio and picture files including AVI, MOV, MP4, MP3, WAV, FLAC, GIF, JPEG, PNG.*
- 3.2.11.4 *It shall have RS-232C and IP controllability to enable control from the AV control system detailed earlier.*
- 3.2.11.5 *Audio outputs shall be on XLR balanced connections.*
- 3.2.11.6 *Supported formats shall include BD25, BD50, BD-RE, DVD, DVD+R, DVD+RW, DVD-R, DVD-RW and Audio CD (CD-R, CD-RW), DTS Music Disc, and HDCD.*
- 3.2.11.7 *Additional content shall be accessible via BD Live utilising the built-in LAN port.*
- 3.2.11.8 *The Blu-ray unit shall be installed in the control room with the output connected to the presentation switcher via a twisted pair transmitter and receiver.*

Example: *Denon DN-500BD MkII equal approved*

3.2.12 Facility Panels

- 3.2.12.1 Facility panels shall be installed as indicated on the enclosed drawings and facility panel schedule.
- 3.2.12.2 Connectors used on the facility panels shall be as follows:

Microphone	Neutrik 3-pin XLR female
Audio tie line	Neutrik 3-pin XLR male and female in parallel
Intercom	Neutrik 3-pin XLR male
Video	Neutrik recessed BNC
Speaker	Neutrik Speakon NL4
DMX in	Neutrik 5-pin XLR male
DMX out	Neutrik 5-pin XLR female
Data	Neutrik EtherCON CAT6A
- 3.2.12.3 Panels shall be sized and manufactured to provide the required quantity and types of outlets required at each location.
- 3.2.12.4 They shall utilise a series of standard sizes wherever possible.
- 3.2.12.5 Back boxes shall be manufactured from 18swg sheet steel, welded where necessary. Welds shall all be ground smooth and all sharp edges shall be rounded off. Finish shall be matt black.
- 3.2.12.6 Back boxes shall be a minimum of 150mm deep.
- 3.2.12.7 Back boxes shall be surface mounted with fixing method to suit the wall construction.
- 3.2.12.8 Finish of front panels shall be a standard RAL colour to be confirmed by the Consultant.
- 3.2.12.9 Panels shall be labelled utilising either separate black labels attached with nuts and bolts with white filled engraving to identify the circuit number or the panels shall be engraved and filled white.
- 3.2.12.10 The boxes shall all be clearly labelled with their box number.
- 3.2.12.11 All faceplates with more than eight connectors shall be fitted with protective crash bars at the top and bottom. These shall be constructed from 8mm diameter steel, fixed 12mm from the edge of the plate and extending 60mm from the plate.
- 3.2.12.12 All faceplates with more than eight connectors shall be attached to the back box utilising a piano style hinge along the bottom edge with M4 black countersunk screws on the remaining three sides to hold the faceplate in place after wiring is complete.
- 3.2.12.13 All faceplates with less than four connectors shall be standard double gang panels suitably punched and labelled.
- 3.2.12.14 All faceplates with more than four connectors but less than eight connectors shall be held in place with screws on all four sides.

Performance Specification

- 3.2.12.15 All connectors shall be securely fixed utilising nuts, black countersunk screws and locking washer.
- 3.2.12.16 The STC shall supply and install all containment and cabling for the facility panels.
- 3.2.12.17 Containment in the hall shall be black finish.
- 3.2.12.18 Containment type and routes to be agreed with the Consultant prior to installation.
- 3.2.12.19 All cables shall carry a permanent cable marker at each end with a unique cable ID and/or reference number.
- 3.2.12.20 A cable schedule detailing the proposed numbering system shall be submitted to the Consultant for approval prior to termination on site.
- 3.2.12.21 A laminated print out of the cable schedule shall be fixed to the side of the AV rack detailed later.
- 3.2.12.22 All cables shall be terminated in accordance with industry and electrical standards and as detailed in Appendix A.
- 3.2.12.23 On completion, all circuits shall be tested for continuity and polarity and test results presented at commissioning stage.
- 3.2.12.24 Audio, video, speaker, data and DMX sockets shall be wired back to patch panels located in the sound and communication rack backstage.
- 3.2.12.25 Intercom sockets shall be wired in parallel around all the facility panels back to the intercom power supply in the sound and communication rack backstage.
- 3.2.12.26 Data sockets shall be wired with shielded twisted pair (STP) cable suitable for Dante and video streaming solutions.
- 3.2.12.27 Video sockets shall be wired with cable suitable for 12G-SDI 2160p60 SMPTE ST-2082 video signals.
- 3.2.12.28 Signals to HDMI sockets shall be sent over twisted pair cables utilising HDMI transmitters and receivers.
- 3.2.12.29 The transmitters/receivers at the panel end shall be surface mounted on the front of the panel so the indicators are clearly visible.
- 3.2.12.30 They shall be powered from the equipment in the sound and communications rack backstage; local power shall not be required.
- 3.2.12.31 All converters shall be HDCP compliant and capable of transmitting and receiving 4K video signals.
- 3.2.12.32 The Speaker sockets shall have all four pins wired to a Speakon patch panel in the sound and communications rack backstage.
- 3.2.12.33 This shall utilise Neutrik NL4 connectors for outgoing speaker lines and Neutrik NL2 connectors for amplifier outputs – two to be provided for each amplifier output.
- 3.2.12.34 All speaker outlets to be wired in 2.5mm LSOH stranded cable for cable runs less than 50m, 4mm for cables runs more than 50m.
- 3.2.12.35 Patch cables shall be supplied for each patch panel, quantities as detailed in the bill of quantities.
- 3.2.12.36 They shall be long enough to reach between any two sockets on the patch panels.
- 3.2.12.37 Drawings for the proposed panels shall be submitted to the Consultant for approval prior to manufacture.

3.2.13 Sound & Communications Equipment Rack

- 3.2.13.1 A suitably sized equipment rack shall be supplied and permanently installed backstage as shown on the enclosed drawings to house the sound and communications equipment.
- 3.2.13.2 The rack shall be 600mm wide x 800mm deep.
- 3.2.13.3 The rack shall be powered from an existing 13A mains supply; the STC shall allow for extending this to the rack location and for providing all mains distribution to all the equipment in the rack.
- 3.2.13.4 A power sequencer shall be provided in the rack to protect the audio system from potential harm by powering them up and down sequentially in the incorrect order.
- 3.2.13.5 This shall incorporate a six-digit keypad and two, sequenced, mains outlets - a 10A feed for the control and ancillary equipment and a 32A feed for the amplifier(s).
- 3.2.13.6 The rack shall be of steel construction finished in scratch resistant textured powder coated paint.

Performance Specification

- 3.2.13.7 It shall have removable front and rear doors.
- 3.2.13.8 Front doors shall have clear Perspex panels to enable the equipment inside the rack to be viewed without opening the door.
- 3.2.13.9 Side panels shall be removable to allow access for service and maintenance.
- 3.2.13.10 Side panels and doors shall be lockable with suited keys.
- 3.2.13.11 The rack shall be on heavy duty castors to allow it to be pulled out from the wall by 1m for maintenance. The two rear castors shall have brakes to lock the wheels when the rack is in position.
- 3.2.13.12 Amplifiers and heavy items of equipment shall be mounted at the bottom of the rack.
- 3.2.13.13 A 1U black ventilation panel shall be installed between any items of active equipment.
- 3.2.13.14 A bulkhead style LED work light with local switch shall be installed inside the rear of the rack to aid service and maintenance.
- 3.2.13.15 All equipment in the rack shall be internally wired, with all cables neatly loomed.
- 3.2.13.16 All cables from the rack to the wall shall be neatly loomed with at least 1m of spare cable to allow the rack to be pulled away from the wall for maintenance.
- 3.2.13.17 Any blank spaces in the rack shall be filled with blank panels.
- 3.2.13.18 The layout for the equipment in the rack shall be agreed with the Consultant prior to installation.
- 3.2.13.19 All equipment shall be positioned in the rack to ensure that it is accessible for servicing and maintenance.
- 3.2.13.20 All equipment and, where applicable, controls shall be clearly labelled with their function utilising securely fixed engraved labels.
- 3.2.13.21 The patch panels shall be located at a convenient working height. All outlets shall be clearly labelled as per the numbering on the enclosed schematics.
- 3.2.13.22 The STC shall allow for all cables to connect the equipment internally within the rack
- 3.2.13.23 ELV cabling and containment from the rack to equipment around the building shall be supplied and installed by the STC.

