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PETERSFIELD FESTIVAL
HALL

THEATRE MACHINERY

EMPLOYER(S) EMPLOYER'S REQUIREMENTS
(SPECIFIC)

PFH764-THP-XX-XX-SP-OT-005001 Revision: C1

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T H E A T R E
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Document History

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Notes:

Client, Construction & Design Teams

Client	Petersfield Town Council The Town Hall, Heath Road, Petersfield, GU31 4EA
Contact:	
Phil Swan Halls Deputy Manager	T: +44 (0) 1730 264182 E: AssistantHalls@petersfield-tc.gov.uk
Architect	Foster Wilson Size 3.4 Hoxton Works, 128 Hoxton Street London N1 6SH
Contact:	
Jonathan Size Partner	T: +44 (0)20 30898963 M: +44 (0)7823 331016 E: jonathan@fosterwilsonsize.com
Project Structural Engineer (PSE)	Conisbee
Contact:	
Gavin McLachlan Associate	T: +44 (0) 20 7700 6666 M: +44 (0) 7850 639 630 E: gavin.mclachlan@conisbee.co.uk
Theatre Consultant (Referred to herein as "the Consultant")	Theatreplan 31 Colonnade London WC1N 1JA
Contact: Dave Ludlam	T: +44 20 7841 0445 E: dave@theatreplan.co.uk
Contact: Peter Crockett	T: +44 20 7841 0455 E: peter.crockett@theatreplan.com

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1 Glossary

BOH	Back of House, or Backstage
FOH	Front of House, including Foyers
SWL	Safe Working Load
TBC	To Be Confirmed
WLL	Working Load Limit

2 Other Relevant Contracts

EC	Electrical Contractor
MC	Main Contractor
PSE	Project Structural Engineer
SEC	Stage Engineering Contractor (this contract)
TEC	Theatre Equipment Contractor

3 General Information

3.1 Contract Details

This specification sets out the operational and performance requirements, location, duty, dimensional constraints and other parameters for the Theatre Machinery Contract detailed in the following table:

Detail	Reference
Contract Name	Theatre Machinery
Contractor Name	Referred to herein as the Stage Engineering Contractor (SEC)
Tender Documents	Employer's Requirements (Specific) Employer's Requirements (General) Employer's Requirements (Technical) Contract drawings: see ER (S) 3.7 Drawings
Details of the Professional Team	See Client, Construction & Design Teams
Definitions of Terms	See ER (G) 1.1 Definitions and ER (T) 1.2 Definitions
Extent of Works	Provision of Drill Drive Rigging Sets and the Hemp Rigging Sets as specified in this document For a detailed list of the Contractor's responsibilities see ER (G) 1 General and ER (T) 1.3 Contractor's Duties .
Interfaces with Other Trades	See ER (T) 1.4 Interfaces with Other Trades
Applicable Standards	See ER (T) 1.8 Standards

3.2 Application of Related Documents

This document was written in the English language and should not be translated from this language.

This document shall be read in association with the Theatre Machinery Employer's Requirements (General) and Theatre Machinery Employer's Requirements (Technical). The table below sets out the document versions and applicable sections for this contract.

Document	Version	Relevant Sections
Employer's Requirements (General)	C1	ALL
Employer's Requirements (Technical)	C1	ALL

IMPORTANT NOTE – The indexes and [cross-references](#) provided in these documents are for the reader's convenience only and shall not be construed as implying any applicability or non-applicability of particular sections or clauses. It is the Contractor's responsibility to familiarise themselves with all relevant sections of the Employer's Requirements (Specific), Employer's Requirements (General) & Employer's Requirements (Technical).

3.3 Scope of Work

The Theatre Machinery can be summarised as the provision of the following systems:

- Drill Drive Rigging Sets
- Hemp Rigging Sets

The SEC shall:

- Prepare and submit for approval shop drawings and samples as specified.
- Supply and install all equipment specified.
- Test and commission the systems. Carry out tests to be witnessed by the Consultant.
- Provide operation and maintenance manuals, and as-built drawings.
- Provide training for the Client's staff in the operation of the systems at times to be agreed with the Client.
- Provide a warranty on the complete installation to run for one year from the date of handover.
- Offer a renewable annual maintenance contract to the Client.

3.4 General Design Aims

3.4.1 Lifespan

In order to ensure good value for the Client's investment, all items of technical equipment and control must have reasonable lifespans. The expected lifespan is, in most cases, identified below; should the required lifespan not be specifically identified, it will be as advised by the SEC at the time of tender. In the event that no life span is nominated, then a life span of 150 years is required.

The following points indicate minimum life expectancy:

- Building elements (e.g.: floors, stairways, corridors, tunnels, pits) – 150 years of building.
- Stage steelwork structures (e.g.: grids and galleries) – 150 years of building.
- Stage timber structures (e.g.: masking panels, stage floor) – 20 years.
- Sacrificial floor surfaces – 1-5 years, partial replacement if damaged.
- Industrial carpet on galleries – 5-8 years.
- The mechanical elements of the stage engineering installations (drive motors, gearboxes, brakes, winding drums, diverter pulleys and similar) shall be procured, manufactured and installed to a standard that will enable them to continue to work satisfactorily for a minimum of 40 years.
- Permanently installed electrical wiring infrastructure – 40 years.
- Flexible electrical cables – 20 years.
- Electrical elements (variable speed drives, axis controllers, encoders and similar) shall be procured, manufactured and installed to a standard that will enable them to continue to work satisfactorily for a minimum of 15-20 years. The supplier shall provide historical lifespan data to prove the anticipated life.
- Electronic and computer systems and components – at least 10 years.

3.4.2 Reliability

All technical and engineering equipment and its control systems shall be robust and able to withstand continued use (within stated design limits) over its stated lifespan.

Simplicity of design is to be encouraged. In-built design of alternative means of operation in case of failure to provide disaster mitigation and ensure the Client's continuation of business must be carefully considered. No bespoke systems shall be employed without prior identification, prototype demonstration and express agreement with the Client and Consultant.

All systems are to be proven "in the field" or rigorously prototyped and tested. In the latter case, test results shall be made available to the Client and Consultant prior to bulk manufacture or installation.

Systems shall generally be planned and developed without a single point of failure that would prevent a show or changeover from proceeding. High availability of all functions at all times shall be the main priority in design development and component selection.

3.4.3 Maintenance

All technical and engineering equipment shall be designed and installed to make maintenance as simple as possible. In all cases, a method of safe access shall be provided for maintenance work. The design of covers, racks and mountings shall take account of the need for maintenance access.

No equipment shall require frequent servicing (minimum service interval of one year).

Regular inspection and maintenance activities shall be required in accordance with statute and best practice and shall be fully described in maintenance documentation. Such documentation shall be provided in software form so that it can be made available at the place where work is to be undertaken.

Fault diagnosis and first-line repair or maintenance shall be able to be undertaken by trained User's staff who should be fully responsible for the equipment that they operate.

3.5 Painting & Making Good

All reworked, reused and new parts of the installation shall be suitably finished. Take particular care priming and finishing bare metal where it has been cut or welded on site. Match paint to the existing colour scheme: details to be agreed with the Consultant. See [ER \(T\) 3.2.3 Paint & Finishes](#).

3.6 Safety & Safety Systems

See also [ER \(T\) 1.11 Personnel Safety](#) and [ER \(T\) 1.8 Standards](#).

3.6.1 Access Equipment

The SEC is responsible for providing their own access equipment throughout the installation testing and commissioning of the works outlined in this document.

3.6.2 Primary Duty of the SEC

The SEC shall design, construct and install the hoists, lifts and other structural elements to minimise the risk of structural failure or collapse and to ensure the health, safety and welfare of the building occupants. Adequate barriers or guarding shall be provided throughout the installation to minimise so far as reasonably practicable the risk of any person suffering guillotine injuries or entanglement with wire ropes.

3.6.3 Work Health & Safety Regulations

The SEC shall provide all information necessary for the on-going management of the overstage machinery and other installations in compliance with the Lifting Operations and Lifting Equipment Regulations 1998 (LOLER) and the Provision and Use of Work Equipment Regulations 1998 (PUWER). Provide an examination scheme with checklists in electronic format and mark relevant equipment as suitable for lifting persons.

3.6.4 Structural Engineering Consultant

Confirm all structural loads and fixing details to the existing steelwork and concrete structure with the Project Structural Engineer.

3.7 Drawings

This document should be read in conjunction with the following drawings:

Drawing Title	Type	Drawing Number
Overstage Rigging - Details	DETAIL	PFH764-THP-XX-ZZ-DR-OT-015501
Overstage Rigging - Future Upgrade works Indicative Design	DETAIL	PFH764-THP-XX-ZZ-DR-OT-015502
Overstage Rigging - Plan & Isometric Details	DETAIL	PFH764-THP-XX-ZZ-DR-OT-015503
Overstage Rigging - Winch Cleat Rail Details	DETAIL	PFH764-THP-XX-ZZ-DR-OT-015504
APPLIED STRUCTURAL LOADS		
Overstage Rigging - Applied Structural Loads	ASL	PFH764-THP-XX-ZZ-DR-OT-015550

4 Drill Drive Rigging Sets

Summary Scope of Equipment to be Provided			
Item/Location	Qty.	Optional	Description
Strip out of existing system (BY OTHERS)	Lot		The Client is responsible for the strip out of any useful equipment from the current overstage rigging system. The Main Contractor (MC) shall be responsible for the remaining strip out and site clearance in advance of the structural strengthening works by the Project Structural Engineer (PSE) List of strip out items summarised below: <ul style="list-style-type: none"> — Existing rigging sets x 20 — Clew Assemblies x 15 — All steel wire ropes — All Header and Drop pulleys — Suspension bars x 20
Drill Drive Rigging Sets	10		Rigging Line sets: Drill Drive winches, Entertainment Load Limit = 350kg Travel = 7.8m (allowing for extra travel), 5 No. suspension lines include all required diverter pulleys and rigging
Suspension Bars	10		200mm deep ladder beam with 48.3mm OD bottom chord and along the bar levelling adjusters 10 No. 10.5 m Length
Suitable Power Drill	1		Suitable power drill to operate hand tool drive hoists with spare battery

4.1 Background

The existing overstage rigging system has been de-rated due to the unknown properties of the existing supporting structural members. As part of this work, the main contractor will install new structural beams aligning with the proposed rigging system diverter pulleys.

The Existing rigging will be stripped out by the Client and the MC in preparation for the structural strengthening works. Following the installation of the new structure, the SEC shall install a full overstage rigging system consisting of 21 line sets at 250mm centres. To fit within both the operational requirements of the venue and the budget this will consist of alternating Drill Drive Rigging Sets and Hemp Rigging Sets.

This solution provides an interim rigging system. The installed equipment shall take into account the future upgrade as outlined in this document to reduce abortive work.

4.2 Functional Parameters

See also [ER \(T\) 2.2.8 Drill / Driver Hoists](#).

The primary design and performance characteristics of the Drill Drive Rigging Sets are to be as set out below. Confirm all estimated figures either by obtaining verification or from calculation.

LOCATION	Overstage rigging system (see drawings)
ENTERTAINMENT LOAD LIMIT (ELL)	350kg UDL excluding bar and rigging accessories with up to 120kg on a single suspension.
MECHANICAL DESIGN STANDARD	EN 17206 - Use Case 1 (UC1)
DRIVE OPTION	Hoist to have a low speed input for hand winding and a high speed input for power driving with an APPROVED power drill. See Also ER (T) 2.2.8 Drill / Driver Hoists

BRAKING DEVICE	Self-sustaining gearbox.
POWER DRILL	Provide a suitable cordless power drill (or paddle mixer as appropriate), spare battery set and charger(s) for operating the winch sets, details to be agreed with the Consultant.
BATTERY CAPACITY	A single set of batteries shall be capable of raising and lowering a fully loaded bar at least 10 No. times
SUSPENSION WIRE ROPES	To suite payload, see ER (T) 3.5.4 Wire Ropes
LIMITS	Not required
TRAVEL	5.4m (Approx.)
SPEED	Speed shall be limited by the safe torque reaction experienced by the operator holding the drill. Details to be agreed with the consultant
OVERLOAD / UNDERLOAD DETECTION	It shall not be possible to overload the hoist using the supplied winding handle with normal manual effort or the supplied power drill.
DUTY CYCLE	One complete raise / lower cycle followed by a 1-minute rest and repeat
FUTURE UPGRADE CONSIDERATIONS	The proposed installation shall provide an interim solution to ensure the rigging system is sufficient for the hall while the await a future upgrade of the space. The SEC shall consider that the travel of the units shall change and the hemp sets will likely require the upgrade to a horizontal clew system which might incorporate a double purchase hauling system. <ul style="list-style-type: none"> — Allow for up to 2400mm extra travel on all drill drive hoists — All hemp set rigging and pulleys shall be capable of sustaining the loads from a double purchase system to maximise the re-use of the components in the future upgrade.

4.3 Construction

TYPE OF MECHANISM	Conventional multi-line suspension powered by a power drill with the option to drive the hoists with a hand winch. Winch may be pile winding. See Also ER (T) 3.5 Rigging and ER (T) 2.2.7 Winding Drums
FORM OF SUSPENSION BAR	Provide 10 No. 200mm deep ladder beams suitable for the intended loads. Provide ALL bars with along the bar levelling adjusters. See ER (T) 3.5.6 Standard Flying Suspension Beams
LENGTH OF SUSPENSION BAR	As existing 10.5m (nominal) (see drawings) See ER (T) 3.5.6 Standard Flying Suspension Beams
NUMBER OF SUSPENSIONS	5 No. steel wire ropes at 2350mm centres
WINCH / CLEAT RAIL	Both the drill drive winches and the cleats shall be mounted to the winch / cleat rail. Provide a steel structure fixed to the stage right structural wall suitable to mount both cleats and winches. The cleats shall align with the hemp sets. Agree details with the Consultant.
TEST WEIGHTS	Required for testing only and not to be retained by the Client
WARNING NOTICES	Allow for the erection of 2 No. notices of two types See ER (T) 3.2.4 Labels, Signs & Notices

5 Hemp Rigging Sets

Summary Scope of Equipment to be Provided			
Item/Location	Qty.	Optional	Description
Hemp Rigging Sets	11		Clewed hemp sets with a single hauling rope and a clew running up the stage right wall. Provide all required rigging and pulleys. Set capacity: 100kg
Suspension Bars	11		Provide single tube aluminium suspension bars 48.3mm OD with along the bar levelling adjusters.
Cleats & Rail	Lot		Provide combined drill drive hoist / cleat rail and all cleats and all structural fixings to the stage right wall

5.1 Background

To improve the density of rigging sets over the stage, there shall be hemp sets set out between the across stage drill drive rigging sets. These shall be operated by a single hemp hauling line connected to a clew plate converting the single hauling line to 5 No. steel wire ropes.

The Hemp sets will form part of the overstage rigging system interim solution and will be retained in the future upgrade. The future upgrade will involve moving the operating location of the hemp sets to a technical gallery significantly reducing the available clew travel. It is expected that this will result in switching to a horizontal clew mechanism (running across stage). This presents an future opportunity to upgrade the system to a double purchase hemp set with a horizontal clew. The interim installation shall dimension the pulleys suitable for loads from a double purchase set to reduce abortive manufacturing and work.

5.2 Functional Parameters

See also [ER \(T\) 2.2 Hoists & Winches](#).

The primary design and performance characteristics of the Hemp Rigging Sets are to be as set out below. Confirm all estimated figures either by obtaining verification or from calculation.