3.3 Communications Systems

3.3.1 Intercom/Talkback System

- 3.3.1.1 An intercom system shall be provided.
- 3.3.1.2 The intercom system shall be single channel consisting of a power supply with wired belt packs and loudspeaker outstations.
- 3.3.1.3 A rack mounting intercom power supply shall be supplied and installed in the sound and communications rack.
- 3.3.1.4 Single-channel wired belt packs shall be supplied for use around the stage.
- 3.3.1.5 These shall each be complete with a 10m cable to connect to the 3-pin XLR intercom sockets on the facility panels detailed earlier
- 3.3.1.6 A Mic on/off button shall be provided, which shall incorporate a push to talk function.
- 3.3.1.7 Illuminated call buttons shall be provided.
- 3.3.1.8 A single-channel loudspeaker station shall be provided for the control room.
- 3.3.1.9 The loudspeaker station shall be supplied with a cable to enable it to be connected to the intercom sockets on the facility panels detailed earlier.
- 3.3.1.10 The loudspeaker station shall have all the functions of the belt pack with the addition of a built-in loudspeaker and gooseneck microphone.
- 3.3.1.11 It shall be possible to connect a headset to the loudspeaker station.
- 3.3.1.12 Single muff heavy duty professional headsets with microphones shall be supplied with the belt packs and loudspeaker station.
- 3.3.1.13 The headsets shall be fully adjustable with a toughened microphone on a moveable arm.

Example: Tecpro BP511, SMH210, LS351, PS754 equal or approved

3.3.2 Paging and Show Relay System

- 3.3.2.1 A two-zone paging system shall be installed allowing for show relay and paging into the

Performance Specification

- backstage areas and paging and background music into the front of house areas.
- 3.3.2.2 100V line speakers shall be installed, either wall mounted or ceiling mounted as shown on the enclosed drawings, although this may vary depending on final co-ordination.
 - 3.3.2.3 Any ceiling speakers shall be recessed into the suspended ceiling tiles.
 - 3.3.2.4 The wall mounted speakers shall be fixed to the wall utilising proprietary wall mounting brackets.
 - 3.3.2.5 Backstage speakers shall be fitted with separate low-level volume controls to adjust the audio level of the show relay only; paging level shall be pre-set internally where shown on the enclosed schematic.
 - 3.3.2.6 Volume controls shall turn the speaker off at the bottom of their travel.
 - 3.3.2.7 Volume controls shall be clearly labelled with their function utilising securely fixed engraved labels.
 - 3.3.2.8 A show relay switch shall be provided in the sound and communications rack to turn off the show relay when not required, paging calls shall always remain operational.
 - 3.3.2.9 Wall speakers shall be compact 2-way units rated at a minimum of 16W with built-in multi-tap transformer.
 - 3.3.2.10 Ceiling speakers shall incorporate a dual cone driver rated at a minimum of 9W with built-in multi-tap transformer.
 - 3.3.2.11 All speakers shall be finished in white.
 - 3.3.2.12 Two desk top mounting paging points with gooseneck microphone and push to talk button shall be supplied, one for the control room and one for the foyer.
 - 3.3.2.13 The system shall provide show relay in the backstage areas, the signal for which shall be derived from a cardioid condenser microphone suspended overhead and connected to the facility panels.
 - 3.3.2.14 A background music input shall be derived from the audio patch bay.
 - 3.3.2.15 Paging calls shall automatically mute the show relay and background music signals while a paging call is being made and restore it when the call is finished.
 - 3.3.2.16 Amplifiers, mixers and signal processing equipment shall be mounted in the sound and communications rack backstage.
 - 3.3.2.17 Amplifiers should have sufficient power to drive all speakers at their full rating with 50% spare capacity.
 - 3.3.2.18 A compressor/limiter shall be supplied and installed in line with the paging microphone to avoid the system being overloaded.
 - 3.3.2.19 Cabling and containment for the paging system shall be supplied and installed by the STC.

Example: Cloud 46-120T mixer/amplifier equal or approved
 Cloud PM4 paging microphone equal or approved
 InterM Cloud PM4 paging microphone equal or approved
 Clever Acoustics BGS25T & CS69LC speakers equal or approved
 Audio Technica PRO45 show relay microphone equal or approved

3.3.3 Assisted Listening System

- 3.3.3.1 There is an existing audio frequency induction loop system (AFILS) installed in the hall.
- 3.3.3.2 The STC shall allow for testing the AFILS to ensure compliance with IEC 60118-4:2006 (also referred to as EN 60118-4:2006) and a Certificate of Conformity to this standard shall be issued on completion.
- 3.3.3.3 Any remedial works required to ensure compliance shall be detailed to the Consultant in a report with works to be instructed if required.

3.4 Stage Engineering

3.4.1 Curtain Tracks

- 3.4.1.1 Heavy duty curtain tracks shall be supplied and installed as shown on the enclosed drawings.
- 3.4.1.2 Tracks shall be operated via a rope at one end of the track.
- 3.4.1.3 An optional price shall be provided for motorised operation of the front stage overlap curtain

Performance Specification

- track.
- 3.4.1.4 Operation shall be variable speed with control panels at the side of the stage and in the control room.
 - 3.4.1.5 Power supply for the motorised track to be supplied and installed by the STC from the control room distribution board.
 - 3.4.1.6 Ropes for manually operated tracks shall be weighted to ensure the rope hangs correctly.
 - 3.4.1.7 Tracks shall be manufactured from steel, painted with a black epoxy powder coat finish.
 - 3.4.1.8 Vertical supports shall be provided between the running surfaces to prevent runners from jamming in the track.
 - 3.4.1.9 Runners shall have nylon wheels encasing precision bearings to ensure smooth operation
 - 3.4.1.10 Rubber buffers shall be fitted to the sides of the runners.
 - 3.4.1.11 It shall be possible to remove or add runners at any point along the track whether corded or not.
 - 3.4.1.12 Curtain runners shall be ball raced with a minimum of 6kg capacity.
 - 3.4.1.13 Curtain tracks shall be fixed off the overhead roof trusses with additional Unistrut steel supports where required between roof trusses as shown on the enclosed drawings.
 - 3.4.1.14 Fixing method is to be confirmed with the structural engineer and Consultant.
 - 3.4.1.15 Tracks and Unistrut supports shall be fixed to the top chord of the roof trusses as detailed on the enclosed structural engineers drawing. No fixings shall be attached to the internal members or bottom chords of the roof trusses.
 - 3.4.1.16 All fixings shall be black finish.
 - 3.4.1.17 Fixings shall be at the manufacturers recommended spacing, but shall be at no more than 1.5m spacing.
 - 3.4.1.18 The STC shall allow for checking measurements of the curtain tracks prior to manufacture.
 - 3.4.1.19 Detail of fixing method for the curtain track shall be submitted to the Consultant prior to manufacture.

Example: Doughty Six Track equal approved

3.4.2 Curtains

- 3.4.2.1 Curtains shall be provided to attach to the tracks.
- 3.4.2.2 These shall either be coloured lined velour or black wool serge as shown on the enclosed bill of quantities.
- 3.4.2.3 Curtains shall be durably flame retardant wherever possible and a certificate of flame retardancy shall be supplied with the curtains and included in the O & M manuals.
- 3.4.2.4 Curtains shall be of a suitable width to fit the supplied tracks and drop as shown on the drawings and bill of quantities and confirmed as part of a site measure.
- 3.4.2.5 The curtains shall have fullness sewn into the top as shown on the enclosed bill of quantities.
- 3.4.2.6 Tops shall have snap hooks to attach to the curtain track runners.
- 3.4.2.7 Snap hooks shall be at a maximum of 300mm spacing.
- 3.4.2.8 Bases shall be chain weighted.
- 3.4.2.9 Sides shall be hemmed.
- 3.4.2.10 The STC shall allow for checking measurements of all curtain tracks and curtains prior to manufacture.

3.4.3 Front Border

- 3.4.3.1 A durably flame-retardant coloured lined velour border shall be supplied and installed in front of the main stage curtain track.
- 3.4.3.2 This shall be supported by a 48.3mm outside diameter aluminium bar fixed to the roof trusses.
- 3.4.3.3 Fixings shall be at a maximum of 2m spacing.
- 3.4.3.4 The border shall be shaped to completely cover the roof truss and the curtain track below.
- 3.4.3.5 Colour to be confirmed from standard range colour swatch.
- 3.4.3.6 The border shall have fullness sewn into the top as shown on the enclosed bill of quantities.
- 3.4.3.7 Tops shall have tie tapes to attach to the border bars.
- 3.4.3.8 Base shall be chain weighted.
- 3.4.3.9 Sides shall be hemmed.

Performance Specification

- 3.4.3.10 Flame retardancy shall be to BS5867 Part 2 types A & B.
- 3.4.3.11 The SSC shall allow for checking measurements of all bars and curtains prior to manufacture.

3.4.4 Leg Curtains

- 3.4.4.1 2m swivel leg bars shall be supplied and installed.
- 3.4.4.2 These shall be mounted on walkalong curtain tracks running diagonally up and down stage as shown on the enclosed drawings to enable them to be pushed to the back of the stage when not required.
- 3.4.4.3 The swivel mechanism shall be mounted on a wheeled carriage with brake to enable the legs to be stopped in the desired position.
- 3.4.4.4 The brake shall be operable from the stage floor and a suitable operating pole shall be provided.
- 3.4.4.5 Track shall be a fabricated steel 'I' beam creating very solid running surfaces with a matt black finish.
- 3.4.4.6 Vertical supports shall be provided between the running surfaces to ensure it never jam.
- 3.4.4.7 Runners shall have nylon wheels encasing precision bearings to ensure smooth operation
- 3.4.4.8 Rubber buffers shall be fitted to the sides of the runners.
- 3.4.4.9 It shall be possible to remove or add runners at any point along the track whether corded or not.
- 3.4.4.10 Carriages shall have a minimum of 50kg capacity.
- 3.4.4.11 Tracks shall be fixed off the overhead roof trusses with additional Unistrut steel supports where required between roof trusses as shown on the enclosed drawings.
- 3.4.4.12 Fixing method is to be confirmed with the structural engineer and Consultant.
- 3.4.4.13 Tracks and Unistrut supports shall be fixed to the top chord of the roof trusses as detailed on the enclosed structural engineers drawing. No fixings shall be attached to the internal members or bottom chords of the roof trusses.
- 3.4.4.14 All fixings shall be black finish.
- 3.4.4.15 The track shall be suspended at the manufacturers recommended spacing, but at no more than 1.5m centres.
- 3.4.4.16 Durably flame-retardant black wool serge leg curtains shall be supplied to attach to the leg bars.
- 3.4.4.17 The curtains shall have 30% fullness.
- 3.4.4.18 Black tie tapes shall be sewn into the top to fix to the leg bars.
- 3.4.4.19 The base shall be chain weighted.
- 3.4.4.20 Sides shall be hemmed flat.
- 3.4.4.21 Flame retardancy shall be to BS5867 Part 2 types A & B.
- 3.4.4.22 The SSC shall allow for checking measurements of all tracks and curtains prior to manufacture.

3.5 Installation and Project Management

- 3.5.1 All necessary installation work and materials shall be included to provide a complete and working system, regardless of whether these items are included in this specification.
- 3.5.2 Delivery of equipment to site shall be included.
- 3.5.3 The work included in this contract shall be supervised by a qualified site foreman of the STC having thorough experience of the class of work detailed in this specification.
- 3.5.4 The representative shall remain on site whenever the works detailed in this specification are in progress.
- 3.5.5 It is anticipated that there shall be monthly site meetings with the Consultant and client, which the STC's site foreman or project manager shall attend.
- 3.5.6 Commissioning, training, on-site warranty, manuals and a site visit of not less than one day at the end of the defects liability period as detailed in section 1 shall be included.

Performance Specification

Supporting Documents

This specification shall be read in conjunction with the following supporting documents.

3.6 Specifications, Schedules, Matrices & Pricing Schedule

Document	Revision	Title
WTC-DBD-ZZ-ZZ-SH-Y-82050	C02	PERFORMANCE SPECIFICATION (this document)
WTC-DBD-ZZ-ZZ-SH-Y-82051	C01	FACILITY PANEL SCHEDULE
WTC-DBD-ZZ-ZZ-SH-Y-82052	C01	BILL OF QUANTITIES

3.7 Drawings - Plans

Document	Revision	Title
WTC-DBD-ZZ-00-DR-Y-82002	C01	GROUND FLOOR PLAN
WTC-DBD-ZZ-01-DR-Y-82011	C01	1 ST FLOOR PLAN
9318CEW-110-P1	P1	STRUCTURAL GA

3.8 Drawings - Sections

Document	Revision	Title
WTC-DBD-ZZ-XX-DR-Y-82021	C01	SECTIONS

3.9 Drawings – Facility Panels

Document	Revision	Title
WTC-DBD-ZZ-ZZ-DR-Y-82031	C01	SUGGESTED PANEL LAYOUTS

3.10 Drawings – Schematics

Document	Revision	Title
WTC-DBD-ZZ-ZZ-DR-Y-82041	C01	PRODUCTION LIGHTING SCHEMATIC
WTC-DBD-ZZ-ZZ-DR-Y-82042	C01	AV SCHEMATIC
WTC-DBD-ZZ-ZZ-DR-Y-82043	C01	PAGING SCHEMATIC

Appendix A General Standards of Workmanship



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APPENDIX A

GENERAL REQUIREMENTS FOR WORKMANSHIP OF ASSEMBLY AND INSTALLATION OF EQUIPMENT

Document Title	General Requirements for Workmanship
Author	Andrew Stone
Creation Date	24 th August 2017
No. of Pages	16

Private and Confidential

INDEX

SECTION	DESCRIPTION	PAGE
1.1	General Requirements	A3
1.2	Equipment Racks	A4
1.3	Dressing of Cables	A4
1.4	Mains Power Cables	A6
1.5	Cable Termination	A6
1.6	Cable and Conductor Preparation	A7
1.7	Connectors	A7
1.8	Solder Connections	A7
1.9	IDC Connections	A7
1.10	Crimp Connections	A8
1.11	Screw Connections	A8
1.12	Electrical Power	A8
1.13	Equipment Earthing	A9
1.14	Containment Installation - General	A9
1.15	Solid Conduit Installation	A9
1.16	Flexible Conduit Installation	A11
1.17	Metal Trunking Installation	A11
1.18	Cable Tray Installation	A13
1.19	Electrical Distribution	A14
1.20	Miniature Circuit Breakers	A14
1.21	Electrical Installations	A15
1.22	Earthing and Bonding	A15
1.23	Painting and Labelling	A15
1.24	Testing and Commissioning	A16

Throughout this document the term 'Subcontractor' is intended to mean the Company that is tendering for the works in the specification document.