LOCATION	Overstage rigging system (see drawings)
ENTERTAINMENT LOAD LIMIT (ELL)	100kg UDL excluding bar and rigging accessories with up to 40kg on a single suspension.
BAR TRAVEL	Maximise bar travel (based on clew travel) Nominally 4.8m
CLEW TRAVEL	Maximise clew travel within space Nominally 4.8m
SUSPENSION WIRE ROPES	To suite payload, see ER (T) 3.5.4 Wire Ropes
HAULING ROPE	18 mm outside diameter natural hemp See Also ER (T) 3.5.3 Fibre Ropes
FUTURE UPGRADE CONSIDERATIONS	The proposed installation shall provide an interim solution to ensure the rigging system is functional while the hall await a future upgrade of the space. The SEC shall consider that the travel of the units shall change and the hemp sets will likely require the upgrade to a horizontal clew system which might incorporate a double purchase hauling system. <ul style="list-style-type: none"> — Allow for up to 2400mm extra travel on all drill drive hoists — All hemp set rigging and pulleys shall be capable of sustaining the loads from a double purchase system to maximise the re-use of the components in the future upgrade.

5.3 Construction

TYPE OF MECHANISM	See ER (T) 3.5.2 (d) Clewed Hemp Systems
FORM OF SUSPENSION BAR	10.5m long single tube aluminium rigging bar suitable for the intended loads with along the bar levelling adjusters. See ER (T) 3.5.6 Standard Flying Suspension Beams
NUMBER OF SUSPENSIONS	5 No. steel wire ropes
CLEW END STOP	Provide a substantial end stop for the clew block at the bottom dead position.
WINCH / CLEAT RAIL	Both the drill drive winches and the cleats shall be mounted to the winch / cleat rail. Provide a steel structure fixed to the stage right structural wall suitable to mount both cleats and winches. The cleats shall align with the hemp sets. Agree details with the Consultant.
LOADING NOTICES	Allow for the erection of 1No. notices of one type. See ER (T) 3.2.4 Labels, Signs & Notices

6 Contract Submissions

6.1 Tender Submissions

Include with the tender the following information in addition to other information required by other tender documents. These submissions will be taken into account in evaluating the tenders received.

Ref	Item	Received
A1	Manufacturers' specifications for all proposed proprietary equipment	
A2	Statement of full compliance with these Employer's Requirements or otherwise full description of all deviations	
A3	Full description of technical approach intended to be followed, particularly stating the details of the Stage Engineering elements of the contract	
A4	Written confirmation that each of the proposed installations will fit into the allocated spaces. Provide details of all loads to be applied to the building structure.	
A5	Description of any problems foreseen which may affect the satisfactory implementation of the works or performance of the equipment	
A6	Confirmation of ability to comply with programme for design, manufacture, delivery, installation and commissioning related to overall Project Time Schedule	
A7	Full details of the one year service contract to be offered (see ER (G) 1.11.4 Service Contract)	
A8	Statement of ability to comply with contract programme	
A9	Names and CVs of team leaders on: 1. Design of mechanical equipment	
A10	Completed Pricing Schedule	

6.2 Management Submissions

Submit the following information within 28 days of being formally notified in writing of the intention to appoint as Stage Engineering Contractor.

Ref	Item	Received
B1	Letter of acceptance confirming personnel to work on the Project and replacement CVs for approval of any changes	
B2	Method statement on envisaged delivery procedures	
B3	Method statement on envisaged installation procedures	
B4	Method statement on envisaged commissioning procedures	
B5	Details of anticipated secondary steelwork and builder's work requirements (fixings, chases, etc.) to be confirmed by drawings	
B6	Manufacturers' specifications for all proposed proprietary equipment	

6.3 Contract Submissions

Submit at least the following working drawings, information and other data, in addition to any documents or samples called for herein or in the Employer's Requirements (General), for review, before commencing procurement, fabrication or software preparation. All drawings shall be cross-referenced clearly and submitted as complete sets illustrating fully a part or system. Related data sheets shall be submitted with the drawings. Submissions issue sheet shall be in number sequence, clearly dated and carry the reference from following tables or an X code indicating additional submission. The weight of all parts to be moved manually and the lifting points must be shown. Where alternative solutions have been proposed and accepted, the list shall be modified appropriately.

6.3.1 General

Ref	Item	Received
C1	Design Risk Assessments for all equipment under this contract	
C2	Schedule of all proprietary components together with cut sheets	
C3	Drawings of all signs and notices	
C4	Full list of proposed spares with individual costs (see ER (G) 1.9 Spare Parts)	

6.3.2 Drill Drive Rigging Sets

Ref	Item	Received
C5	General arrangement of winch sets showing suspension bar attachments, head pulleys, drop pulleys and winch unit. Show any secondary steelwork, pulley mounting and any other relevant features. Show access for maintenance.	
C6	Provide gearbox performance data to prove the winch will be self-sustaining under all operating conditions. See ER (T) 2.2.8 (h) Safety case	
C7	Provide details of the rigging ladder beams including steel wire rope termination details and ladder beam deflection under expected loads.	
C8	Details of proposed cordless drill, batteries and battery chargers	
C9	Schedule of all proprietary components together with cut-sheets	
C10	Clarify all the applied loads imposed by the proposed system	
C11	Drawings of all signs and notices.	

6.3.3 Hemp Rigging Sets

Ref	Item	Received
C12	General arrangement of hemp sets showing suspension bar attachments, drop pulleys, return pulleys, clew pulley block, clew guides, clew end stop and winch / cleat rail. Show any secondary steelwork, pulley mounting and any other relevant features. Show access for maintenance.	
C13	Provide details of the rigging bars including steel wire rope termination details and ladder beam deflection under expected loads.	
C14	Schedule of all proprietary components together with cut-sheets	
C15	Clarify all the applied loads imposed by the proposed system	
C16	Drawings of all signs and notices.	

6.4 On Site Testing & Commissioning

6.4.1 Testing Procedures

Representatives of the Consultant and of the Client will carry out general periodic inspections of all aspects of the installation of the equipment, systems and wiring on site. In addition, the Consultant's representatives and others will be present, after the equipment is fully installed, connected and has been set to work, to witness a number of scheduled tests to be carried out by the SEC. The following list indicates the extent of testing required. The SEC shall prepare a full schedule of testing and commissioning procedures, together with a programme, for approval by the Client and the Consultant. Any further tests which may be considered necessary by the Consultant's representatives shall also be carried out at no extra cost to the contract.

6.4.2 General

Ref	Item	Seen
E1	Check location and fitting of all notices and warning signs	
E2	Check spares provided against proposed list	

6.4.3 Drill Drive Rigging Sets

The SEC shall carry out the following tests on every winch:

Ref	Item	Seen
E3	Full static proof load test at 125% of SWL with suspension beam at the top limit of travel (worst case condition for a pile wind hoist). Check for any excessive structural, mounting or other deflections. Confirm there is no slippage in self sustaining gearbox. Repeat test after 5 full cycles of the load and check for any slippage. (see ER (T) 1.12.5 Proof Load Tests).	
E4	Perform at least one full cycle of motion unloaded and then fully loaded with 110% of rated payload. Check for unnecessary friction and smooth and quiet motion. Confirm both manual and power drive operation at full load is neither too easy nor too difficult.	
E5	Perform 10 No. full raise / lower cycles at 100% payload and confirm sufficient capacity in the battery(s).	
E6	Check location and fitting of all notices and warning signs.	

6.4.4 Hemp Rigging Sets

Ref	Item	Seen
E7	Full static proof load test at 125% of SWL with suspension beam a short distance above the floor. Check for any excessive structural, mounting or other deflections. (see ER (T) 1.12.5 Proof Load Tests).	
E8	Perform at least one full cycle of motion unloaded and then fully loaded with 110% of rated payload. Check for unnecessary friction and smooth and quiet motion	
E9	Check location and fitting of all notices and warning signs.	

6.5 Test & Measurement Equipment

Provide at least the following test equipment for the duration of the tests. Any other items reasonably required shall be procured in order that the quality of the installation and performance of the equipment can be confirmed. Please ensure that all test equipment has new batteries.

6.5.1 Minimum Equipment Required

Ref	Item	Seen
F1	Easily-moved certified test weights for all types of tests (see ER (T) 1.12.5 (b) Test Weights)	

6.6 Operation & Maintenance Manuals

6.6.1 Submittals

Prepare and submit the following in accordance with the Employer's Requirements (General). The manual shall contain, amongst other things, the following:

Ref	Item	Received
G1	Direct telephone number for firm providing specified response under warranty	
G2	Schedule of adjustments set on equipment during commissioning	
G3	Complete record of test results for all control cables	
G4	Full operational instructions and Maintenance Manual covering both bespoke and proprietary equipment (see ER (G) 1.7 Operations & Maintenance Manuals)	
G5	Full maintenance instructions: ensure full information about the systems and full contact addresses are provided	
G6	Index of record drawings	
G7	Within 3 months of Completion provide a complete set of new as-built Record Drawings of the entire installation based on the changes made during installation as recorded on the site office record set or the site office computer records	
G8	Contact details including email addresses for manufacturers / distributors of all proprietary equipment	

6.7 Training

6.7.1 Submittals

Provide full operational and maintenance training for the appropriate User's staff (no more than **five persons** in total). This shall include both classroom and practical sessions planned to ensure that there are no operational disruptions due to incorrect operation of the equipment.

Prepare and submit the following in accordance with the Employer's Requirements (General):

Ref	Item	Received
H1	Provide a detailed training plan for the service set out in ER (G) 1.10 Training of User's Staff	

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ER (G) EMPLOYER'S REQUIREMENTS
(GENERAL)

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1 General

1.1 Definitions

1.1.1 Specialist Consultants

The specialist consultants handling the Lighting and Sound Equipment for the Project are Theatreplan, 31 Colonnade, London, WC1N 1JA; telephone +44 20 7841 0440, email engineering@theatreplan.com. In the documents the specialist consultants are referred to as "Theatreplan", "THP", or as "the Consultant".

1.1.2 Stage Engineering Contractor (SEC)

Any firm appointed to undertake part of the Theatre Equipment Works as specified in the documents is hereinafter referred to as Stage Engineering Contractor or "SEC".

1.2 Tender

1.2.1 Tender

By submitting a tender for these works, the Tenderer represents that it has relevant extensive experience in the design, manufacturing and installation of the type of equipment and works described herein and undertakes, if awarded a contract related to these Employer's Requirements, that it will design and provide a safe, reliable and fully operational installation in the defined time scale.

1.2.2 Alternatives

Tenderers shall provide prices for alternatives where described and requested and may give their view as to the preferred option. The alternatives may not be illustrated on the current drawings. Tenderers may also offer clearly described alternatives of their own, provided that these offer economic solutions, comply with the intent and performance described in these Employer's Requirements and can be fitted and maintained in the spaces available.

1.3 Extent of Works

1.3.1 Summary

The Works shall comprise the detailed and final design, manufacture, supply, installation, testing and commissioning of the Theatre Machinery and systems specified herein for the contract, including all labour, plant and transport.

1.3.2 Standards & Regulations

The works shall be carried out in accordance with all parts of this Specification, all statutory requirements and all applicable European Standards.

1.3.3 SEC's Responsibility

The SEC shall provide all equipment, items, articles, materials and operations listed, mentioned, scheduled or implied in the documents, including all design skills, tools, plant, scaffolding, labour, supervision and incidentals necessary and required for the completion and testing of the works and for the full and satisfactory operation of the systems described.

1.3.4 Conflict

In case of conflict between individual clauses or between clauses and drawings, the following order of preference shall apply:

- Local Statutory Requirements
- National Statutory Requirements
- Applicable European Standards

- Employer's Requirements (Specific)
- Employer's Requirements (General)
- Employer's Requirements (Technical)
- The Relevant Drawings

1.3.5 Clarification

Where the Local Statutory Requirements or applicable European Standards affect the design or operation of the equipment or installations, such matters shall be raised with the Consultant immediately. Where any matter is unclear, or the tenderer is concerned about any aspect of the Employer's Requirements or Drawings, these points shall be brought to the attention of the Consultant immediately. Tenders shall not be submitted unless the tenderer is confident that they can supply equipment which performs as specified and can be installed, commissioned and maintained in the spaces, and in the time, available.

1.3.6 Work by Others

Related structural, building, electrical and other work which is so indicated in the documents will be provided by others. Any additional items, whether or not shown on drawings or described in the specification, such as steel required for the mounting of equipment, shall be supplied and installed by the SEC at no extra cost to the contract.

1.3.7 Timber Work

Where timber work forms part of this contract and is to be carried out by the SEC, the cost of suitably experienced carpenters and their materials, including carcassing and finishing timber and plywood, shall be included in the tender price. This work shall be carried out only by trained and experienced craftsmen under the direction of the SEC in accordance with the timescale for the works.

1.3.8 Final Design

Under this contract the SEC has detail and final design responsibilities. These include, inter alia, interpreting the Employer's Requirements (Specific) and Drawings and preparing detailed designs and shop drawings of the equipment and installations which will accomplish the functions described, whilst maintaining the theatre planning and performance concepts set out in the documents. It is accepted that different contractors will offer variations on some of the equipment principles described. The appointed SEC is responsible for producing and installing equipment which is entirely suitable for the purposes described, fits into the spaces available and performs as specified.

1.3.9 Design Personnel

Mechanical, structural, electrical and control system design work shall only be carried out by suitably qualified and experienced engineers of the appropriate discipline. Specifically, audio and lighting control system design shall not be carried out by unqualified electricians or technicians. Similarly, PLC and computer software shall only be designed, written and tested by qualified engineers or software professionals. The Consultant reserves the right to demand documented proof of staff competence in the event of there being concern about the quality of work.

1.3.10 Demonstration

All the equipment and systems offered shall be of a type or principle which the SEC can demonstrate in satisfactory use elsewhere, or operating as a prototype installation. The SEC shall make all necessary arrangements so that the Consultant or their representatives may attend a working demonstration of specific items of equipment if so required.

All demonstrations shall be of a similar installation or equipment to that specified herein which has been designed, manufactured and installed by the SEC.

1.3.11 Performance

5 The SEC is solely responsible for the means and methods used for all design, manufacture, assembly, installation and testing processes and is responsible for the safety of their employees and for coordinating their work with that of other trades on site to avoid conflicts of any sort.

1.3.12 Errors & Omissions

10 Any errors, omissions or ambiguities in the Specifications or Drawings are not to condition the scope, design or implementation of the works, but shall be brought to the attention of the Consultant immediately for clarification of their possible effect on the intent of the documents.

1.4 Quality & Project Management

1.4.1 Quality of Product & Workmanship

20 An essential requirement for the equipment installation and all its ancillary items and accessories is that it shall be of first-rate quality throughout. In addition to operating fully and correctly in accordance with the specification, all systems, items of equipment, materials shall be brand new and workmanship shall be of the highest standard.

1.4.2 Quality Assurance

25 Demonstrate and operate an acceptable system of quality assurance for all work on this Contract and, if required to do so, submit regular reports, at time periods to be agreed, on the checks and inspections carried out throughout the Contract. Quality assurance shall cover, inter alia, detail design and shop drawings, purchasing, manufacture, factory tests, site installation, testing and commissioning processes.

1.4.3 Review Meetings

35 Prior to the award of a contract, the SEC shall attend meetings as required with the Consultant and others to examine in detail their design approach to each item of equipment, system and installation, the components to be used and to agree details of power supplies, structural provision and how each item is to be fitted into the building. Further meetings will be required after award of contract to resolve more detailed matters.

1.4.4 Compliance with Timescale

45 The provision of equipment which performs as specified and which is fabricated, delivered, installed and tested according to the project timescale is of paramount importance. The SEC shall ensure that sufficient and suitable resources are used on the project so that quality is not compromised by the timescale. Penalties may be imposed if the design, submission, manufacturing and installation processes are not diligently progressed through the project.

1.4.5 Project Supervisor

55 Appoint a Project Supervisor whose duty shall be to coordinate and manage this contract. The Project Supervisor shall have previous direct experience of managing contracts of similar size and type. The Project Supervisor shall attend all design review, progress and site meetings. The Project Supervisor shall keep themselves aware on a day-to-day basis of all aspects of the Works, including progress being made towards completion. Grant the Project Supervisor full authority to make necessary decisions and to direct and control the work on the contract.

1.4.6 Site Supervisor

65 During the period when any installation work is being undertaken the SEC shall appoint a Site Supervisor or foreman who shall be responsible for progress, the quality of site work and ensuring the availability of all necessary parts and all necessary resources on site as required to maintain the installation, testing and commissioning programme. The Site Supervisor shall be available for liaison meetings as required by the Main Contractor.

1.4.7 Health & Safety

75 Comply with all Regulations and Ordinances relating to Health & Safety and note particularly all matters set out in the Contract Documents issued by the Main Contractor. Ascertain thoroughly any information required to ensure the safety of all persons involved in the works being carried out on site and during manufacture and implement all necessary safety measures.

1.5 Submittals & Reviews

1.5.1 With Tender

When tendering for the works, submit all information and items set out in the Employer's Requirements (Specific).

1.5.2 Works Programme

85 Submit with tender a programme for design, manufacture and installation work which complies with the overall project programme. The submitted programme shall include realistic periods for submittal and review of drawings and other required information. Procurement and manufacture shall not commence until drawing review is completed. If purchase or manufacture does precede review, this shall be at the SEC's risk.

1.5.3 General Arrangement Drawings

95 Prepare and submit full general arrangement drawings of all pieces of mechanical equipment showing all moving parts, with all fittings mounted on them, and the resulting clearances in all operating positions, in addition to any drawings listed for individual items. In addition, the clearances of all runs of wire ropes, ropes, chains, hanging cables and similar and all other moving parts, whether or not these are being supplied by the SEC, shall be laid out in plan, section and elevation to establish the satisfactory working of the total intended installation.

1.5.4 Detail Drawings

105 Prepare and submit detailed shop and installation drawings and schedules for all disciplines (mechanical, electrical, control, rigging, carpentry, etc.) showing all information necessary to explain fully the design features, appearance, function, fabrication, installation, operation and use of system components. Drawings shall show the rating, size, reference, type number and manufacturer of all proprietary equipment and components or provide a clear, unambiguous reference to other submitted data.

1.5.5 Calculations

115 Prepare and submit full design calculations for all major structural elements, drive motor, gearbox and brake torques, transmission components and similar in addition to any specifically listed as required for particular items. 120 Structural calculations shall include the maximum working stresses in the materials employed and the deflections. Calculations shall state the safety factors of all the essential structural and mechanical components selected for the installations. Copies of all normal design calculations and those relating to safety factors shall be submitted and 125 copies included in the record information.

1.5.6 Physical Loads

Calculate and report the static and dynamic physical loads imposed on the building structure by each item of equipment. Where any physical loading appears to be in excess of the capacity of the structure or other equipment to which it is to be attached, this shall be brought to the attention of the Consultant immediately.

1.5.7 Data Sheets (Catalogue Cuts)

Submit catalogue cuts for all proprietary equipment except items that are specifically defined by model number in the Employer's Requirements. Catalogue cuts may also be submitted for certain standard equipment items in lieu of drawings. All catalogue cuts must contain full information on manufacturer, supplier, dimensions, construction, applications and usage, such as to permit proper evaluation. In addition, each must be properly identified as to its intended use and any options or variations selected must be clearly identified. Incomplete information and poor faxed copies will be rejected.

1.5.8 Samples

If the Consultant requires to see samples of equipment for evaluation, particular materials, small specimens of work, the operation of particular features, components, their mountings or paint finishes these shall be made available at no extra cost to the contract. Samples of all push buttons, indicators and other control panel components and all plugs, sockets, flexible cables and connectors for use external to equipment shall be provided and must be approved before inclusion in the installation. Other items described as "approved" in the Technical or Equipment Specifications must be formally submitted for acceptance prior to inclusion in the project or delivery to site.

1.5.9 Structural Alterations

All holes in, and attachments or alterations to, the structure (whether concrete, brick, block, steel or whatever) shall be shown clearly on submitted drawings. Such drawings shall be approved by the Project Structural Engineer before the holes, attachments or alterations are made and such work shall then be undertaken subject to all the procedures stipulated in the approval.

1.5.10 Power & Wiring

Provide complete wiring schedules and electrical schematic drawings for each system or item of equipment. These shall give full details of cables types, sizes and routes. Confirm the electrical supplies necessary for the switchgear associated with the installation, including any ancillary circuits, and establish capacities of all the individual circuits required. Submit drawings of all cable tray routes and sizes.

1.5.11 Submission Quantities

Numbers of copies of drawings, cut sheets and schedules to be submitted shall be as set out in the Contract Documents. In the absence of any figure therein, four copies shall be submitted. Unless otherwise instructed all drawings and schedules shall be submitted in the first instance to the Main Contractor. Drawings shall be submitted in sets relating to items of equipment, complete systems or specific areas of the installation. Mechanical and electrical drawings for equipment or systems shall be submitted together. Partial submissions may be rejected.

1.5.12 Drawing Sheet Format

All drawings shall be on standard size sheets, preferably not larger than A1 size. Title blocks shall be located in the bottom right-hand corner of the drawing such that the title shall be fully displayed when the drawing is folded to A4 size for submittal. When a drawing is revised a note

describing all significant parts of the revisions shall be added, the revision marked as a cloud and a revision letter added to the drawing number.

1.5.13 Drawing Review

Drawings and other submissions shall be reviewed before fabrication, installation or erection of the items covered by the drawings begins. Review is solely for determining conformance with the design concepts and with the instructions and information given in the Employer's Requirements, drawings and other documentation. Any non-conformance or errors detected during the review will be noted and brought to the attention of the SEC for correction.

1.5.14 Design Responsibility

Review and comment on the drawings does not relieve the SEC of the responsibility for the design or of providing equipment fully in accordance with the Employer's Requirements, Performance Specification and Drawings. The SEC remains responsible for the completeness and accuracy of their drawings and full compliance with the Employer's Requirements.

1.5.15 Drawing & Submission Status

Following review, comments on the drawings will be forwarded by email to the SEC for action. In some circumstances one copy of the drawing will be marked with comments and returned to the SEC. The response will include a statement of the drawing status, as follows:

- "A" status: manufacture can proceed
- "B" status: manufacture can proceed subject to comments, but drawing must be revised and reissued
- "C" status: manufacture cannot proceed; drawing to be revised and resubmitted

The SEC shall not commence installation of the equipment until all changes advised or noted on the returned drawings have been made to the relevant master records and the drawings have been resubmitted.

1.5.16 Contract Issue

After review, the appropriate number of "A" status drawings shall be forwarded to the Main Contractor for general issue. The number of copies of each shop drawing to be issued shall be as stated in the Contract Documents. In the absence of this information, six copies shall be supplied.

1.5.17 Site Records

Maintain on site a set of up-to-date drawings of all items of equipment, clearly marked up with any additions, omissions or modifications made during installation. The marked-up copies shall be available for inspection by the Consultant at any reasonable time during the installation period. These records may be kept as computer files provided they are backed-up and the printed copies are made available when required by the Consultant. These drawings shall form the basis of the as-built record drawings required to be submitted immediately following commissioning of the installations.

1.5.18 Site Changes

Do not make any significant alterations to details shown on "A" status drawings, unless such are instructed and confirmed in writing by the Consultant.

1.6 Delivery & Installation

1.6.1 Packing & Handling

Ensure satisfactory packing and protection of all components and materials for the journey from factory to the site. Any items suffering damage or loss during transit due to unsatisfactory packing or bad handling are to be replaced without charge.

1.6.2 Protection On Site

Take full responsibility for protection and security of all parts of the works and the installations until they are accepted and have been handed over. In the event that the SEC fails to protect their installations from damage, another contractor may be instructed to provide suitable protection and the cost of this charged to the SEC. Equipment damaged from any cause shall be replaced with new by the SEC at no extra to the contact price. The SEC shall also be solely responsible for storage and the security of their equipment, plant and tools on site.

1.6.3 Sequence of Installation

The sequence of work on site shall be established by thorough discussion with the Consultant. Storage and access to areas in which work has to be carried out shall be arranged in advance.

1.6.4 Installation Conditions

Electronic equipment shall not be installed until the area where it is to be installed is clean, dry and secure.

1.6.5 Rubbish

Regularly clear all residual rubbish from work areas.

1.6.6 Consultant's Approval

Carry out the works to the satisfaction of the Consultant who shall have the right at any time to reject any component, material or workmanship which is, in their opinion, defective, of less than first-class quality or not in compliance with the Employer's Requirements. The SEC shall, immediately they are so instructed, replace defective material or components, rectify poor workmanship or modify their designs so as to be satisfactory without charge.

1.7 Operations & Maintenance Manuals

1.7.1 Draft Manuals

One draft copy of detailed Operation and Maintenance Manuals shall be submitted for approval to the Consultant not later than 21 days prior to the Consultant's attendance on site to witness any testing. Failure to provide such manuals may delay testing and any consequent payment. The preparation of the Manuals and associated Record Drawings shall proceed in parallel with the installation of the equipment and shall be carried out by personnel experienced in documentation work.

1.7.2 Final Copies of Manuals

Submit Operational and Maintenance Manuals in high-quality lever arch files to provide facilities for updates and additional pages. Give full details for the operation, maintenance and repair of the equipment and shall include full schedules of parts and components, full circuit diagrams, wiring schedules and the record drawings. All items shall be consistently cross-referenced with a unique code number for clarity. The as-built record drawings shall be included in the final issue of the Manuals.

1.7.3 CD Records

Prepare, in addition to the Manuals, one or more CD-ROMs containing the text and drawings forming the Manuals. These shall allow quick access and searching to the content of the Manuals.

1.7.4 Content

The Manuals shall contain, inter alia and where relevant:

- an index of the record drawings
- general descriptions of the systems
- operating instructions
- operational procedures
- safety procedures
- contact details including email for all manufacturers and suppliers
- 24-hour emergency assistance telephone number
- replacement component catalogue numbers
- manufacturers literature
- schedule of equipment duty and performance
- a schedule of items requiring routine maintenance
- frequency and details of maintenance procedures
- other information required by other parts of the contract documentation
- general technical information

1.7.5 Record Drawings

The record drawings shall include, inter alia:

- system schematics
- cabinet layouts
- patch panel layouts
- jackfield layouts
- equipment layouts at not less than 1:50
- cable schedules
- wiring diagrams for all purpose made equipment
- schedules of components for all purpose made equipment
- block diagrams and logic diagrams

1.7.6 Operational Health & Safety

The operational section of the Manuals shall spell out very clearly the Health & Safety issues related to operation, maintenance and replacement of the equipment. Where necessary this section of the handbooks shall be prepared by a specialist with training and experience of Health & Safety matters. Particular attention shall be paid to the theatrical operational procedures and maintenance access aspects of the installations.

1.7.7 The Building Manual

Where requested, provide input into the Building Services Section of this document, which is compiled by others. The Building Manual provides a comprehensive information source and guide for the Client and end users regarding the safe and efficient operation and maintenance of the specialist theatrical installations.

1.7.8 Copies to be Supplied at Handover

On approval of the Manuals by the Consultant, the number of copies stated in the Contract Documents shall be supplied to the Main Contractor. In the absence of a quantity being given, forward two copies of the Manual, two sets of Record Drawings and four copies of the CD-ROM to the Main Contractor, plus one copy of the CD-ROM to the Consultant. Attention is drawn to the fact that the Works will not be accepted as complete and that payments may not be made until the completed Manual and Record Drawings are submitted and accepted as satisfactory.

1.7.9 Test Certificates

Provide test certificates for all items listed. Test certificates shall be submitted within protective punched A4 sleeves and handed over in complete batches for each item or part of the installation against an advice note. If local by-laws require other tests and, consequently, other certificates, these shall also be supplied without additional cost when requested by the Main Contractor. Manufacturers test certificates are required for the following, inter alia:

- Electric motors
- Wire ropes, chains, shackles and all similar suspension components
- Proprietary hoisting equipment
- Safety components
- Hydraulic components
- Pressure vessels
- Fabric manufacturers certificates stating that fabrics have been treated with a durable flame retardant or are made of inherently flame-resistant fibres as specified

Unless other Regulations apply, certificates required under EN 17206 shall be submitted for all suspension items and equipment. All small loose items shall be individually proof tested and marked with an identifying number. A certificate of test covering and identifying a number of individual similar items shall be supplied.

1.7.10 Certification

The whole of the electrical installation shall be certified to the relevant National Standard.

1.7.11 Declarations of Conformity

Where appropriate the test certificates shall include UK Declarations of Conformity in respect of the Supply of Machinery (Safety) Regulations.

1.8 Inspections & Tests

1.8.1 Manufacturing Inspections

All parts and components for the installation shall undergo proper inspections and quality checks at appropriate times during manufacture and finishing. Full records shall be kept, and these records shall be available for inspection by the Consultant on request. Any parts or components which do not comply with industry standards, good workmanship, good engineering quality or good practice shall be corrected or replaced by the SEC immediately without charge.

1.8.2 Factory Tests

To control costs and minimise delays on site, so far as possible fully test all systems in the factory prior to delivery to site. All powered equipment and mechanical assemblies shall be tested in the factory in agreed procedures appropriate to their place in the final installation. The operation of all control panels and switching facilities shall be checked. Other items listed in the Employer's Requirements (Specific) shall be inspected in their place of manufacture and their basic function demonstrated. Offer the Consultant the opportunity to witness all such tests. All such tests and demonstrations shall take place at least seven days before the equipment is packed for shipment to site. Such tests shall be thorough and the results of the performance of the equipment recorded and copies submitted to the Consultant upon request.

1.8.3 Tests On Site

Carry out the tests listed in the Employer's Requirements (Specific) in the presence of a representative of the Consultant and any additional tests necessary, in the sole

opinion of the Consultant, to prove that the equipment is operating fully and reliably and achieving an appropriate level of performance. Include full tests on software programmes, all safety features and similar, in addition to load and motion tests.

1.8.4 Consultant's Attendance

Give the Consultant sufficient advance notice of all tests both in the factory and on site so that they, or their representatives, may be present if appropriate. The Consultant must be given at least fourteen days' notice of formal testing on site that they are required to witness.

1.8.5 Test Facilities

Provide suitable facilities, labour and apparatus (including mechanical and electrical loads, signal sources, metering and measuring devices) for all necessary tests whether in a factory, in an independent testing house, or on site. As a minimum, provide the test equipment described in the Employer's Requirements. Where necessary, provide safe and easy access equipment for inspection of inaccessible items. The personnel running the tests must be suitably qualified to perform this work and to carry out such adjustments as may be required. The Project Supervisor and Site Supervisor shall attend during site tests.

1.8.6 Attendance by Other Parties

Where local by-laws, any public authority, the Client or the Insurers of the Project or any other authorised body require any work, equipment or parts of the installation to be tested, inspected or approved over and above the tests to be witnessed by the Consultant, such inspections and tests shall be arranged by the SEC. Only in exceptional circumstances as determined by the Consultant shall additional payments be made for such tests.

1.8.7 Test Schedule

Arrange a programme of inspection, testing and commissioning to be agreed with the Consultant. The Consultant will witness the tests carried out by the Contractor. Carry out any further tests which may be considered necessary by the Consultant at no extra cost to the Client.

1.8.8 Test Conditions

At the time of certain inspections or tests on site of audio, video or other particularly sensitive equipment, no other work shall be performed in the same or immediately adjoining areas of the auditorium or stage. This shall particularly apply to tests by others on the installed loudspeaker systems, systems for the hearing disabled, Paging / Show Relay systems and the like.

1.8.9 Equipment Failure

Any equipment which fails to meet the Employer's Requirements or reasonable professional expectations where not set down explicitly shall be modified or replaced with suitable equipment within 14 days and the inspection shall be rescheduled under the same conditions as previously applied. The method of modification, repair or alteration shall be agreed between the Consultant and the SEC but the SEC shall remain responsible for carrying out the work and the costs thereof in order to ensure the equipment functions correctly.

1.8.10 Witnessing

Unless otherwise agreed, testing that is carried out without being witnessed by the Consultant or their representative will not be accepted as evidence of completed work. Final approval and payments will be withheld until all systems

have been thoroughly tested and found to be in full compliance with the Employer's Requirements.