1.1 GENERAL REQUIREMENTS

- 1.1.1 The Subcontractor shall be solely responsible for the design and manufacture of all equipment and systems and for the installation processes.
- 1.1.2 The Subcontractor shall be solely responsible for the safety of his employees and subcontractors.
- 1.1.3 The Subcontractor shall allow for coordination of their works with that of other trades on site to avoid conflicts and to ensure completion of all works within the programme.
- 1.1.4 The Subcontractor shall be responsible for the discipline, work and performance of his employees and subcontractors.
- 1.1.5 All fabrication, machining, welding, assembly, wiring, testing and other specialist work shall be carried out by trained and experienced personnel.
- 1.1.6 All equipment and materials shall undergo proper inspections and quality checks at appropriate times during manufacture and finishing. Any parts or components which do not comply with good engineering quality or practice, shall be corrected or replaced.
- 1.1.7 As far as possible all equipment shall be fully assembled, tested and inspected prior to delivery.
- 1.1.8 Any on site material cutting shall be limited to working areas specifically designated or approved for this purpose by the Main Contractor.
- 1.1.9 Cable and wire stripping scrap and conductor strands shall be kept away from sensitive electronic equipment such that loose pieces do not become lodged inside equipment.
- 1.1.10 Racks, consoles, connection boxes and other equipment enclosures shall be degreased and vacuum cleaned prior to installation of equipment or panels.
- 1.1.11 Equipment supports and rigging shall be designed for purpose and furnished with manufacturer certification or third party load test certificates.

This includes:

- Chains, brackets, shackles, wire ropes, loudspeaker top frames, proprietary loudspeaker rigging and other items used to suspend equipment
- Specialist or proprietary hoisting equipment, whether used for temporary purposes during installation or permanently installed

- 1.1.12 All fabrics shall be provided with fire and spread of flame treatment certificates.
- 1.1.13 The Subcontractor shall take measures to protect all cabinets, casework, finished flooring, wall coverings and equipment from damage resulting from his work. This shall include the installation of temporary protective coverings, unless agreed otherwise with the Main Contractor.
- 1.1.14 Any damage caused by the Subcontractor due to insufficient protection being provided shall be rectified at no additional cost to the Client or Main Contractor.
- 1.1.15 All equipment racks and sub-assemblies shall be constructed and assembled off site. This shall include wiring, labelling, cable dressing and equipment supports.
- 1.1.16 The Subcontractor shall produce any additional drawings or information required for fabrication, installation and wiring of all items required to provide working systems.
- 1.1.17 The Subcontractor shall be responsible for the proper alignment, loading, adjustment and calibration of all equipment supplied.
- 1.1.18 The Subcontractor shall inform the Consultant of the unsuitability of any related works being carried out by others. This includes electrical, mechanical and structural work.

1.2 EQUIPMENT RACKS

The following shall apply to all equipment racks supplied:

- 1.2.1 Equipment mounting shall conform to EIA industry standards of 1¾" rack height units.
- 1.2.2 All fixings shall be metric.
- 1.2.3 M6 Posidrive or black rack screws with nylon washers shall be utilised for all fixings where appropriate.
- 1.2.4 The Subcontractor shall ensure all equipment racks are adequately ventilated.
- 1.2.5 All equipment racks shall be approximately 800mm deep with 19" mounting rails at the front and rear. 600mm racks may be installed within confined spaces with prior agreement of the CONSULTANT.
- 1.2.6 Where possible, racks shall be sited to allow both front and rear access. Final locations shall be agreed with the Operator and CONSULTANT, after due conference with and acceptance by the Architect.
- 1.2.7 All racks shall be sufficient in depth to accommodate all equipment and allow space for signal and power wiring, unless specifically indicated otherwise.
- 1.2.8 All racks shall be inspected carefully prior to installation. All rough or sharp edges that may cause injury to personnel or damage equipment or cabling shall be deburred or a permanent protective covering applied.
- 1.2.9 The Subcontractor shall provide blank rack panels in all rack openings not occupied by equipment. Blank filler panels shall not exceed three rack units in size. Perforated panels may be used to aid ventilation.
- 1.2.10 Racks shall include side panels, rear doors with bottom 150mm open for cable access and top and bottom perforated panels.
- 1.2.11 Devices shall be mounted in the racks in logical order. Generally, signal flow should move from the top of the rack to bottom. Heavier devices should be mounted in the lower portion to ensure that the assembly is not too top heavy. Frequently used devices shall be mounted at the optimal elevation for operator use.
- 1.2.12 All equipment shall be mounted in accordance with manufacturer's recommendations.
- 1.2.13 Adequate provision shall be made to maintain rated maximum temperatures within each equipment item and the rack as a whole under worst case operating conditions.
- 1.2.14 The Subcontractor shall review estimated heat loads and provide confirmation or updated requirements to the CONSULTANT and Services Engineer within 8 weeks of appointment.
- 1.2.15 Each rack shall be uniquely identified with an engraved, self-adhesive label affixed to the front top frame. Individual items of equipment shall be identified by similar labels affixed to the front rack edge, allowing interchange of similar equipment items without loss of identification.
- 1.2.16 Contractor rack logo panels shall be confined to a single rack unit.

1.3 DRESSING OF CABLES

- 1.3.1 All cabling shall be terminated to broadcast standards as typified by BBC document ED128.
- 1.3.2 Cable dressing shall be considered from a maintenance standpoint. Suitable service loops shall be provided to allow removal of equipment, or to extend equipment that is mounted in the rack on rack slides. Where there is no rear access to the rack mounted equipment, this requirement shall be carefully addressed, and cabling shall be of sufficient length to enable the removal and replacement of any individual piece of equipment with all others in place.
- 1.3.3 The Subcontractor shall fabricate all reasonable sections of the systems off-site unless otherwise agreed with the CONSULTANT. Pre-wiring is acceptable provided

that the pre-wired assembly can easily be transported to its final location without complication, and without risk of cable or equipment damage. Use of intermediate connections for inter-rack cables is not acceptable.

- 1.3.4 Equipment specified as "Future" shall be provided with cables installed and routed normally, with the un-terminated end labelled, sealed in a plastic bag and tagged appropriately.
- 1.3.5 The Subcontractor shall determine the proper length of all cables whether manufactured on or off the site.
- 1.3.6 The Subcontractor shall determine the desired method of securing cables on Facility Panels and within any equipment consoles and racks. The following requirements must be met by the systems:
 - 1.3.6.1 Plastic cable ties are the preferred method of cable lacing. Lay-in systems are not acceptable except as applied to a horizontal cable tray.
 - 1.3.6.2 Wires and cable shall be installed in a neat and orderly fashion, with like cable types following similar paths. Groups of cables shall be neatly combed and harnessed.
 - 1.3.6.3 Harnessed groups of cables shall be anchored at suitable intervals to reduce and relieve wire strain, especially strain on connections. Adequate service loops shall be provided at all cable endpoints.
 - 1.3.6.4 Some rack-mounted equipment utilises slide assemblies for front extension while in operation. For this type of mounting, additional, carefully dressed service loops on all cables shall be provided and installed with spring operated cable retractor assemblies to gather and recoil the service loop.
 - 1.3.6.5 No point in a cable path shall be subjected to a bend radius of <8 times the cable diameter or the minimum cable bend radius specified by the manufacturer.
 - 1.3.6.6 Captive cables shall not be laced such as to prevent removal of the equipment to which they are captive.
 - 1.3.6.7 Wires and cables shall be segregated according to signal type. In addition, audio circuits shall be subdivided into three classes: microphone level, line level and loudspeaker level.
 - 1.3.6.8 Microphone level audio circuits shall be kept $\geq 75\text{mm}$ from any other type of parallel signal circuits and $\geq 150\text{mm}$ from any parallel AC power circuits.
 - 1.3.6.9 Loudspeaker level audio circuits shall be kept $\geq 75\text{mm}$ from line level audio and AC power circuits. All other signal circuits shall be kept $\geq 75\text{mm}$ away from any parallel AC power circuits.
 - 1.3.6.10 Where circuits of different types must cross, they shall do so at right angles and then return to the above required separations in as short a distance as possible.
 - 1.3.6.11 Conductors, wires, and cables shall be continuous between termination points. Splices are not acceptable.
 - 1.3.6.12 Cable tie and lacing installation shall be accomplished using hand tools specifically designed to apply proper tension to the cable tie, and to cut the end off flush with no protruding sharp edges. The Subcontractor's field supervisor shall spot check assemblies using cable ties both visually and by touch, thereby detecting any sharp edges of improperly cut cable ties. Install cable ties on all cable runs of two or more cables that are not supported by raceway, cable tray or other means. Place cable ties approximately 150mm apart. Do not use more cable ties than are necessary for a neat installation. Cable ties shall not be applied with excessive force that may damage or deform sensitive and fragile cables.
 - 1.3.6.13 Rack mounting rails shall not be used for cable lacing. Lacing bars and/or tie mount bases mounted to cabinets or console shall be provided where appropriate.

1.4 MAINS POWER CABLES

- 1.4.1 All equipment mains power cables shall terminate in a standard BS1363 13A plug top that shall be wired in compliance with current codes and standards.
- 1.4.2 The power cable may be laced to the rack as long as it is removable at the power connector on the equipment. This is to allow removal of the equipment without removing any cable lacing.
- 1.4.3 Power cables shall not be laced in the same bundle with signal or control cables.
- 1.4.4 If the power cable is permanently attached to the equipment, the cable shall be laced separately from all other cables to facilitate easy removal of the equipment.
- 1.4.5 All power cables shall be plugged into an AC power distribution strip prewired into the rack prior to delivery to site.
- 1.4.6 All 13A plug tops shall incorporate an appropriately rated BS1362 fuse.

1.5 CABLE TERMINATION

- 1.5.1 All cabling shall be terminated to professional standards.
- 1.5.2 Cable cores shall go direct to the connections on the apparatus or equipment terminating there in suitable sized sockets or terminals, as appropriate to the type of switchgear and cable. Termination shall be made strictly in accordance with best modern practice and recommendations made by the manufacturer to suit the particular cables with regard to oil migration and water or moisture penetration.
- 1.5.3 Cable core terminal connections shall be by means of sweated or crimped lugs of ferrules or approved manufacturer's procedure.
- 1.5.4 Wherever possible connections between audio equipment shall utilise balanced connections. Where this is not possible, an electronic balancing device or balancing transformer shall be used to convert unbalanced signals to balanced.
- 1.5.5 The Subcontractor shall be responsible for utilizing best wiring practices to ensure maximum sonic quality for audio cables and resistance of systems to external electrical noise interference.
- 1.5.6 The Subcontractor shall determine the correct mating connectors for all equipment supplied prior to cable fabrication and installation.
- 1.5.7 Any exposed portions of shield or internal conductors shall be protected with PVC heat shrink sleeving.
- 1.5.8 Any exposed ends of outer sheaths on shielded cables shall be insulated with sleeves to cover the cut shield and ensure this doesn't touch adjacent metal.
- 1.5.9 Bare shield drain wires shall be insulated with small diameter clear Teflon or PVC heat shrink from under the sleeve to within 3mm of the point of termination.
- 1.5.10 Conductors of 25mm² or greater cross-sectional area shall be terminated with compression lugs.
- 1.5.11 Conductors of 16mm² or less may be terminated with compression lugs or screw clamp terminals.
- 1.5.12 Pinch screw terminals may be used for conductors not larger than 6mm² unless the terminal forms part of a component or equipment defined elsewhere in the Specification.
- 1.5.13 Cables shall be supported at terminations such that there shall be no strain on the cable, lug or termination in any direction.

1.6 CABLE AND CONDUCTOR PREPARATION

- 1.6.1 Cables shall be prepared in such a way that the sheath is removed without damage to the individual conductors, shield or their insulation.

- 1.6.2 Proper procedures shall be indentified and followed for shield jacket removal, shield breakout, and stripping contacts with and without insulation support.
- 1.6.3 The outer sheath of the cable shall be cut perpendicular to the cable.
- 1.6.4 Any paper or plastic material between the braid and the conductors shall be removed.
- 1.6.5 The shield should be twisted into a single conductor, insulated and solder tinned if required.
- 1.6.6 Insulation shall be removed from conductor in such a manner that conductor strands shall not be nicked to the extent that base metal shows through the plating and wire strands remain in the original lay, and are not combed out.
- 1.6.7 The conductor's insulation shall be cut square within 6mm of the outer diameter of the insulated conductor.

1.7 CONNECTORS

- 1.7.1 Professional quality cable connectors shall be utilized throughout.
- 1.7.2 All cable mounted connectors shall incorporate a strain relief device which securely grasps the outer sheath to prevent the cable being pulled from the connector.
- 1.7.3 A cable boot with polyurethane gland shall be fitted to provide high protection to cable bending stresses
- 1.7.4 All connectors shall incorporate a mechanical means of attaching connectors to ensure that a connector shall not disconnect unless intentionally removed.

1.8 SOLDER CONNECTIONS

- 1.8.1 All cabling shall be terminated to professional standards.
- 1.8.2 Good quality lead free solder designed for electronic use with internal flux shall be used.
- 1.8.3 Ensure soldering iron is at correct temperature before commencing any soldering work.
- 1.8.4 Soldering iron tip shall be matched to the size of work being carried out.
- 1.8.5 Soldering iron tip shall always have a thin coating of solder to avoid oxidation of the tip.
- 1.8.6 All cables shall be tinned prior to final connection.
- 1.8.7 Solder fillets shall wet and flow around conductor and terminal. In no case shall the general outline of the conductor be visible in excessive solder.
- 1.8.8 The insulation shall not be charred, melted or burned by the soldering operation.
- 1.8.9 The final solder joint shall be bright and shiny and shall show no evidence of being a "cold" joint where insufficient heat has been applied.
- 1.8.10 Mechanical connections made to terminals prior to soldering shall be the minimum required to reliably retain wire, usually a simple bend around solder eyelet or post.

1.9 IDC CONNECTIONS

- 1.9.1 Insulation displacement connections (IDC) such as ribbon cables, telephone and data connectors shall only be installed with the correct termination tooling as specified by the connector manufacturer.
- 1.9.2 Individual conductors of cables installed on IDC terminal blocks shall not be stripped, and shall be punched down with a spring loaded impact tool designed for this specific purpose.
- 1.9.3 Any bare cable conductors shall be insulated with Teflon, PVC heat shrink or other insulating sleeve prior to being punched down on terminal block.
- 1.9.4 No more than two conductors shall be terminated into the same IDC terminal.
- 1.9.5 The punch down process shall automatically cut back any excess cable.
- 1.9.6 Any off cut cable shall not be left within the connector or connector assembly.
- 1.9.7 Only cables designed specifically for insulation displacement termination with the specific termination device employed shall be used.
- 1.9.8 Cables shall be fixed in position utilising a suitable cable tie after termination to avoid undue stress on the cables and terminal block.

1.10 CRIMP CONNECTIONS

- 1.10.1 Where crimp connectors are utilised, they shall be installed using the manufacturer's recommended crimp tool ensuring that the correct crimp pressure is applied.
- 1.10.2 A procedure shall be in place to ensure that the crimp tooling is properly checked for compliance with the manufacturer's standards, and that crimp connections are completed within the required tolerances.
- 1.10.3 Only pins and connectors of the proper size and design for the cable to which they are to be applied shall be used.
- 1.10.4 There shall be no abnormal deformation of the contact during the crimping operation.
- 1.10.5 There shall be no damage to the contact during the crimping operation that could interfere with its retention in its shell or it's mating.
- 1.10.6 There shall be no damage to the conductor that either severs strands or exposes the individual strands base metal by the crimping operation.