1.8.11 Consumables

5 Replace items with limited life and consumables used during installation or testing immediately following final testing without charge to the Client.

1.8.12 Additional Attendance Costs

10 Should any item of equipment or part of an installation fail to operate fully, such that testing cannot be completed, at a time when the Consultant has been scheduled, or requested, to attend on site or in the factory to witness tests or demonstrations, the SEC shall be responsible for all costs for such abortive attendances, including additional travel, accommodation and subsistence costs incurred by the Consultant or their representatives and any additional fee or time work charges.

1.8.13 Partial Completion

15 If, by reason of default by the SEC, the installations are not complete, tested and satisfactory by the required Completion Date for the Works Package (this not necessarily being the Completion Date of the Contract), any part of the installation which is workable and able to be operated safely by trained personnel may be taken over and used by the Client as necessary, subject to the SEC being given reasonable opportunity to complete the work. Maintain labour on site to work at times around the Client's schedule and correct or complete the work in the shortest possible time. The necessity for such action shall be at the sole discretion of the Consultant. Such partial use shall not imply that the equipment is complete or satisfactory and any risks shall remain with the SEC until the items are fully handed over. Completion work may have to be undertaken at night.

1.8.14 Incomplete Equipment

35 Where equipment which is essential to the Client is not installed and operable by Completion Date, provide suitable alternative equipment until the contract equipment is accepted as complete and satisfactory, so that the building can be used and the Client does not suffer loss or expense. Provision of such equipment shall be at no cost to the Client. The Main Contractor shall determine the necessary equipment in collaboration with the Consultant.

1.8.15 Loose Equipment

45 Supply all loose, non-installed equipment suitably packed and labelled. Deliver such equipment to an authorised representative of the Client and obtain an authorised signature on a detailed list of all items.

1.9 Spare Parts

1.9.1 List of Spare Parts

50 Propose a short list of necessary first-line maintenance spares appropriate to the equipment. The cost of these spares shall be included within the Pricing Schedule and shall form part of the Tender Price Submission. The Client in conjunction with the Consultant will decide whether or not these spares will form part of the Contract. In the event that they are not purchased, they may be deducted from the total and the remaining figure becomes the Contract Price.

1.9.2 Supply of Spares

60 Supply all agreed spares supplied suitably packaged and labelled and place these where agreed with the Consultant who will consult the User on this matter. Obtain an authorised signature on a detailed delivery list for all loose

65 spare items so supplied. Copies of the signed delivery note detailing the spares supplied to be passed to the Consultant. Spares used during the acceptance tests or during the period of guarantee shall be replaced by the SEC without charge.

1.10 Training of User's Staff

1.10.1 Requirement

70 Make a detailed proposal for a period of both operational and technical training on all aspects of the installations. This shall cover working methods, safety and first line maintenance necessary to allow operations to continue in the event of operator errors, equipment malfunctions and minor faults. The training must ensure that a full understanding of the various systems forming part of the installations is imparted and that proper methods of overcoming difficulties are explained.

1.10.2 Staff Involved

80 Assume that both operators and maintenance staff are to be trained and provide both combined and separate sessions. There is no requirement to train staff in basic theatrical operations or engineering disciplines, but to teach the way this equipment installation is intended to be used and maintained. Arrange timing, periods and numbers of staff with the User through the Main Contractor or as otherwise instructed.

1.10.3 Details

90 The training shall be both practical and theoretical, and shall include clear written instructions on both operations and maintenance matters taken from the Manuals. The training course shall include an introduction to the full Manuals and identification on site of all equipment. Identify and explain all relevant power isolators, circuit breakers and other items that may affect the basic working of the installations.

1.11 Guarantees & Servicing

1.11.1 Guarantees

100 The contract requires the SEC to provide a ONE-year written guarantee against defects in design, materials or labour starting from the date on which the majority of equipment is accepted. Items accepted later shall have their guarantees run from the date of acceptance of each major item. The guarantee shall cover the repair of all defects in design, workmanship or materials. During the guarantee period the User's staff will be responsible for straightforward trouble-shooting and minor emergency repairs, and for any routine maintenance as specified in the Manuals. In the event of difficulties or problems, the User's staff will contact the specialist contractor directly by phone or email and later advise the SEC in writing.

1.11.2 Exclusions

115 The guarantee shall exclude failure due to damage caused by neglect or improper use, UNLESS the Operation and Maintenance Manuals have NOT been made available by the time when the Client needs to use the equipment. The guarantee shall exclude failure due to normal wear and tear.

1.11.3 Response Required

120 Under the guarantee any essential repair or replacement shall be carried out or provided by the SEC within 24 hours of the SEC being notified. Where the equipment cannot be repaired or replaced permanently in this time, alternative arrangements to allow performances to continue shall be

made, or equal or better equipment shall be provided free, on loan, until such time as the repair can be completed.

1.11.4 Service Contract

5 The SEC shall make arrangements for the prompt repair of normal equipment failures or faults and the regular servicing of all equipment forming part of the Contract. This shall be on the basis of a service contract to be entered into with the User. Within one month of handover the SEC shall quote for the provision of a full repair and service contract
10 for the User's consideration. Such a contract shall include

repair or replacement of equipment affecting operational or safety matters within 24 hours of request, other matters within seven days, and all necessary regular servicing.

1.11.5 Technical Support Staff

15 Staff who were involved in the installation, setting-to-work and testing of the equipment and systems shall be available to advise and assist with any technical problems which arise with the equipment.

END OF THEATRE MACHINERY EMPLOYER'S REQUIREMENTS (GENERAL)
PFEH Stage Engineering ERs Rev 0.1

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PETERSFIELD FESTIVAL
HALL

THEATRE MACHINERY

ER (T) EMPLOYER'S REQUIREMENTS
(TECHNICAL)

PFH764-THP-XX-XX-SP-OT-005003 Revision: C1

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T H E A T R E
P L A N

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1 General

1.1 Application

This Technical Specification is intended to establish the general type and quality of workmanship, materials and components used on the stage engineering, machinery, rigging and associated installations. This specification is not intended to exclude standard products which can be shown to be of the required quality, that perform as specified and can be shown to have suitable longevity. Such standard products may be proposed for inclusion in the work.

1.2 Definitions

(a) Contract

Within this document this term refers to the works which are the subject of the order or contract to which these documents refer.

(b) Stage Engineering Contractor (SEC)

This term refers to the firm or organisation employed or contracted to carry out Contract.

(c) Provide

Unless stated otherwise, this term shall mean the design, manufacture, supply, installation, commissioning and testing of the equipment described.

(d) Axis

The term refers to single-driven motion of a piece of equipment, such as a single hoist or Elevator.

(e) Agreed

The term shall apply to items which are acceptable to both Contractors where the contract is split.

(f) Approved

The term shall apply to items which have been specifically submitted in the form of cut sheets or samples, or as otherwise requested, to the Consultant and are passed as acceptable for use on this Contract. Any such approval shall not affect the responsibility of the SEC for full compliance with, and satisfactory operation of every aspect of any contract arising from, these Employer's Requirements.

1.3 Contractor's Duties

1.3.1 Scope

Provide the equipment described or implied herein and in all the relevant associated drawings and Pricing Schedule. Additionally, prepare full and comprehensive operating and maintenance manuals, provide record drawings of the completed installations and train staff in the operation and maintenance of these installations.

1.3.2 Design

Full structural, mechanical, acoustic, electrical, wiring, motor drive and control system design, including submitting all necessary drawings, calculations, data sheets and samples for review.

1.3.3 Manufacture

Procure, fabricate and assemble the equipment and materials for all the specified systems, including the power distribution switchgear and all electrical power and control wiring.

1.3.4 Installation

Deliver to site and install all the specified systems including the on site electrical wiring from a single heavy current supply provided by others and any acoustic and noise control measures incorporated in the design or found to be required.

1.3.5 Work Sequence

Comply with the sequence of work on site established with Client, Project Manager, Main Contractor or Management Contractor as appropriate. Minimise double handling and allow reasonable time for following trades to complete their work.

1.3.6 Site Facilities

Establish extent of available storage, scaffolding and similar site facilities prior to tendering and make full provision for costs in this connection within tender price. Arrange access to areas in which work has to be carried out with site managers in advance.

1.3.7 Testing

Full pre-testing and commissioning of all the physical and software parts of the installation followed by load and functional testing witnessed by the Consultant and Client's representatives.

1.3.8 Responsibility for Dimensions

The SEC shall take their own dimensions on site for all fabrications, equipment, cabling and materials and shall be entirely responsible for their accuracy. They shall not commence manufacture of any item of equipment until they have satisfied themselves that the equipment as designed will fit into, can work satisfactorily in, and can be maintained in the space available. All critical dimensions, particularly those associated with operations and clearances, shall be shown on working drawings.

1.3.9 Drawings

Examine the relevant drawings as listed in the Employer's Requirements (Specific), which show the principles of the design envisaged. These drawings should not inhibit further thought or the development of other approaches provided they offer all the required functions and can be fitted into the spaces shown. The SEC is responsible for reviewing and taking into account information on **all other drawings** relating to the building, its structure and services and this installation.

1.3.10 Additional Work Drawings

Prepare drawings of ALL associated work to be undertaken by other trades to ensure this is carried out satisfactorily. This shall include showing and making allowance for all items supplied and fitted by others, for example: flooring, floor traps, seat mountings, air grilles and Work Light fittings. Prepare Builders' Work Drawings for the whole installations as appropriate.

1.3.11 Guarantee of Component Supply

The SEC shall undertake to supply components which are necessary for normal operational replacement for a period of at least ten years after handover. After this period full manufacturing drawings of necessary replacement components shall be made available to the Client at cost if so requested.

1.3.12 Additional Structure

Provide any additional fixings or fixed or moving steelwork necessary over that indicated on the Engineer's drawings.

1.3.13 Finishes

- 5 Undertake full preparation, apply protective coatings and finish painting of all the structural elements of the installation. Identify fixed and moving parts by agreed colours. Provide high-quality finishes on all other items and components.

1.3.14 Electrical Works

- 10 Carry out complete electrical design from the point of supply, define distribution requirements and establish circuit capacities, selection and specification of cable types (including any flexible and hanging cables), route
15 specification, location of physical termination points and preparation of drawings of cubicles and panels.

- Provide, as specified, power switchgear, all cable tray, bus-bar, power and control wiring, variable speed electrical drives, electrical distribution and similar equipment and
20 items necessary for the full operations of all the equipment forming the contract.

- All wiring to equipment or to items identified on the drawings shall also be supplied and connected by the SEC. The SEC shall include for this electrical work in the tender
25 price and shall carry this out in accordance with the overall project programme.

- Carry out testing, core identification and sorting and installing cables tidily into cubicles and termination points. Check and correct any faults or incorrect cables or routes.
30 Make all power and control circuit connections. Prepare for power-up and checking of voltage and phase sequence. Undertake full testing and commissioning.

1.3.15 Electrical Supplies

- The SEC shall confirm the supply voltage and frequency of
35 the building electrical supplies and design the equipment in accordance with written information obtained from the electrical consultant or Supply Company. The location and anticipated rating of distribution boards for the equipment installations are shown on the project drawings or in the
40 individual specifications. Equipment shall be protected from unexpected mains failure and mains-borne interference.

1.3.16 Delivery & Handling

- The SEC shall be responsible for the satisfactory packing
45 and protection of all mechanical, electrical, electronic, motor drive, computer and similar components of their system for delivery to, movement around and storage on the site. Full allowance shall be made for the anticipated condition of the site and for the work of other trades in the
50 area. No item shall be unpacked until conditions are such that no damage will occur to the equipment. Covers or temporary enclosures shall be provided while the equipment is not actually being worked on. Any items suffering damage during transit or on site due to
55 unsatisfactory packing or protection shall be replaced by the SEC without charge.

1.3.17 Protection During Installation

- The SEC is responsible for protecting all mechanical,
60 electrical and other equipment forming part of this contract from environmental and physical damage at all times during installation and commissioning. This includes exposure to adverse weather while hoist, control and drive equipment is being craned onto site when parts of the building will be open to the external environment. The SEC

- 65 shall make himself aware of all such risks and take all precautions to ensure no equipment is damaged and, in such an event, shall repair any such damage at no extra cost.

1.3.18 Maintenance Equipment

- 70 Where non-standard test equipment, accessories, connectors, fittings or tools are necessary for the adjustment, operation or maintenance of the installation, two sets of such items shall be supplied as part of the contract, unless another number of items is specified.
75 Complement shall include extender cards, test leads, alignment equipment, adjustment tools etc., and is especially applicable where long-reach tools and similar mechanical non-standard devices are required.

1.4 Interfaces with Other Trades

1.4.1 Electrical Power

- 80 Design the electrical switchgear to accept a single large-current power supply cable, cables or bus-bar supply as agreed with the Engineers. Procure and install suitable switchgear and isolator / distribution. Take responsibility for
85 the sub-circuits and all equipment supplied from this distribution switchgear, including the supplies for sub-circuits and equipment being installed by others. Confirm that the construction, details, functioning and fault levels of this equipment are as required for such equipment on this
90 project and in compliance with the Project Electrical Specification. Assistance may be sought from the Engineers.

1.4.2 Structural

- Obtain formal written approval from the Project Engineers
95 (Structural) for all loads passed to the structure and for the way in which all attachments (whether load bearing or not) are made to the structure.

1.4.3 Service Routes

- Plan routes for the power and control wiring within the fly
100 tower and around the stage and auditorium. Submit drawings of these to the Consultant for coordination with other services. The use of trays provided for any other systems (lighting, sound, communications, etc.) is strictly forbidden.

1.4.4 Environmental

- 105 Provide information regarding the long-term quiescent heat dissipation from machinery and control system equipment to the Engineers on request. Such information to include
110 dissipation from the equipment when operating at maximum duty cycle and the maximum ambient temperature in which any part of the equipment installation may operate.

1.4.5 Other Contractors

- 115 Unless specifically stated or agreed in writing, all work in connection with the Contract is to be carried out either directly by the SEC or by one or more approved sub-contractors for whom, and for whose work, the SEC remains entirely responsible.

1.5 Design Principles

1.5.1 Usage

- 120 The equipment forming part of the Contract shall be in use every day and shall be powered up continuously except during infrequent maintenance periods. Generally, planned maintenance shall be able to be carried out in less than two
125 hours. Most maintenance work shall be able to be carried out by replacement of cards, units or modules.

During maintenance or repair it is important that only parts of the installation are out of service at a time and that the remainder can provide movement of operational axes to pre-recorded and new positions as appropriate. The SEC shall propose the levels of isolation for maintenance which are practical with their system.

1.5.2 Standardisation

On all equipment forming part of a given system or installation, all like components shall be mechanically and electrically interchangeable. Standardised components of minimum variety shall be used in the equipment design. All control panels and handheld controllers must use the same ranges of components and be consistent in design and operation.

1.5.3 Design Life Span

Design the mechanical equipment for a life in service of twenty-five years without major mechanical overhaul, based on the specified duty cycle being executed twice every 24 hours on average. Electrical drive and basic control systems shall achieve a reliable operational life of at least twenty years and related computer systems shall achieve a reliable operational life of at least fifteen years.

1.5.4 Design for Maintenance

All equipment shall be designed to require minimum routine maintenance, which shall be able to be carried out in an easy and straightforward manner by the User's staff. Electronic, computer and other control systems shall include hardware test and self-diagnostic systems so as to simplify fault-finding and maintenance. Any component shall be replaceable without the removal of other functioning components unless these are mounted on or carrying the faulty part. All parts shall be replaceable without strain or damage to other parts.

1.5.5 Mechanical Maintenance

Maintenance shall, as far as possible, be designed to be carried out rapidly and without disruption to rehearsals or performances. This shall require simple access without steps, ladders or other equipment. All necessary electrical and mechanical parts shall be readily accessible for inspection, servicing and maintenance with minimum dismantling of the equipment. Components such as gearbox filling and draining plugs shall be easily accessible so that oil inspection, replacement and topping up can be done without dismantling any parts of the installation. All wire ropes and chains shall be able to be inspected over their full length. Limit boxes and other electrical equipment shall be positioned so that it can be inspected, maintained and reset easily and safely.

1.5.6 Environmental Conditions

All equipment shall operate satisfactorily in an ambient temperature of between 10-35°C (50-95°F). The equipment shall withstand a wider temperature cycle of 0-40°C (32-104°F) when not in operation. The equipment shall operate satisfactorily in a relative humidity of between 1% and 90%. When not in operation the equipment shall withstand a relative humidity of 5% to 100% without damage.

1.5.7 Derating

The design of mechanical and electrical systems shall be such that all the components and assemblies employed within them work at less than their maximum ratings. The SEC shall identify any electrical or electronic components that are required to perform above 70% of their nominal rating. Special provision shall be made to accommodate the powering up of electronic equipment which has a high

in-rush current. All equipment and components shall be selected for long operating life and reliability.

1.5.8 Captive Parts

Any part, fitting, column, leg, cover, shroud or fixing which has to be taken off and replaced frequently in the course of erecting, dismantling, moving or operating the equipment or any part thereof shall be made captive to the appropriate part of the installation in some approved way. Such parts shall be minimised and alternative arrangements using hinged or captive parts used wherever possible. Fixing down or clamping bolts and all similar shall be captive. A method of restraint for loose parts shall be an appropriate diameter of flexible wire rope properly made off to both parts. Where parts have to rotate or be withdrawn to be removed or fitted, the restraint and its fixings shall be suitable.

1.6 Proscribed Materials

The following, and any other substances or materials not in accordance with applicable and current Standards or Codes of Practice of the British Standards Institution or which are generally considered within the construction industry to be deleterious, shall not be used in the design or implementation of the works. If in doubt, check against list of proscribed materials available from the Architect.

- High Alumina Cement or Concrete
- Woodwool Slabs in permanent formwork or in structural elements
- Concrete or mortar additives containing calcium chloride
- Aggregates for use in reinforced concrete which do not comply with British Standard Specification 882:1992 and aggregates for use in concrete which do not comply with the provisions of British Standard 8110:1985
- Calcium silicate bricks or tiles
- Concrete that may be susceptible to alkali/silica reaction
- Any product or materials containing urea formaldehyde foam or materials which may release formaldehyde in quantities which may be hazardous with reference to the limits set from time to time by the Health & Safety Executive Guidance Notes EH40 / 91 "Formaldehyde Occupational Exposure Limits" or any other limits or criteria set from time to time by the Health & Safety Executive
- Asbestos or asbestos containing products of whatever nature
- Lead or any materials containing lead which may be ingested, inhaled or absorbed except where copper alloy fittings containing lead are specifically required in drinking water pipework by any relevant statutory requirements
- Polyurethane foam
- Materials which are generally composed of mineral fibres, either man-made or naturally occurring, which have a diameter of 3 microns or less and a length of 200 microns or less or which contain any fibres not sealed or otherwise stabilised to ensure that fibre migration is prevented
- Bitumen coated polythene save where the use of bitumen coated polythene is specifically permitted for tanking and damp-proof membranes
- PTFE fabrics, except where the PTFE is used as a jointing tape in plumbing applications and on specialist applications such as valve seats, bearing material or sealing rings in pre-manufactured items of plant and equipment
- Galvanised wall ties

1.6.1 Rigging Spanner

In order to limit the types of tools necessary for normal rigging and fitting up tasks, the standard size of bolted fitting shall be either M10 or M12. These shall be the bolt sizes to be used wherever the Project Rigging Spanner is referred to.

1.7 Design & Selection Criteria

1.7.1 Quality of Materials & Workmanship

All materials used in the fabrication and installation of the equipment shall be new. The whole of the materials and workmanship shall be of first grade quality. In no case will materials of lesser design or workmanship than those specified be acceptable. All fabrication, machining, welding, assembly, joinery, wiring, programming, testing, textile making and other work shall be undertaken only by fully trained and experienced tradesmen or professionals.

1.7.2 Component Reliability

The selection of any components for the mechanics, electronics, computing elements and all other elements of the installation shall take account of the long-term reliability and longevity of each item.

If required, provide a detailed failure risk analysis identifying all critical components and their mean time between failures (MTBF) and mean time to repair (MTTR).

This shall cover all components, including those that are likely to be powered and dissipating 24 hours a day, such as power supply units, video displays and cooling fans. All items that are essential to the operation of the system shall have an MTBF of at least five years and an MTTR of **fifteen minutes**, based on a spare being available in the theatre.

1.7.3 Reference Types

Where a Reference Type or Reference Manufacturer is specified, this shall define the type and quality of equipment and installation required. Such a reference shall not exclude the submission, for specific reasons, of equal and approved equipment which will perform as specified, but the Reference Type or Reference Manufacturer may still be used by the Consultant as the standard for the evaluation of the quality of the installation.

1.7.4 Demonstration Systems

Any demonstration systems shall be running in a theatre or similar venue with a full production model of the proposed control system. Multi-axis systems shall consist of a fully operational set-up of at least thirty axes. The satisfactory control of axes and similar operational control functions to those described shall be able to be demonstrated by any tenderer immediately upon submitting a bid for the works.

1.7.5 Quality of Operation

All moving equipment, unless specifically excluded, shall operate with any load between maximum and minimum and at any speed within its specified range, smoothly and without jerks, inconsistencies, excessive noise or overruns. The quality of design and selection of equipment and materials shall be of the highest standard and equipment which does not perform fully for any reason will incur penalties under the contract.

1.7.6 Minimum Site Time

Equipment shall be designed for easy prefabrication and speedy and effective site assembly and installation. All motorised, electrical and control equipment shall be pre-tested in the factory before delivery to site. Where

practicable, control and other connections shall be by locking or latching plug and socket. Every reasonable step shall be taken to minimise site installation, testing and commissioning time.

1.8 Standards

1.8.1 General

All equipment and components forming part of the installation shall comply with EN 17206 where applicable and all relevant European Standards, Codes of Practice and other Regulations (herein referred to as Standards) except where a Standard is designated as not applying to stage engineering, theatre machinery or rigging installations. All equipment shall comply with currently accepted International Standards.

Where such Standards are in conflict with this Technical Specification or the Individual Specifications, the matter in conflict shall be raised by the SEC for clarification. Where any doubt exists as to the application of a Standard to a particular item or part of the installation, the matter shall be raised for clarification.

List the references and names of all the main Standards to which the equipment in this contract will be designed, constructed and installed with the return of any tender submission.

1.8.2 UK Machinery Safety Regulations

Comply with the Supply of Machinery (Safety) Regulations. If necessary, seek the necessary specialist advice to ensure compliance. Include copies of UKCA Certificates of Incorporation for all safety-related and other significant components in the Operations & Maintenance Manuals. Submit a list of the components requiring UKCA Certificates of Incorporation to the Consultant for review.

1.8.3 UKCA Marked Components

Irrespective of whether the installation is to be UKCA certified under the Supply of Machinery (Safety) Regulations, all new components used in the contract shall be UKCA marked. Copies of UKCA Certificates of Incorporation shall be provided for all safety-related components and a selection of other key components to be agreed.

1.8.4 Health & Safety

Comply with the requirements of the relevant Health & Safety Authorities. Assistance can be provided with such contacts if needed.

1.8.5 Building Regulations

Comply with all applicable Building Codes and Regulations.

1.8.6 O&M Manuals

Unless otherwise directed, prepare all technical manuals in accordance with EN 21600 and operating instructions in accordance with EN 20607 .

1.9 Labels, Signs & Notices

1.9.1 General

Equipment forming part of the installation shall be marked indelibly with tidy, permanent, adequately-sized labels giving essential information, basic operating instructions and sufficient information to permit correlation with manuals, drawings and spares lists. All labels containing text information rather than just reference codes shall be in the local language and, where specified, also in English.

1.9.2 Equipment Labelling

All equipment enclosures shall be clearly labelled externally as to function. All controls and indicators shall be clearly labelled for ease of operation. The colours, size and typeface of all labels shall be selected to ensure high legibility in dim lighting.

1.9.3 Internal Labelling

All labelling of components within equipment cabinets and racks shall use proprietary systems suitable for permanent use. Temporary adhesive labels or marker pen identification will not be acceptable.

1.10 Interference

1.10.1 Suppression

All electrical and radio frequency interference from any equipment forming part of the specified installations shall be suppressed to an acceptable level and in compliance with the Electromagnetic Compatibility Regulations (EN 61000 and 89/336/EEC) and other relevant Standards. Equipment shall be designed in accordance with current European Standards.

EMC testing and any remedial work that may be required shall be at no extra cost to the contract.

1.10.2 Harmonics

Under no conditions shall the installed equipment cause harmonics in the electrical supply in excess of those acceptable to the electricity supply authority. If required by the Engineers or Consultant, provide all necessary data on harmonic currents and if necessary install harmonic filters.

1.10.3 Specific Protection

Interference caused by switching, commutation, pulse generation or thyristor circuits which could affect the Sound, Video, Communication, radio or telephone systems or any other control equipment in or adjacent to the building shall be eliminated. The external electrical and magnetic fields of all equipment shall be kept to a minimum and shall be at a level that will not cause interaction with microphones, magnetic device replay heads, audio or radio-frequency loops, computers, VHF or UHF transceivers, radio microphones or any other apparatus likely to be used in the vicinity.

1.10.4 Equipment Protection

The installed equipment shall be designed so as to be immune from levels of electromagnetic radiation permitted under the specified Standards. All computer, control, audio, video and similar equipment shall be installed in screened enclosures and fitted with effective line conditioners and anti-surge protection on the incoming power lines.

1.10.5 Technical Earth

Where an isolated low-impedance technical earth is provided, this may be used for control equipment subject to other sensitive systems not being affected.

1.11 Personnel Safety

1.11.1 General

(a) Principle

All the equipment and installations shall conform to applicable safety code requirements and with theatre industry standards for operation and working practices. All systems, equipment arrangements and operating procedures shall be in accordance with local Health & Safety requirements and/or legislation and shall allow the users to set-up, use, operate, maintain and de-commission

the equipment and installations in a safe working environment.

(b) Working Environment

Stage machinery will be used by trained personnel during fit-ups, technical and general rehearsals, and performances, to move loads around and above the stage where performers, technical personnel and others may be positioned or working. The safety of such personnel and others working in the theatre shall be ensured by the thorough and quality-assured design, engineering, installation and testing of the driven equipment and control system as determined and implemented by the SEC.

(c) Design for Safety

All installed equipment and systems shall be inherently safe. Design out any hazards that can be so eliminated; protect personnel from any remaining hazards to the extent that is practicable. Provide clear warning signs and alarms, ensure that only authorised and trained personnel are allowed to operate the equipment and operate strict exclusion regimes as part of the operational philosophy. All mechanical, electrical and control components and systems shall be designed or selected to be failsafe.

(d) Motion Warning

All transmission shafts shall be painted or marked in such a way that their presence is obvious and that their rotation is indicated by spiral stripes or similar.

(e) Manual Effort

Design shall concentrate on ease of use, particularly in terms of access, operational facilities and the weights of items which have to be moved manually. Equipment that has to be moved frequently shall be of minimum weight and designed to minimise risk of injury. Handles for lifting, pushing and pulling shall be provided in accordance with the specified Standards. Procedures for setting up and repeating regular operations shall be as simple as possible. Actions and effort necessary to achieve regular repeating operations shall be minimised. This shall also apply to items of equipment which need to be removed for maintenance and inspection.

(f) Weight Marking

Items which have to be lifted and moved manually shall be marked with their weight in kilograms, the approximate centre of gravity and an indication of the number of persons who should carry out the lifting or moving process.

(g) Equipment Starting

No moving, rotating, elevating or reciprocating equipment shall be able to start moving under any circumstances without a positive intentional action by an operator. This shall apply to equipment in any state and following any sequence of events. All equipment shall be provided with a local isolator incorporating a method of locking in the OFF position. Such an isolator shall carry a label clearly identifying the equipment it controls.

(h) Remotely-Controlled Equipment

All equipment which can be started from a remote position shall be clearly labelled to this effect and provided with a local isolator incorporating a method of locking in the OFF position.

1.11.2 Guarding

(a) Fixed Machinery Guarding

All parts which can be reached from normal or maintenance access positions and which rotate or move when the equipment is in motion shall be guarded to

prevent danger to personnel. This shall include equipment in Elevator pits and all other areas where transmission equipment, rotating couplings, drive belts, screw-jack or equipment is installed. These items shall all be protected with robust sheet metal panels, small-opening wire-mesh grilles or similar guards that can be easily removed for inspection and maintenance. Fixed guards shall require the use of a tool to remove them and shall employ the minimum number of fixings.

(b) Access Doors & Guards

Doors or moveable guards that permit access to danger zones surrounding machinery (e.g.: doors to Elevator pits, cages around winches and, in some cases, access doors to grids) shall be electrically interlocked to prevent the motion of any machinery within the spaces they permit access to. If required, the access doors or guards shall be electrically locked while any related machinery is in motion to physically prevent entry to the danger zone.

The selection of interlock switches on doors or moveable guards and the design of the associated circuitry shall be the same as for safety devices (see [ER \(T\) 3.4.9 Safety Devices](#)).

(c) Other Guards

Counterweights on Safety Curtains, Dividing Doors and similar shall be guarded to at least 2.5m above the adjacent floor level. Manually operated counterweights shall be guarded to a similar height wherever accessible except at operational levels. All maintenance openings in walk- or access-ways shall be fitted with either removable panels which hinge to form guards or other methods of warning personnel of the temporary opening. Such hinged openings shall incorporate simple mechanical interlocks.

1.12 Safety Factor (FoS)

1.12.1 Definitions

(a) WLL Working Load Limit

The maximum load the device is designed to lift. This load measured under steady state (i.e.: static) conditions.

(b) MDSL Maximum Dynamic Service Load

The load the device will see when operating under "normal" conditions (static plus the acceleration / deceleration load).

(c) MC0 Maximum Class 0 Load

The likely (calculated or tested) load the device will see under worst-case emergency conditions (normally, fully-loaded at max lowering speed and a total power failure).

1.12.2 General Mechanical Components

All devices shall demonstrate adequate FoS in ALL the above load cases. These FoS numbers shall be proposed by SEC and agreed with the Client on mutual consideration of the risk assessment but as a minimum shall be:

- WLL **4:1**
- MDSL **2:1**
- MC0 **1.5:1**

In all cases a risk assessment must take into account the full load path – including where the brakes are in this load path (as this will affect the required FoS on gearbox). Materials should be assessed for fatigue and this factored into the agreed FoS.

1.12.3 Wire Ropes

Wire ropes used for hoisting or suspension shall have a guaranteed breaking strain of not less than **TEN** times the maximum operating tension. Maximum operating tension shall include the tension caused in the rope by the maximum Safe Working Load plus the inherent loads on the wire and an allowance for any increase in tension due to diverter pulleys in the system which might fail to rotate when the equipment is in operation.

Additionally, it must be demonstrated that if all the diverter sheaves in the rope path fail to turn, with the rope at maximum operating tension, a residual FoS of at least **FOUR** remains.

1.12.4 Winding Drums

The drum must be considered as part of the load path and comply with the WLL / MDSL / MC0 FoS requirements above.

1.12.5 Proof Load Tests

(a) Test Loads

Static proof loads shall be 125% of Safe Working Load and dynamic proof loads shall be 110% of Safe Working Load, except where specifically agreed otherwise.

(b) Test Weights

Provide sufficient wheeled weight trolleys so as to be able to load fully each suspension wire or Elevator platform. Ensure trolleys have a simple but secure method of attachment suitable for dynamic stop tests. The trolleys shall be able to accept additional weights so that proof load may be applied and so that full load may be imposed on one less than the number of suspensions as required. The test weights and trolleys remain the property of the SEC and shall be removed from the site on the satisfactory completion of all testing.