1.11 SCREW CONNECTIONS

- 1.11.1 Only insulated crimp on spade terminals shall be used for application to barrier strips. Ring lugs are not acceptable for this purpose.
- 1.11.2 All conductors shall be stripped prior to installation underneath screws on terminals.

1.12 ELECTRICAL POWER

- 1.12.1 All equipment racks shall have pre-wired AC power distribution strips mounted within the rack.
- 1.12.2 The Subcontractor shall coordinate the power connections and containment interface between the building and the equipment racks with the Main Contractor. This is to ensure that a clean, independent earth is maintained to all sound and communications equipment.
- 1.12.3 All systems shall be designed such that power may be supplied or removed at any time without causing damage to system equipment or disturbing audible 'thumps'.

Power failure shall not result in equipment failure or delays in start-up following resumption of power.

- 1.12.4 The Sound and Communications Systems system shall be designed to operate on unconditioned power, or the system shall include power conditioning devices.

1.13 EQUIPMENT EARTHING

These are general earthing requirements for standard installation projects. Where a separate technical earth is being provided please refer to Appendix B – Earthing Requirements for further information.

- 1.13.1 The earthing system shall follow good engineering practice as detailed below to minimise crosstalk and to maximise signal-to-noise ratios in Sound, Video and Communications systems.
- 1.13.2 The following earthing procedures shall be adhered to:

- The earth, phase and neutral cables shall all be contained in the same containment throughout their route.
- Equipment with a 2-pin mains plug shall also be fitted with a separate earth wire connected between the equipment chassis and the technical earth. Under no circumstances shall the earth pin of a 3-pin plug be disconnected or removed.
- The shield of screen of audio cables shall be connected to earth at one point only. This earth point shall be at the system earth of the destination device, which shall be connected to the system earth in the rack.
- All video and RF connectors shall be insulated from the mounting panel.

1.14 CONTAINMENT INSTALLATION - GENERAL

- 1.14.1 Mains power cables (in particular those from lighting dimmers) and some data and control cables can interfere with Sound and Communications cabling, even though they are contained in a separate steel containment.
- 1.14.2 All Sound and Communications cables shall be contained in steel containment.
- 1.14.3 Any Sound and Communications cable containment shall be separated from any other containment containing such cables by a minimum of 300mm.
- 1.14.4 Cables that typically produce interference include those feeding or coming from lighting dimmers of all types, power feeds to variable speed motors or motors generating large currents at start or stop.
- 1.14.5 All containment shall be installed vertically; it shall not be run diagonally across any area.
- 1.14.6 Containment shall be installed a minimum of 150mm away from all non-electrical services.
- 1.14.7 A separation of at least 50mm shall be maintained between any data/telecommunications and main cables, unless the latter are metal sheathed or are enclosed in conduit or trunking.
- 1.14.8 If an induction loop system for the hard of hearing is to be installed phase and neutral mains cables shall be kept as close together as possible to avoid introduction of a mains voltage loop.

1.15 SOLID CONDUIT INSTALLATION

- 1.15.1 The conduit diameter sizes where not indicated on the drawings shall have a minimum diameter of 20mm and sized in accordance with BS 7671:2008.
- 1.15.2 It is essential that the manufacturer's instructions are followed implicitly in the installation of metal conduit systems with regard to bending, setting, etc.,

- particular care being taken to ensure that no indentation or reduction in cross sectional area occurs.
- 1.15.3 During the progress of the works open ends of conduit and boxes etc., shall be capped to prevent the ingress of foreign matter.
 - 1.15.4 Conduit laid in screed or cast into concrete shall be firmly fixed to the building fabric, to prevent displacement while the screed/concrete is being laid.
 - 1.15.5 Conduit buried in concrete shall have at least 35 mm depth of cover. Where conduit buried in concrete crosses an expansion joint in the concrete, it shall be wrapped with waterproof building paper for a distance of 300 mm on either side of the joint, or protected from stresses by an approved alternative method.
 - 1.15.6 Metal conduits shall be relied upon as a continuous earth path. Separate earth conductors for each circuit contained within the conduit systems shall be installed.
 - 1.15.7 Conduit installed without cabling is to be fitted with suitable draw wires.
 - 1.15.8 Conduits that protect PVC insulated and sheathed cable in cases shall be finished with rubber or PVC brushes at open ends to prevent abrasion.
 - 1.15.9 Conduits shall be protected from weather and all mechanical damage during storage and installation.
 - 1.15.10 Unless stated otherwise, all components of the metal conduit system shall be heavy gauge, screwed and/or butt welded, conforming to BS 4568, (latest edition and amendments).
 - 1.15.11 Care shall be taken to ensure that all conduits are adequately protected while stored on site prior to installation and no damaged conduit shall be used, conduits showing traces of rust after installation shall be wire brushed and painted with an approved metallic paint.
 - 1.15.12 Galvanised conduit shall be used for all surface work, all work in plant rooms, and for positions subject to damp, including work in progress.
 - 1.15.13 Galvanised conduit shall have serrated washers when used at conduit entry points on surface boxes and accessories.
 - 1.15.14 Where running joints or similar items are essential, and at the discretion of the Contract Administrator, lock nuts with knurled edges shall be used. At all conduit fittings, the conduit shall be screwed into an integral spout or alternatively fixed with machined sockets with a hexagon male bush and serrated washer.
 - 1.15.15 Exposed thread, vice marks, etc., shall be painted immediately the conduit is erected. Ends of conduit shall be square and the burrs or cut ends shall be removed. Exposed ends of conduit left during work in progress shall be stopped with proprietary plugs. Paper, debris and the like shall not be used for this purpose. The whole of the conduit system shall be swabbed through to remove dirt and loose matter before cables are drawn in.
 - 1.15.16 Surface installed metal conduit shall be supported at intervals not greater than 1.5m using appropriate saddles; galvanised saddles shall be used where galvanised conduit is used. Fixings shall be appropriate for the surface and load in question plugged and screwed.
 - 1.15.17 Unless stated otherwise, all components of metallic conduit fittings shall be manufactured from malleable iron conforming to BS 4568, latest edition and amendments. Metallic conduit fittings shall be of screwed pattern.
 - 1.15.18 Where Galvanised conduit is being installed the conduit fittings and junction boxes shall be hot dipped galvanised and fixed using round head screws.
 - 1.15.19 Metal conduit boxes not carrying lighting or other accessories shall be fitted with a suitable cover, fixed in position with brass round head screws. Where these boxes are flush, the cover shall overlap the surrounding surface and be of a rust proof pattern.
 - 1.15.20 Adaptable boxes shall be to BS 4568: Part 2 (Latest edition and amendments) constructed from 16 swg sheet steel or best quality cast iron. Such boxes shall be of suitable size and a minimum space of 12mm shall be left between conduit and holes.
 - 1.15.21 Draw in boxes shall be provided to give access to all conduit for the drawing in or out of any cable and shall be of ample size to enable the cables to be neatly

diverted from one conduit to another without undue cramping. No joints shall be allowed in draw in boxes under any circumstances. Generally, where conduit is to be installed from point to point in a straight line, draw in boxes shall be installed every 13m of conduit run.

1.16 FLEXIBLE CONDUIT INSTALLATION

- 1.16.1 Unless stated otherwise, all components of the flexible metallic conduit system shall comply with BS731:Part 1, (Latest edition and amendments).
- 1.16.2 Except where otherwise specified, the final connection to all motors, machines and other moveable apparatus shall be made by means of flexible conduit.
- 1.16.3 The flexible metallic conduit shall be:-
 - Type A – Unpacked, for use in clean dry conditions only.
 - Type B – Packed with heat resisting fibre, for use in damp conditions exposed to high Temperatures.
 - Type C – rubber packed for use in damp, humid or dusty conditions not exposed to high temperatures.
- 1.16.4 Flexible metallic conduit shall be of an approved proprietary type comprising a continuous, helical coiled galvanised or leaded steel wire or strip covered by a continuous PVC sheath.
- 1.16.5 The conduit shall be watertight, with crushing strength equal to that of conduits in BS 731 part 1, (Latest edition and amendments) and suitable for use in damp humid or dusty conditions, not exposed to high temperatures.
- 1.16.6 Flexible metallic conduit shall only be used with items of equipment which are subject to vibration.
- 1.16.7 Flexible metallic conduit shall be terminated at each connection with factory made adapters.
- 1.16.8 Where the change from solid conduit to flexible conduit occurs a standard conduit box shall be inserted between the two types of conduit. The flexible conduit adapter shall be screwed into the spouted entry of the conduit box, the use of dome covers shall not be permitted.
- 1.16.9 Flexible conduits shall be installed in such a manner that the conduit shall suspend naturally and that no stress shall take place due to bends or sets being created against the lay of the conduit.

1.17 METAL TRUNKING INSTALLATION

- 1.17.1 The trunking installation shall be made with due recognition of the following main points:
 - Clearance from all other services.
 - Fully accessibility throughout the installation.
 - Fully rewirable.
 - Wires not to be fixed to cover of trunking.
 - Rigidly supported throughout its length.
 - Expansion and settlement joints purpose made.
 - Round headed screws shall be used throughout for fixing.
 - Run parallel to building lines.
- 1.17.2 Trunking systems shall be installed so that they are self draining in the event of ingress of moisture due to condensation or any other reason.
- 1.17.3 No trunking shall be installed until the building is in such a condition that there is no likelihood of ingress of rain water to the trunking. Any trunking which suffers

- corrosion and/or damage shall be made good before practical completion. Covers shall be fitted to exclude risk of building debris, etc., entering. Any debris entering the trunking during cabling shall be completely removed before the covers are fitted.
- 1.17.4 Trunking shall be free from rust patched or other defects on delivery and protected from the weather by proper storage on site. Damaged sections shall be wire brushed to remove any rust or dirt and painted with cold galvanised primer or equivalent treatment.
 - 1.17.5 Before commencement or cabling, the trunking shall be cleaned out and the inside shall be free from sharp edges, burrs, fixing screws, etc, liable to damage cable either when installed or after the cover has been fitted. Where tees and bends, or similar fittings are used, particular attention shall be given to avoid damage to cables; corners shall be free of all sharp projections and edges, as for the straight trunking runs.
 - 1.17.6 When using trunking with an inside bends, a piece of conduit is to be used to support and prevent cables from hanging in the way of the cover. All trunking to use earth tags.
 - 1.17.7 Where drilled boxes are connected to trunking the connection shall be made using a brass male bush, locknut and female brass bush. A serrated or compression washer shall be fitted between the male bush and the trunking, and between locknuts and box.
 - 1.17.8 Plastic conduit connections to trunking shall be made by means of flange type couplings, lead washers and brass male bushes.
 - 1.17.9 Bends, tees and other accessories shall be supplied by the same manufacturer as the trunking and be of similar sheet metal and finish. Site fabricated accessories shall not be acceptable, without prior approval of the Contract Administrator.
 - 1.17.10 Where trunking passes through walls or floors the whole cut must be made good to give the partition the same degree of fire protection it had before the hole was made. Since it is possible for fire to spread through the interior of the trunking, fire barriers shall be inserted within the trunking at the point where it passes through the wall or floor. During installation, temporary fire barriers must be provided so that the integrity of the building is maintained.
 - 1.17.11 To prevent the build up of excessive heat at the top of a long vertical trunking runs and to comply with the above clause, heat barriers shall be installed at each floor level.
 - 1.17.12 Where trunking is run horizontally and the lid is on the underside, cable retaining bridges shall be installed at not more than 2m spacing.
 - 1.17.13 Connections shall not be made to lids except where specified.
 - 1.17.14 Trunking shall be fitted with overlapping, drip proof, well fitted covers, screwed to the trunking with captive mushroom head screws. Screws and bolts securing covers to the trunking, or sections of the trunking together must be arranged to prevent damage to the cables.
 - 1.17.15 Where trunking is to be installed flush with the building fabric the trunking shall be fitted with overlapping cover plates when installed flush with the building fabric. The finished edge of the trunking to be flush with the finished surface of the building fabric.
 - 1.17.16 Where trunking is used to connect switchgear and fuse boards, such connections shall be made by trunking fittings manufactured for this purpose, and not by multiple conduit connection couplings.
 - 1.17.17 Trunking shall be rigidly fixed with at least two solid fixings per factory length. Notwithstanding, this, trunking shall be fixed such that there is no apparent deflection in vertical or horizontal planes. The installation being to the entire satisfaction of the Contract Administrator.
 - 1.17.18 Trunking shall be made electrically and mechanically continuous throughout, all joints shall be bonded together by means of tinned copper links bolted across each joint in the system to ensure earth continuity in accordance with the BS 7671, latest edition and amendments, all links to be visible. Connection shall be made

- by means of electroplated bolts and paint, grease and other such items shall be removed from under earth bonding strips to ensure good earth continuity, the entire trunking system being efficiently earthed in the main Switchroom.
- 1.17.19 Metallic multi-compartment trunking shall be used wherever segregation of services cabling is necessary.
- 1.17.20 Where multi-compartment trunking is specified, this shall be purpose made by an approved manufacture.
- 1.17.21 Multi-compartment trunking may be drilled to allow conduit access directly to the appropriate section where conduits are connected to multi-compartment trunking. Holes shall not be oversized or eccentric.
- 1.17.22 Trunking sizes shall make due allowance of cable grouping factors, correction factors for temperature variations and any other restraints in accordance with the BS 7671, (Latest edition and amendments) including an allowance for future additions to be agreed with the Contract Administrator.
- 1.17.23 Unless stated otherwise, all components of the metallic trunking system shall be of robust construction manufactured from sheet steel including lids, rust proofed and painted, in accordance with BS 4678: Part 1 (Latest edition and amendments).
- 1.17.24 Rust proofing of the metallic trunking shall consist of one of the following accepted methods:
- Zinc coated sheet steel, finished in grey stove enamel.
 - Galvanised sheet steel.
 - Etch primer with acrylic base stove enamel.
 - Zintec sheet steel finished high quality grey enamel, complete with all necessary bonding straps, connections, removable covers, angles, blanking ends, etc.
- 1.17.25 The metallic trunking shall be constructed from the following gauge sheet metal:
- Trunking up to 75 mm x 75 mm or equivalent cross sectional area 18 SWG
 - Trunking above 75 mm x 75 mm or equivalent cross sectional area 16 SWG
- 1.17.26 The trunking shall be manufactured with inward return – edge flanges and fitted with flange couplers.
- 1.17.27 Where multi-compartment trunking is used the largest compartment shall determine gauge of metal used.
- 1.17.28 The under floor trunking system shall be properly packed underneath with screed to ensure that no voids exist to allow the trunking to collapse when any weight is applied on the surface.

1.18 CABLE TRAY INSTALLATION

- 1.18.1 Cable tray either metallic or non-metallic shall be used where specified and shall be of adequate size to support the cables without undue bunching and capable of carrying without undue deflection the total weight of cables likely to be carried on the tray.
- 1.18.2 Cable trays shall be of perforated mild steel of the following material gauges:
- Up to 100 mm width – 20 SWG
 - From 100 mm to 150 mm width – 18 SWG
 - Above 150 mm – 16 SWG
- 1.18.3 All cable trays shall be galvanised. All fitting, bends, etc., shall be of the same manufacture and finish as the tray.