1.13 Proprietary Equipment

1.13.1 Standard Product

As much of the installations as possible shall consist of manufacturers' standard products. In cases where a standard product complying with the individual specifications is not available, the equipment shall preferably be a standard product with modifications made by the original manufacturer, or by the manufacturer's recognised distributor, and guaranteed by the manufacturer or distributor.

1.13.2 Technical Support

Every standard product and modified product shall be backed by a local manufacturer or local recognised distributor who handles the particular product in the locality of the project and who undertakes to provide spares and service. Products manufactured by the SEC and not distributed or offered for general sale will not be accepted in cases where a generally distributed standard product or approved factory-modified product is available which complies with the specification.

1.13.3 Applications

As incorporated in the installation, each item of proprietary equipment shall be operated according to the manufacturer's recommendations and within the limits of the manufacturer's published specification.

1.14 Purpose-Made Equipment

1.14.1 General

5 Specific items of equipment may need to be purpose-made for the installation. All relevant design and manufacturing drawings, with full schedules and data sheets for all the significant components, shall be submitted to the Consultant for all equipment that is to be purpose-made.

1.14.2 Samples

10 Samples of all components intended for use in equipment which is purpose-made for the contract shall be submitted to the Consultant for approval.

1.14.3 Finishes

15 All purpose-made equipment shall be finished to a high standard. All finishes shall be stove-enamelled, unless agreed otherwise. Finishes on all panels and cabinet fascias shall be non-reflective.

2 Mechanical

2.1 General

2.1.1 Auxiliary Equipment

5 If hydraulics or pneumatics are used for auxiliary systems such as brakes, decelerating devices and dampers then these shall be self-contained, powered electrically and not supplied by external pipes or feeds.

2.1.2 Drip Trays

10 Fit suitable drip trays under any hydraulic equipment, however minor the system, as well as under all gearboxes.

2.2 Hoists & Winches

2.2.1 Design

(a) Performance

15 Hoists shall be suitable for full operation at any speeds and with loads up to the maximum specified, and where required, in synchronisation in motion and position servo-control giving accurate repeated stopping at recorded dead ends. The hoists shall directly lift the specified loads, be quiet, smooth and free of any judder, shaking, rattles or similar mechanical degradation under all conditions of load and speed.

(b) Hoist Unit

25 Each hoist unit shall incorporate, inter alia, the prime mover, a main brake, a secondary brake, continuously-grooved winding drum(s), sensors (see [ER \(T\) 3.4](#) Sensors) and other feedback components as required. The use of a gearbox and the inclusion of detection and control components on the hoist shall depend on the system provided. All elements of the hoist, other than perhaps the winding drum and its bearings, shall be easy to replace. Each element shall have the minimum of other components mounted on it. It shall be possible to lock mechanically the winding drum to the frame to service or repair the hoist with full payload suspended. This shall be an external device applied by maintenance engineers who will be responsible for disconnecting the hoist under these conditions.

(c) Emergency Stopping

40 Design the hoist units such that a maximum load moving at maximum speed can be stopped safely by either of the brakes operating alone in the established Emergency Stop travel distance.

2.2.2 Hoist Safety

(a) Mechanical

45 Design the complete mechanical installation to guarantee that under maximum dynamic stress all the wire rope attachments, pulleys, pulley mountings and similar remain complete and fixed to the structure and that no parts become loose or unattached. Where the payload is removable, the users remain responsible for the strength of the scenery or other suspended equipment and its attachment to the suspension beam, truss or load hook or other driven item.

2.2.3 General

(a) Layout

55 Set out the hoists logically to achieve the specified flying centres and position them so that all parts may be reached easily and safely for setting up and maintenance. Introduce the minimum number of wire rope diversions into the system.

(b) Prime Movers

65 The prime movers for hoists in a Powered Flying installation shall be electrical. These prime movers shall be capable of a wide speed range and shall produce full load torque at standstill.

(c) Wire Rope Rigging

70 When specified or required for operational reasons, hoists or winches may be fitted with manually- or electrically-operated clutches so as to release the winding drum to allow the wire rope to be run out or taken in, for example when setting up a movable diverter pulley system on the Grid. Such winches shall be fitted with a failsafe method of detecting end-of-travel appropriate to the rigging then set up so as to stop the unit without damage to the winch, structure or load being moved. Such equipment shall incorporate an interlock to ensure power drive is not possible during resetting.

(d) Hand Winches

80 All hand winches shall be a tested, proprietary type incorporating a reliable self-locking device. Pressure on the winding handle or operation of a release lever shall be necessary to unlock the winch and allow lowering motion. Hand winches shall not be used for loads in excess of those able to be handled safely by one person or in locations in which it is difficult to operate them. Generally, hand-winches shall not have a payload of more than 250 kg.

2.2.4 Multi-Line Hoists

(a) Suspension Points

90 Coordinate the layout of the diverter pulleys and wire rope drops for suspending the loads to ensure that these are at the specified centres and that the wire ropes for each bar or lattice beam drop accurately in line and at right angles to the stage centre-line.

(b) Head Pulleys

95 It is preferred that the distance between the point of contact with the drum and the head pulleys shall be at least that necessary to comply with the required maximum fleet angle so that no fleet angle correction mechanism shall be necessary. Where necessary, approved mechanical methods of maintaining fleet angle will be acceptable. The prime mover may be mounted in line with the winding drum or at right angles to it depending on the space limitations and the requirement for, and type and format of, any gearbox.

2.2.5 Maintenance

(a) Space Limitations

110 The equipment and installations proposed must be capable of being installed and easily maintained at the close centres and in the spaces indicated in the drawings. Ensure all parts of the hoist unit are accessible, or can be removed, for maintenance without removing the hoist itself from its position.

(b) On-Load Maintenance

115 Ensure that maintenance or repair to any part of the unit, other than to the wire ropes, diverter pulleys, suspension bar or winding drum, but including the brakes, can be carried out, if necessary, without removing any suspended load. Motors shall be able to be rapidly replaced in the event of a failure.

(c) Sub-Assembly Weight

All mechanical equipment that might need to be removed from site for repair or maintenance at any time in the future must be capable of disassembly into parts weighing less than 50kg. These sub-assemblies shall fit into the fly tower lift where one is provided.

2.2.6 Brakes

(a) Brake Action

Each brake, operating through the selected gearbox, shall be capable of decelerating and stopping a full load from maximum operating speed within an acceptable travel distance. The SEC shall propose this distance for approval. In normal use, brakes shall only hold the load when stationary after the load has been decelerated and brought to a stop by the control system.

(b) Brake Interlock

On all hoisting equipment the brake and motor power shall be interlocked and monitored so that the brake cannot be released unless the motor power is present and capable of holding or otherwise controlling the load.

(c) Emergency Holding Device

All such equipment shall be designed so that, in the event of the primary brake releasing without suitable control being exerted over the load, the load is held stationary or lowers only at a slow controlled speed. In the event of the primary brake failing to operate when power is removed from the motor when lowering, the load shall decelerate to standstill or shall lower only at a slow controlled speed.

Where necessary, additional equipment shall be fitted to the hoist to comply with this requirement. This may require a secondary brake, sprag brake or friction device.

(d) Independent Test

It shall be possible to check the effectiveness of each braking device separately.

2.2.7 Winding Drums

(a) Grooved Winding Drums

Where wire ropes are wound on drums, a grooved drum shall be used in which the wire rope is wound in a single layer. The drum groove shall have a form and pitch to suit the size of wire rope used in accordance with the wire rope manufacturer's recommendations. For each wire rope wound on a drum, there shall be a minimum of two dead turns and a clearance of at least two empty grooves to the end of the drum or to the start of the next winding. Compliance with this requirement shall be checked carefully at both extremes of travel during installation.

(b) Form of Grooved Winding Drums

Grooved winding drums shall be machined from high-quality castings or from a welded construction using seamless steel tubing and end plates. The bore shall be machined such that the concentricity of the groove pitch diameter in relation to the rotational axis is within $\pm 0.5\text{mm}$. The groove form shall be in accordance with applicable Standards.

(c) Wire Rope Retention

All grooved winding drums shall be fitted with a method of preventing the wire rope coming out of, or crossing, a groove either when under load or slack if such a condition can occur. Where adjustable retaining pulleys or rollers covered with polyurethane or similar are proposed, these shall be of a diameter such that they do not rotate at excessive speed or cause noise.

(d) Crossed Groove Detection

A wire rope crossing a groove shall be detected immediately and the mechanism stopped safely. This condition shall be designated a FAULT and shall require attention by maintenance personnel. The mechanism shall not be able to be run under main power until the fault is cleared.

(e) Use of Pile Winding Drums

Pile winding drums may only be employed in situations where a grooved winding drum is not practicable. The design and fabrication of such drums shall take full account of the lateral forces exerted on the drum side plates. Only wire ropes approved by the manufacturer for such service shall be employed.

(f) Form of Pile Winding Drums

The minimum diameter of pile winding drums shall be not less than 30 times the diameter of the wire rope and two full dead turns shall remain on the drum at all times. The radius of the side plates and dividers shall be greater by at least twice the wire rope diameter than the maximum radius of the turns of wire rope to be wound on the drum. The side plates and dividers shall be free of all burrs and sharp edges and the drum aligned so that the wire rope passes clear of the side plates and dividers.

(g) Wire Rope Termination

Each wire rope that terminates on a winding drum shall be provided with an easily-accessible positive fixing point. Passages from the groove to a remote fixing point shall be formed so as not to distort or damage the wire rope or affect the operation of the crossed groove detector and shall be free of burrs and sharp edges.

(h) Shaft Mountings

Winding drums shall be fitted with integral hubs which will accept suitably-sized continuous solid steel shafts passing through both hubs and both mounting bearings. Keys shall engage the full dimension of the hubs and bearings. The drum hubs shall be keyed to the shaft with keys and keyways suitably sized for the maximum torsional load exerted. The keys shall be locked or approved proprietary torque bushes employed.

2.2.8 Drill / Driver Hoists

(a) Self-Sustaining Gearbox

Due to the requirement for the hoist to be driven by a portable power drill it would be impractical to interlock any form of mechanical brake with the prime mover. Therefore, the hoist gearbox shall be fully self-sustaining.

(b) Gearbox Selection

Select a gearbox that is fully self-sustaining in the worst-case loading condition (top of travel). Allow for any degradation in the self-sustaining properties of the gearbox over the anticipated service life of the hoist.

(c) Speed Variability

Select a pile wind drum core diameter such that the hoist speed does not vary more than **33%** over the full travel distance.

(d) Overload Through Misuse

Through integrated design ensure the hoist cannot be inadvertently overloaded to the point of failure. The hoist design shall allow for operation by a person of above average strength using an oversize winding handle or power drill. Consider installing a torque limiting device in the input drive train.

(e) Drill Selection

To minimise the risk of excessive loads being lifted through the use of a high output torque drill, design the hoist to use a high output low speed drill, such as those designed for mixing plaster, rather than a conventional "battery drill".

(f) Drill Coupler

Ensure the drill is positively coupled to the winch but can be easily disconnected in an emergency. Design the coupling to maintain a positive connection for a minimum duty of **10,000** mating cycles.

(g) Special Labelling

Clearly and permanently label the approved drill "For use with winch sets ONLY" and each hoist with "Winch sets to be driven with an APPROVED drill".

(h) Safety Case

There is a history of this class of winch failing to self-sustain, particularly when dynamically loaded. The SEC shall provide a detailed Safety Case setting out the factors of safety for the winch and gearbox in both the static and dynamic cases.

3 Components

3.1 Acoustic Performance Requirements

3.1.1 General

5 (a) Acoustic Terms

The technical acoustic term used herein is: LAeq,T the "A-weighted" equivalent continuous sound level that is used to measure intermittent noise. This noise level, which is defined below for each item of equipment, shall be measured (with an "F" meter response) over the duration of the move at the worst-case location in the auditorium, mostly likely the front row of the stalls.

(b) Acoustical Responsibilities

The SEC is responsible for minimising both electrical and acoustic noise from the equipment forming part of the Contract. The noise limits given for the equipment apply at all times and to electrical drive equipment, brakes, locks, clutches, cooling fans and similar peripheral items. Design noise out of the installations such that minimum adjustments are made in late corrective measures. All stage machinery equipment and installations shall be designed in accordance with the acoustical performance requirements set out in the Employer's Requirements (Specific) which, where applicable, take precedence over these clauses.

25 (c) Noise Generally

All equipment shall operate quietly and all mechanical rattles, squeaks, guide noise, gearbox coupling and other extraneous noise chatter shall be eliminated. All elements of the construction shall be sufficiently rigid to avoid excessive generation of noise by panel excitation, as a result of movement or impacts on the surface or from other causes.

The SEC shall comply with maximum noise levels specified in the Individual Specifications. Wherever sound insulation is necessary, this shall be provided by the SEC who shall ensure that such sound insulation does not cause overheating of the equipment or other problems. Sound insulation shall not be used to eliminate noise caused by unsatisfactory engineering or poor component selection.

40 (d) Achievement & Tests

Further assistance in respect of this term and achieving the noise levels required may be sought from the Project Acoustics Consultant. The Acoustics Consultant will witness noise testing carried out by an independent organisation at the cost of the SEC in the event that there is any concern about the noise levels achieved.

(e) Vibration Control

All equipment shall operate without undue vibration. Sympathetic vibration of any parts due to manual or mechanised operation of any equipment under performance conditions shall be eliminated. All parts shall be fitted with vibration-proof fixings. All nuts and bolts shall be fitted with shake-proof washers, Nyloc nuts or similar. This shall apply to all machinery, portable items, suspended items and to any part of the installations which may vibrate, flex or move in use.

(f) Vibration Isolation

Motors, gearboxes, brakes, transmissions, switchgear, etc., and all associated services shall be isolated from the building structure via resilient mounts or other appropriate flexible connections as necessary to meet the noise limits. A good quality vibration isolation system should provide

95% isolation efficiency at typical drive rotational frequencies.

65 (g) Sound Reducing Slots

If required, install sound reducing enclosures around each of the openings through which wire ropes pass into the external motor rooms. Make the height of the slots at least **ten times** the minimum slot dimension and face the interior of the slots with 25% open area perforated metal with a maximum hole diameter of **3.5mm**. Back the perforate with **50mm** thick tissue-faced mineral wool of minimum density **48kg/m³**.

(h) Motors & Drives

75 Where possible, select motor control equipment so as to use low speed motors and high frequency control units and inverters (16kHz or above). Provide sound absorbent enclosures around the motors where necessary to reduce high frequency noise whilst ensuring maximum temperatures are not exceeded. Remove cooling fans attached to motor drive shafts where these are operating at low duty cycle and their removal would not cause degradation of performance or premature failure. Otherwise select all fans for low noise operation and attenuate all fans as necessary to meet the noise limit.

3.1.2 Noise Limits

(a) Base Noise Levels

The noise-creating elements of moving equipment which is remote from the stage area shall be enclosed and the resulting noise shall be baffled so as to reduce the sound pressure level to a maximum of **60dB(A)** at a distance of 1m from the unit. The noise level generated by any Control Cabinet or other ancillary equipment shall be **≤30dBLAeq** at 1m from the unit.

95 3.1.3 Performance Noise Levels

All equipment used during performances (including all rotating, moving or reciprocating parts, pneumatic exhausts, contact breakers, transformer and thyristor controls and similar) shall be designed and / or enclosed so as to not cause the noise level to exceed the criteria set out in the Employer's Requirements (Specific). Where no other criterion are given, the noise level shall not exceed the following criteria at any point in the defined areas, measured at between 1m and 2m above floor level:

In any part of the auditorium	NR20
In any part of the performance area	NR20
In control or translation rooms	NR25

105 3.2 General Mechanical

3.2.1 Structure & Steelwork

(a) Building Structure

110 The building structure, including any grid, galleries, head and loft steels and other major parts of the building indicated as being load bearing will all be constructed to carry the loadings indicated or implied by the project drawings and specifications. Any discrepancy in respect of loading and apparent structural strength identified or noticed by the SEC shall be reported immediately.