- 1.18.4 The entire cable tray system shall be bonded and 12 mm x 1.5 mm copper links shall be bolted across each joint in the system by means of M6 brass nuts and bolts, complete with flat and spring washers.
- 1.18.5 The cable tray shall be supported at intervals not exceeding 1.5 m by suitable brackets necessary to provide a rigid fixing. Brackets shall be galvanised and of a type to permit easy adjustments or medications and such that a space of 25 mm is left between the structure and the tray.
- 1.18.6 Fixing of the brackets to the building fabric shall be by means of specially designed masonry plugs or bolts with galvanised nuts, screws, washers, etc.
- 1.18.7 Holes in the brickwork on concrete for the fixing plugs or bolts shall be neatly drilled in the fabric using the appropriate size masonry drill.
- 1.18.8 Cable tray is to be installed on structures that the Contractor has satisfied himself are capable of carrying the load. If difficulty is anticipated or experienced the Contract Administrator shall be notified.
- 1.18.9 Cable tray shall be installed using manufactured fittings wherever possible. When purpose made fittings are used all sharp edges are to be removed.
- 1.18.10 Any damaged finished shall be treated as for metal conduits and trunking.
- 1.18.11 Trays shall be suitably protected by means of PVC flashing where holes have been cut to allow cables to pass through.
- 1.18.12 Cables shall be fixed to the tray by means of PVC cable ties or covered saddles or straps secured with, nuts and washers.

1.19 ELECTRICAL DISTRIBUTION

- 1.19.1 All switchgear shall be 600 volt rated housed in a metal clad enclosure of robust construction and protected against corrosion.
- 1.19.2 All enclosures shall have at least 25% spare space for future expansion.
- 1.19.3 Switchgear shall conform to the relevant section of BS 5486.
- 1.19.4 Distribution Boards shall be surface mounted of metal clad construction.
- 1.19.5 All protection shall be via miniature circuit breakers complying with BS 5486 part 12.
- 1.19.6 Distribution boards shall incorporate a neutral bus-bar providing an outgoing terminal for each and every neutral conductor connected to it.
- 1.19.7 Distribution boards shall incorporate a bus bar with multiple terminals for the circuit protective conductors with one terminal for each outgoing circuit. It shall be directly connected to the earthing terminal without dependence on the exposed conductive parts of the enclosure.
- 1.19.8 Each MCB shall be clearly labeled either with its function or with a number and separate index.
- 1.19.9 Cartridge fuse links, fuse carriers, bases and associated parts shall comply with BS 1361.

1.20 MINIATURE CIRCUIT BREAKERS

- 1.20.1 All Miniature Circuit Breakers (MCB's) shall be of suitable current rating and type for the load connected to them and shall comply with BS EN 60898.
- 1.20.2 Unless stated otherwise, Miniature Circuit Breakers shall have a minimum rated breaking capacity of 6A.
- 1.20.3 Combined MCB/RCD – Residual Current Circuit Breaker with over current protection (RCCBO) shall comply with BS 4293.
- 1.20.4 Unless stated otherwise, all RCCBO units shall be of type C characteristics and set at 30mA tripping sensitivity.
- 1.20.5 Moulded Case Circuit Breakers (MCCBs) shall comply with BS 4752: Part 1: 1977.
- 1.20.6 MCCB's shall be of the independent manual closing air break type rated for an uninterrupted duty unless otherwise indicated.

1.21 ELECTRICAL INSTALLATIONS

- 1.21.1 All electrical installation work shall be in accordance with BS 7671:2008. Requirements for electrical installations, 17th Edition of the Wiring Regulations, as issued by the Institution of Electrical Engineers including all latest amendments.
- 1.21.2 All cables shall be installed neatly and securely, without joints other than at equipment and terminal fittings, no junction boxes shall be used.
- 1.21.3 Cable strands shall be efficiently secured by screws, nuts and washers or other approved means.
- 1.21.4 No cable shall be bent to a radius smaller than the minimum recommended by the manufacturer.
- 1.21.5 Single core PVC insulated cables, non-armoured, with or without sheath shall comply with BS 6004 or BS 6231 or BS 6346 as applicable.
- 1.21.6 600/1000 Volt grade, multi core PVC insulated, non-armoured cables shall comply with BS 6004 or BS 6346 or BS 7629 as applicable.
- 1.21.7 600/1000 Volt grade, single & multi core PVC insulated, armoured cables shall comply with BS 6346; 600/1000 Volt grade.
- 1.21.8 Cables with PVC sheaths shall not be installed in contact with expanded polystyrene insulation or be directly embedded in concrete or plaster. The cables shall be enclosed within metal conduit or trunking.
- 1.21.9 Cables with PVC sheaths shall not be installed externally to the building without additional mechanical protection.

1.22 EARTHING AND BONDING

- 1.22.1 All metal items of equipment shall be earthed in accordance with BS 7671 latest edition and amendments, and the Electricity Supply Regulations 1937.
- 1.22.2 Switches and distribution boards shall have all incoming and outgoing cables or containment bonded to the earthing terminal by copper conductors in accordance with BS 7671.
- 1.22.3 Switches and distribution boards shall have any moveable panels carrying items of equipment such as push buttons or meters bonded using a flexible earth cable.

1.23 PAINTING AND LABELLING

- 1.23.1 All electrical items of equipment shall be clearly labelled as to their function. All labels shall be positioned at a reasonable working height.
- 1.23.2 Circuit schedules shall be attached to all distribution board. These shall be encapsulated within clear plastic laminate and securely fixed to the equipment.
- 1.23.3 All Warning, Prohibition, Mandatory and Safe Condition signs and labels shall comply with BS 5378.
- 1.23.4 Fire equipment symbol signs shall comply with BS 5499.
- 1.23.5 All signs shall also comply with European safety sign directive 92/58/EEC and shall contain a pictogram, as applicable.
- 1.23.6 Warning labels shall be fitted on all three phase equipment and on containment that contains three phase circuits.
- 1.23.7 The lettering shall be coloured 'Black' on a 'Yellow' background and read 'DANGER - 400 V'
- 1.23.8 At the main distribution point a notice shall be provided stating the date that the electrical installation was tested and the date when the installation should be next tested as required by BS 7671:2008, latest edition and amendments.

1.24 TESTING AND COMMISSIONING

- 1.24.1 All electrical installations and equipment shall be completely tested and commissioned in accordance with the latest edition of BS 7671:2008, latest edition and amendments.
- 1.24.2 As a minimum the following tests shall be carried out:
- Continuity of Protective Conductors and Bonding.
 - Continuity of Final Ring Circuit Conductors
 - Insulation Resistance
 - Insulation of site built assemblies
 - Electrical separation of circuits
 - Protection against direct contact, by barriers or enclosures provided During Erection
 - Insulation of Non-Conducting Floors and Walls.
 - Polarity.
 - Earth Fault Loop Impedance
 - Operation of Residual Current Operated (RCD) and Fault Voltage Operated Protective Devices.
- 1.24.3 The method used to verify test residual current devices shall give the operating time and the current used which shall not exceed 110% of the nominal setting of the device.
- 1.24.4 For a fault-voltage operated device the test voltage between the exposed conductive part and earth shall not exceed 40 volts. In addition to the tests simulating an appropriate fault condition any test facility incorporated in the device shall be operated to test its effectiveness.
- 1.24.5 Where necessary equipment shall be disconnected during testing to prevent damage.
- 1.24.6 The results of all tests shall be recorded on the appropriate inspection and electrical installation certificates and/or log books.
- 1.24.7 All inspection and electrical installation certificates and/or log books shall have the company NICEIC certificate number clearly indicated.