(b) Secondary Steelwork

All stage rigging and machinery steelwork supplied and installed by the SEC, including welding, drilling and all steel bolts, nuts and washers used in assembly and installation, shall be provided in accordance with the specified Standards. The steelwork may be of bolted or welded construction except where a specific construction is indicated on the drawings. The SEC's working drawings shall show clearly the detailed construction of the steelwork, the type and size of nuts and bolts and the size and types of welds. Site welding shall be minimised and only carried out where specifically approved.

(c) Design of Steelwork

All component members of any frame or structure shall be rigid enough to ensure unrestricted operation of all equipment under any load up to maximum and any specified or implied operating condition. Such frames and fixings to them shall withstand shock loads including those imposed by Emergency Stops.

(d) Lateral Loads

Ensure the steelwork supporting Multi-line and Point Hoists and all diverter and drop pulleys, rolling beams, and similar are efficient and well-planned, and arranged so that minimum lateral forces have to be taken out to the building structure. Details of any required constraints and of the final loads on the building structure shall be formally submitted to the Engineers for approval prior to fabrication.

(e) Progressive Collapse

Any stage rigging and machinery steelwork shall be designed to preclude the possibility of progressive collapse. All frames and structures shall be designed to minimise the effect, and likelihood, of welding failures. In the event of any such failure no stress in excess of the maximum permissible shall be imposed on any other member, but deflections in excess of those specified would be allowed until corrective action can be taken.

(f) Deflection

Generally, stage equipment shall be designed with maximum deflections less than those specified or implied in Standards relating to normal building structural components. Particular members will have to be designed for a lesser deflection in order to comply with the operational requirements and accurate alignment of the parts of the equipment. Comply with all detailed parameters given in the Employer's Requirements (Specific) which take precedence over these clauses.

(g) Lighting Rails

These shall be either 48mm \pm 2mm steel or aluminium tubes or standard DIN rail back-to-back channels as specified. Lighting rails shall be clear of other fittings and obstructions to allow the mounting of luminaires. Where lighting rails are to be adjustable, this shall be achieved using hinged or sliding devices which can be locked in position using the Project Rigging Spanner.

3.2.2 Fixings & Anchorages

(a) General

All fixings to steelwork, walls and structural ceilings shall be appropriate for the loads carried and shall be positioned so that the equipment is plumb and level. Fixings shall be designed so as to minimise eccentric loads on structural members. All anchorages and fixings shall be pre-planned, submitted for approval and shown on the shop drawings. All fixings and anchorages are the responsibility of the SEC.

(b) Safety Factor

All fixings carrying significant loads shall be adequately sized and designed generally for a minimum factor of safety of **SIX**.

(c) Suspension Points

Any general-purpose suspension points shall be proof tested with an agreed load. An approved label shall be permanently fixed adjacent to the suspension point stating the Safe Working Load, a unique identifying code and any usage restrictions such as the direction(s) in which a load may be safely applied.

(d) Preferred Form

All major loads, particularly those of stage engineering equipment, shall be taken back to steel members or to steel plates embedded into concrete walls or ceilings.

(e) Expansion Bolts

Appropriately-sized expansion bolt fixings may be used in shear in concrete walls. In no circumstances shall pre-cast concrete panels or in situ concrete be drilled without the prior specific approval of the Client's Structural Engineer. All expansion bolts shall be correctly fitted.

(f) Other Fixings

Where other constructions are used, equipment shall be mounted using appropriate and approved proprietary anchorages. Proprietary chemical fixings, which are in general use, may be acceptable. All fixings shall be secure and rigid. Inadequately fixed equipment will be rejected.

(g) Lightweight Fixings

All lightweight fixings to masonry or concrete walls and ceilings shall be made with greased sherardised steel woodscrews and shaped plastic plugs. Wood or fibrous plugs shall not be used. All fixings shall be fitted to the correct depth in the wall material and not in gaps between the masonry. In damp or exposed situations greased brass screws and soft metal non-deteriorating plugs shall be used. Approved proprietary fixings which are driven into specific types of wall by hammering or rotating are acceptable.

(h) Bolts & Screws

The diameter of bolts or screws used shall be the largest permitted by the diameter of the hole in the apparatus concerned and bolts and screws shall be to metric standard and of adequate length. When attaching any item of equipment all bolt or screw holes designed or provided for fixing therein shall be used and the attachment in each hole shall be secure. Bolts shall have at least three full turns of thread showing above the final nut or locknut.

3.2.3 Paint & Finishes

(a) Preparation

All parts shall have a smooth finish and have all burrs and sharp edges removed. Rough cuts and rough welds will not be accepted. All parts shall be degreased prior to painting. All ferrous surfaces shall have rust removed and shall be prepared with a rust preventative. Structural members shall be sandblasted and treated with a rust preventative prior to leaving the factory.

(b) Painting

All components which have to be painted shall have one coat each of primer and undercoat and shall be finished in accordance with the equipment specification. Any damage to the preparatory coats of paintwork must be made good

without delay and all rust patches cleaned back to bright metal and correctly painted.

(c) Omissions

5 Technical equipment items such as motors, gearboxes, brakes, transmission components, load and rating plates, serial numbers, connectors and similar items shall NOT be painted. Where instructions are given for components for use on stage to be painted, load, rating and serial number plates shall be left untouched.

10 (d) Site-Welding

All welds shall be cleaned down and correctly painted immediately they are finished. Tubes and similar components with interior surfaces which cannot be protected shall have their ends completely sealed to prevent rusting from the inside.

(e) Permanent Marking

20 All demountable parts shall be tidily and indelibly labelled to ensure correct reassembly. All factory identification marks shall be removed after installation and checking on site.

(f) Finishes

25 All fixed and moving steelwork in the lower part of a theatre stage area shall be finished MATT BLACK. In other areas it shall be as specified in the individual specification. The SEC shall seek confirmation and detail of all painting instructions before undertaking the work.

(g) Purpose-Made Equipment

30 All purpose-made equipment shall be finished to a high standard whatever the material or detail. All finishes shall be stove-enamelled, unless agreed otherwise. Finishes on all panels and cabinet fascias shall be non-reflective.

(h) Aluminium

35 Aluminium tubes and sections which are specified as being other than natural finish shall be powder-coated or treated by some similar approved method. Sections used in structural or equipment applications which may be seen in view shall be finished MATT BLACK.

3.2.4 Labels, Signs & Notices

(a) Serial Numbers

40 Mark every machine indelibly with a unique serial number, the format, sequence and method of such marking to be reviewed with the Consultant.

(b) Warning & Safety Notices

45 Mount suitable durable and approved notices advising of the safe procedures for operation of the equipment and for treatment for electric shock and similar in all equipment and operational areas. Typically, notices shall be fitted to equipment cabinets, each row of hoists, switchgear and at the access points to Machine Room, on the Grid and other work areas. Manufacture only when wording, size, colour and format proposed by SEC are approved by the Consultant.

(c) Informative Notices

55 Provide all equipment with suitable signs and labels indicating pressures, Safe Working Loads, voltages present, maximum simultaneous operations and other safety information. The weight of safety curtains, stage dividing doors, their counterweights and similar major loads shall be displayed on the item.

60 (d) Equipment Labelling

All equipment enclosures shall be clearly labelled externally as to function. All controls and indicators shall be clearly labelled for ease of operation. The colours, size and typeface of all labels shall be selected to ensure high legibility in dim lighting.

(e) Specific Signs

70 Each hoist and motor drive unit, isolator, control cabinet and similar shall be clearly labelled with its established number or reference. These labels shall enable the unit to be quickly identified from the nearest easy access location without difficulty. Minimum character size shall be 30mm high.

(f) Loading Information

75 Each section of the installation shall be fitted with clear signs designating the loading which may be imposed on equipment and suitable safety, operational and access limitation signs. These shall be in accordance with any current legislation. Minimum character size shall be 30mm high.

80 (g) Safety Notices

85 These shall define the Safe Working Load (SWL) which can be imposed on the equipment and shall give information on loading restrictions, operations and safety. Safety signs shall be fitted in agreed positions for all items of equipment unless otherwise agreed.

(h) Manufacture

90 All signs relating to the equipment installation, access, safety, load and design limits shall be purpose made by a sign company in a consistent style. Signs shall be designed to be visible in the anticipated normal lighting at a distance of 3m. Such signs shall be in accordance with the specified Standards and shall be produced by a silk-screening process on 3mm thick rigid plastic or a similar hard-wearing method.

95 (i) Approval

Proper drawings of all signs and notices shall be prepared for approval before manufacture. The location and fixing of all signs and notices shall be established on site and agreed before erection.

100 (j) External Labels

105 External numbering and similar labels on mechanical equipment shall be of engraved plastic construction revealing a contrasting colour character, using a material such as Traffolite or similar. Such labels shall be screwed in place with brass screws. Numbers on motors and similar large items shall be large proprietary labels fitted with a permanent adhesive.

(k) Internal Labelling

110 All labelling of components and units within equipment cabinets and racks shall use proprietary systems suitable for permanent use. Temporary adhesive labels or marker pen identification will not be acceptable.

3.3 Machinery

3.3.1 Gearboxes

115 (a) Types

120 Except for specific applications (such as in a safety curtain hoist requiring a reversible gear ratio) gear speed-reducers transmitting substantial torques shall generally be of the worm gear or cyclo-gear type. Other gearboxes of proven reliability may be acceptable in particular applications. The

efficiency of the gearbox and the changes in efficiency on starting shall be taken into account in the design of transmission systems.

(b) Rating

- 5 All geared drives shall be selected to transmit safely the required torque, power and impact. The service factor used shall take account of the type of drive, rating factor and any shock loads which may be applied through the gear.

(c) Design

- 10 Reducer gear cases shall be high-quality cast iron or steel, fully machined and fitted with an oil filler, drain and simple method of checking oil level. All gear and screw boxes shall be filled with suitable good-quality oil and checked and topped up if necessary on handover. All shafts extending
15 through gearbox and similar casings shall be provided with suitable oil seals to ensure no leakage. No fixing holes shall penetrate through the casings.

(d) Worm Gearing

- 20 Worm gearing shall consist of a precision-machined, centrifugally-cast phosphor bronze worm wheel on a machined cast iron shaft carried on suitable roller bearings. The worm shall be high carbon steel with ground profile and bearing surfaces and also carried on roller bearings.

(e) Drip Trays

- 25 All units shall be fitted with drip trays which extend under all points where oil or grease is used for whatever purpose. The drip tray shall cover all positions above which oil or grease is likely to be channelled and shall have capacity to hold all the oil stored in the unit. All the fixings for the tray
30 shall be arranged so as not to provide further leakage paths for oil. All drip trays shall have drain plugs provided in an accessible position.

3.3.2 Brakes

(a) Principles

- 35 All brakes shall be of the failsafe type, being applied by pressure of a spring when power is removed and held off (released) by the connection of an electrical supply. Brakes shall be supplied by an established manufacturer and shall be able to decelerate safely the maximum load in the
40 specified time and to hold the equipment static under the proof test load.

(b) Types

- 45 Brakes shall either be of the disc or calliper type. Brakes shall remain effective under all conditions and their performance shall not be degraded by vibration and wear. Brakes shall normally be rated higher than the drive motor torque, the application determining the over-sizing.

(c) Brake Operating Signal

- 50 In order to simplify control, minimise noise and increase security the brake operating signal shall be direct current. AC brakes are only acceptable in specifically-approved applications. Where AC brakes are permitted additional steps shall be taken to ensure they are released and applied
55 gently and without causing excessive noise.

(d) Brake Sequencing

- 60 Irrespective of the type of prime mover, design the control circuit to prevent the brakes from being released until the prime mover is sufficiently energised to support the load when the brake holding torque is removed. If a load signal is available, use this to derive a torque offset signal so that the correct torque for supporting the load is established before the brakes are released. Ensure there is no visible

“snatching” of the load in either direction when the brakes are released and motion begins.

65 (e) Brake Interlocks

- So far as is reasonably practicable, interlock all related power control devices such as motor starters, soft-starters, variable speed drives, hydraulic pumps and similar such that the brakes are immediately applied should any of these
70 devices fail or de-energise the prime mover for whatever reason. Protect against the loss of the prime mover power supply by energising the brakes from the same supply.

(f) Rating

- 75 Brakes can be intermittently rated, depending on the anticipated service. The brakes selected shall operate quietly and gently, shall be easy to maintain and set-up correctly and shall be of a type in which the brake shoes or disc are completely clear of rotating parts when the brake is powered.

80 (g) Position

- Brakes shall generally be fitted to the high-speed part of the mechanical system and gearboxes and other components shall be designed to withstand the deceleration forces imposed by the application of the brake. All brakes shall be
85 adequately keyed to shafts. Where vee-belts or timing belts are incorporated in a transmission, the brake shall be incorporated in the driven (output) side of the system and linked directly with solid shafts and / or gearing to the load being carried or moved.

90 (h) Manual Release

- All brakes shall be fitted with a manual release. Where non self-cancelling is appropriate, the manual release device shall be such that it indicates clearly on cursory examination that the brake is in a released state.

95 (i) Bedding-In

- All working brakes shall be bedded-in during factory tests such that the final setting to work on site can be achieved with minimum delay.

3.3.3 Bearings & Transmissions

100 (a) Bearings

- Bearings shall be tapered roller, precision ball or accurately-sized phosphor bronze (oil impregnated bush type), depending on the application. The appropriate bearing shall be selected for each task and installed and used strictly in
105 accordance with the manufacturer's recommendations. All bearings other than sealed-for-life types shall be greased packed and provided with a means of lubrication.

(b) Transmission Shafts

- 110 All shafts, keys and keyways shall be in accordance with specified Standards and shall be designed to transmit safely all applied loads, torques and their combinations with full and proper allowance for impact loadings. Keys shall engage fully with the appropriate component. Shafts shall be fitted at each end with suitable flexible couplings to accommodate possible misalignment and to reduce noise.
115 Transmission and link shafts shall be designed to limit twist to less than 0.3° per metre at maximum torque.

(c) Roller Chain

- 120 Removable chain links and fittings to connect roller chain to other items shall be of a proprietary manufacture and shall have a strength equal to or greater than that of the roller chain itself.

(d) Transmission Noise

Where necessary to comply with noise limitation requirements, transmission components shall be installed on suitable anti-vibration mountings. Advice as to the correct mounting type shall be sought from established manufacturers with experience of the particular problem.

3.4 Sensors

3.4.1 Limit & Dead Switches

(a) Acceptable Switch Types

Select all end-of-travel limits and intermediate dead switches to be in accordance with [ER \(T\) 1.8 Standards](#). The use of small case micro-switches below size V3 will not be accepted. The SEC must submit a sample of the type they wish to use for approval. Limits and deads shall be set up by the SEC but shall be able to be safely and easily adjusted by the User's staff after instruction.

(b) Mounting

Show limit switches and their mountings on the drawings and do not "site-fit" these items.

(c) Circuitry

All limit switches and similar contacts shall be closed wherever possible during normal motion of equipment. Latching circuits will not be acceptable unless there is no reasonable alternative.

(d) Accuracy

The switches must be able to be set with appropriate accuracy. The quality of the limit box and the drive thereto shall be equal to or surpass other parts of the installation. Play and backlash shall be minimised. All couplings, roller chain or toothed belt pulleys in the drive to the limit box shall use proper keyways or locked keys. The limit or dead shall be repeated within the specified tolerance from whichever direction approached and under any conditions of loading or speed.

(e) Intermediate Deads

Where appropriate, intermediate dead switches and slow-down switches may be included in the limit box. Where proximity switches, potentiometer, optical or magnetic encoder devices are proposed for these functions they shall be selected for reliability and to provide at least the accuracy called for in the equipment specification.

(f) Setting Threshold

Limit switches, particularly for intermediate deads, must be able to be set as close to each other as is appropriate in the application. For Elevator equipment this shall be within $\pm 50\text{mm}$ and for normal hoisting equipment within $\pm 10\text{mm}$. Closer deads of $\pm 2\text{mm}$ or better shall require encoders or resolvers and a position control system.

(g) Repeat Accuracy

Motorised hoists, winches and similar suspension equipment shall reposition to within $\pm 2\text{mm}$. Stage and forestage Elevators and other floor moving equipment shall reposition to within $\pm 1\text{mm}$. All limit switches or positional control systems shall be arranged to operate and to stop the equipment within the tolerance specified, from either direction and, on variable speed systems, at any speed setting.

(h) Direct Struck Limits

Direct struck limits shall be mounted so as to be reliably operated by, but not damaged by, motion of the equipment. Excess motion shall be accommodated within

the available overtravel of the switch selected or by arranging for passing action. Only substantial industrial-grade switches will normally be acceptable. Normal limit switches shall be self-resetting when the mechanism is run in reverse.

(i) Rotary Limit Switches

Rotary limit switches shall be directly and positively coupled to the hoist mechanism with a keyed shaft or similar. Grub screws locking collars to shafts are not acceptable.

(j) Screw-Driven Limits

Approved types include screw driven units consisting of a precision-machined lead screw with one or more bronze operating nuts restrained by a linear guide, with the ends of the screws undercut to allow the actuating nuts to turn freely in overtravel. The nuts actuate operational end-of-travel and intermediate dead switches. Other and proprietary limit boxes must be specifically approved for the proposed application.

(k) Labels

Clearly label all limit switches with their function.

3.4.2 Overtravel (Ultimate) Limits

See also [ER \(T\) 3.4.1 Limit & Dead Switches](#).

(a) Function

Provide separate overtravel switches on all powered equipment to prevent physical damage in the event of a software **and** end-of-travel limit failing. Fit and connect these limit switches so as to give maximum reliability.

(b) Direct Struck Limits

Direct struck limits are the preferred form of overtravel detector. Use safety-grade lever-arm types with forced disconnect contacts to EN 60947-5-1, operated by the motion of the equipment. The switches shall be operated reliably within the specified overtravel distance. On some hoist and winch units the overtravel switch can be operated by the travel of the wire rope on the winding drum.

(c) Electronic Overtravel Limit Switches

When permitted in the Employer's Requirements (Specific), shall be implemented and certified as a SIL3 safety function under EN 61508 irrespective of the actual risk reduction required.

(d) Rotary Limit Switches

Use ONLY proprietary "limit boxes" with force break contacts that are intended for safety applications.

(e) Action

Design the ultimate limit function such that it acts directly on the motor drive to stop the hoist at maximum deceleration rate **independently** of the control system.

(f) Override Switch

Provide a key switch or similar approved mechanism to override each overtravel limit to allow the machine to be move away from the ultimate limit position. Arrange for the operation of the override device to automatically inhibit further motion in the direction of overtravel.

(g) Overtravel Distance

Design all drive mechanisms and guides to allow sufficient overtravel distance for deceleration under the worst conditions after operation of an overtravel switch.

3.4.3 End-Of-Travel (Initial) Limits

See also [ER \(T\) 3.4.1 Limit & Dead Switches](#).

(a) Function

Provide sensors to detect the limits of normal travel (top and bottom initial limits) and bring the machine to a controlled operational stop. Generally, the end-of-travel limits shall be in a proprietary or purpose-built switch unit mounted on the drive assembly but may be direct struck limits.

(b) "Intelligent" Position Sensors

"Intelligent" position sensors or similar electronic devices that include a limit switch function that is independent of the primary position sensing system may be acceptable subject to approval by the Consultant.

(c) Action

Design the initial limit function such that it acts via the control system to bring the hoist to a smooth stop before the [ER \(T\) 3.4.2 Overtravel \(Ultimate\) Limits](#) are reached, irrespective of the hoist speed when the stop was initiated. Do not inhibit motion away from the limit of normal travel.

3.4.4 Overload Detection

(a) General

All winch, Elevator and hoist units shall incorporate overload detection. Operation of the overload device shall stop motion in the direction which would increase the overload. It shall be possible to operate the unit under power in the reverse direction only to clear the fault, for example by lowering a load back onto the stage. Indicate an overload condition as an operational snag to the operator for correction.

(b) Principle

Provided each individual wire rope suspension and its pulley connections to the structure are such that each can carry the maximum imposed load under any operating conditions within their safety factors, a load cell to monitor the whole load imposed on the hoist can be employed. Such a load cell shall prevent the hoist from operating if the load exceeds the specified maximum for the hoist. Otherwise the load in the individual wire ropes shall each be monitored, and the hoist stopped if the load in any wire rope

(c) Overload Setting

Calibrate the overload setpoint using certified test weight to nominally 10% above the specified design load.

(d) Load Measurement

Unless otherwise specified or agreed, load cells shall be used for determining overload. In some less critical applications, motor torque measurement may be used to determine overload. In all cases, ensure that excessive overload does not strain any part of the installation.

(e) Load Cell Electronics

Ensure load cell signal processing electronics are failsafe in the event of a strain-gauge or wiring fault.

(f) Indication

If no specific overload indicator is provided, overload shall be signalled by flashing, at 30 times per minute, the top and bottom limit indicators on the panel.

3.4.5 Dynamic Load Monitoring

(a) Function

If required, design a system to provide a high degree of sensitivity to load using direct real-time load cell measurements. Machines shall be brought to a rapid but safe stop if they catch on fixed parts of the building or on heavy scenery. Catching on these items shall be detected by load, position, velocity, acceleration, or other change which shall be monitored at all times that a machine is not both stationary and not selected. Classify such a situation as a snag and indicate it to the operator for correction.

(b) Sensitivity

It is accepted that picking up light additional loads is a normal hazard and that the equipment cannot be expected to detect reliably a change of load **in motion** of less than 15% of payload. Provide an adjustable load detection window with a default value. The system must differentiate between an operational load-change and a full-load overload situation from standstill.

(c) Computer Control

Where a computer or programmable logic controller is operating the drive, the load cell signal shall be monitored, and any sudden change used to signal a snag.

3.4.6 Slack Wire Detection

(a) Direct Sensing

Include a no-load or slack wire system to detect **each** individual slack wire rope and maintain any slack wire ropes in position on the winding drum and in diverter pulleys so that, when the load is again applied, the wire ropes are correctly reeved. Classify a no-load situation as an operational snag and, in addition to stopping the hoist, indicate it to the operator for correction. No-load shall permit the hoist to be raised under power so as to reinstate the tension in the suspension wire ropes.

(b) Load Cells

In certain situations, subject to the Consultant's approval, load cells may be used to measure changes in load to detect a slack wire rope situation.

(c) Grounding Sensors

Design crossed groove or slack wire sensors that rely on the steel wire rope grounding an electrically isolated metal electrode to be failsafe. Ensure the monitoring circuit can sense a broken connection to the sensing electrode and is sensitive enough to detect wire rope contact with contaminated electrodes. Assume a worst-case contact resistance of 500Ω.

(d) Indication

If no specific slack wire or no-load indicator is provided, slack wire or no-load shall be signalled by flashing, at 30 times per minute, the top and bottom limit indicators on the panel.

3.4.7 Speed Error Detection

If required, arrange to directly measure the actual speed of the machine using an encoder or tachometer. Compare this "actual speed" with the speed demanded by the control system and securely stop the machine if the actual speed deviates from the demand speed by more than 5% of the maximum speed. Signal this fault condition as a SPEED ERROR. The "speed error function" built into an open loop (sensorless) "vector drive" may be used to implement this requirement without an external speed sensor subject to the Consultant's approval.

3.4.8 Speed & Position Feedback

(a) Application

Where specified, include devices for speed and position feedback that are directly and positively coupled to the motor with a keyed shaft or approved similar arrangement. Where absolute and incremental devices are incorporated into a single unit, ensure there are no failure modes that could create danger.

(b) Couplings

Ensure that the drives to any of the feedback devices cannot be misaligned and that the mounting puts no strain on the unit or onto the drive shaft. These items must not be subject to premature failure or any cause of unreliability.

(c) Ease of Replacement

Encoders and all similar feedback devices shall be easily accessible and readily replaceable, and the system shall be able to be recalibrated quickly in the event of a change being necessary.

(d) Approvals

Submit full details of any proposed encoders to be used in the installation to the Consultant for approval. Encoders which provide separate absolute and incremental signals within a single device may be acceptable.

3.4.9 Safety Devices

(a) Application

In all places where moving parts pass in a guillotine action, safety devices shall be installed. Such safety devices and the stopping mechanism(s) on the equipment shall operate totally reliably and in such a way as to ensure that the equipment causes no damage or injury to the obstruction. All safety switch devices shall be inherently failsafe and connected in a series configuration.

(b) Risk Assessment

A Risk Assessment shall be carried out on each safety function to determine the appropriate risk category and risk reduction using the methodologies set out in EN 62061, EN 13849, EN 61508 or some other approved standard. It is the responsibility of the SEC to develop the risk assessment in writing, especially the identification of all potential hazards and the analysis of every conceivable failure mode.

(c) Guard & Door Solenoid Interlocks

Where guards or access doors have to be locked shut during motion, fit only approved metal-cased heavy-duty solenoid locking safety interlock switches to EN 14119. Unless specified otherwise, solenoid locks shall be energised to unlock (failsafe). Provide at least three override (unlock) keys for each type of lock supplied.

(d) Devices

All safety devices shall be proprietary equipment, conforming to European Standards. Each device shall have been independently tested or type approved as appropriate.

(e) Operation

Operation of safety switches shall prevent any further motion of the equipment onto the obstruction. Only operation in the reverse direction so as to release the obstruction shall be possible from any control panel.

(f) Indication

Activation of a safety switch shall be classified as a MALFUNCTION and shall be indicated on the control

panel. All safety switches shall be traced in sections and the section activated indicated on the control panel. Where necessary a reset button shall be fitted to the panel.

3.5 Rigging

3.5.1 Diverter Pulleys

(a) Drop Pulleys

Pulleys shall be arranged such that the corresponding drops for each bar are on parallel lines accurately at right angles to the up-down centre line of the stage. The passing wire ropes shall be positioned to either side of the earlier drops.

(b) Pulley Size

Wherever practicable, pulleys for working wire ropes shall be of pitch circle diameter not less than twenty-five times the rope diameter in order to minimise the wear on the wire rope. Where specifically approved, pulleys which have a very low duty cycle or around which the wire rope is deflected less than 45°, may have a diameter of not less than twenty times rope diameter. Each application of less than thirty times rope diameter shall be clearly indicated on the drawings.

(c) Pulley Blocks

All pulley blocks used for turning, aligning, supporting and separating load-carrying wire ropes or other ropes shall be proprietary items selected for the application or shall be designed specifically for the application and purpose made. The selection and design of each item shall take full account of the loads to be carried, the speed of operation and the mounting position.

(d) Multi-Groove Blocks

Where pulley blocks are required to accommodate more than one wire rope (or a combination of wire ropes and fibre ropes) for manual operations, such ropes may be carried in independent grooves machined in the same pulley or in separate pulleys within the common pulley block as may be appropriate. In all instances where more than one pulley is included in a block, each pulley shall be enclosed on both sides by side plates. The pitch circle diameter of all grooves in a common pulley block shall be the same.

(e) Pulley Blanks

Pulley blanks shall generally be solid steel, high-quality close-grained grey iron castings, high-strength cast nylon or approved stable plastic depending on the loading and use. The potential noise of wire ropes running over the drop pulleys must be considered when specifying the pulley material. Grooves for the appropriate number of wire ropes shall be machined in the rims to a profile and tolerance appropriate for the rope to be used. The grooves shall be sufficiently deep so that the flange projects above the seated rope. The outer part of the groove shall be flared at about 15° to permit the specified fleet angle without rubbing.

(f) Side Plates

Pulley side plates shall be steel of a thickness determined by the maximum load on the block. The side plates shall enclose the majority of the pulley assembly and be attached to one another by at least three spacers. The spacers shall prevent the rope leaving the pulley groove under any circumstances. The block shall be installed so that no ropes bear on the spacers.

(g) Pulley Form

Each pulley shall be faced and bored concentrically with the groove pitch circle to receive a sealed ball or roller bearing. The groove and flange shall be concentric to within $\pm 0.5\text{mm}$ with the axle. The bearings shall be carried on solid steel shafts fitted with spacers and lock nuts between steel side plates. The shaft size shall take full account of shear and bending. Ensure the resultant pulley sheave assembly is free-running and can be reeved with the specified rope without any dismantling.

(h) Pulley Mountings

Pulley blocks shall be designed to be retained to the supporting steelwork under all conditions of loading by correctly-fitted proprietary or purpose-made flange clamps in order to retain the possibility of future adjustment. This particularly applies to Grid and loft diverter pulleys. Swivel diverter units shall have a means of locking the pulley at the correct installed angle. Where the steelwork / pulley configuration results in forces that are parallel to the axis of the steel members, a positive shear fixing such as through bolts or welded stops shall be incorporated.

(i) Diversion

The relative positions of pulleys and / or drives shall ensure that for all conditions of use the wire ropes are diverted by a minimum of 5° round every pulley and that the pulleys are always rotated by the movement of the wire rope.

(j) Fleet Angle

The fleet angle of wire ropes to pulleys and winding drums shall not exceed 2.5° and shall be minimised wherever possible by careful design. The alignment of wire ropes onto pulleys and winding drums, under all conditions of operation, shall be carefully checked during installation and this condition fully complied with.

3.5.2 Hemp Sets

(a) General

Multiple line hemp sets shall be designed for a maximum load of 120kg. Hemp sets and cleats shall be designed to be able to be mounted at 200mm centres and where possible shall be limited to three lines. Cleats shall generally be mounted at an angle of 20° on timber rails. Where full height hemp flying is to be carried out a higher working rail and a lower deading rail of cleats shall be provided.

(b) Grid Pulley Blocks

Grid pulley blocks shall be 3-way, 2-way and single sheaves designed for the specified rope which can be bolted to the Grid in any position so that the hemp rope will fall through the centre of the Grid lagging slots. Design the pulley mounting to allow the rope to pass to the head pulleys. Lock the unit in position on the Grid using hand-operated captive clamping devices.

(c) Head Pulley Blocks

Shall be suitable for a maximum of three lines of the specified rope. Make the pulleys up into blocks with suitable lightweight bases to locate and clamp easily to the hemp slot steels on either side of the Grid using captive fixings.

(d) Clewed Hemp Systems

Suspend the scenery bar on wire ropes coupled to a horizontally travelling clew block. The clew block is then hauled by one double-purchased hemp rope and tied off to a cleat on the gallery in the usual way. Maximise the diameter of the double purchase pulley on the clew block to minimise operating friction: diameter to be not less than

eight times rope diameter. Guide the clew block in a low friction track.

(e) Cleats

Unless stated otherwise these shall be proprietary 450mm overall size, malleable iron castings with smooth rounded wearing surfaces. Fit suitable mounting bolts so that there is timber both above and below the cleat body.

(f) Sandbags

Sandbags shall be of high-quality reinforced double-sewn canvas, size 300mm x 200mm, supplied filled with dry sand and sewn up. Securely and permanently fasten a 70mm galvanised ring to each sandbag.

(g) Pulleys & Cleats

All hemp ropes shall be provided with sufficient pulleys to be fully supported throughout their travel. Separate pulley sheaves shall be provided for each rope in head pulleys or where ropes pass diverters. Suitable sizes of pulleys and cleats shall be established for the particular application prior to manufacture or purchase.

3.5.3 Fibre Ropes

(a) Type

Unless otherwise specified, fibre ropes for counterweight hauling lines and general hemp set use shall be Grade 1 4-strand natural hemp rope as supplied by Splicing and Allied Services Co. Ltd, Eldorado Works, Drake Avenue, Gresham Road, Staines, Middlesex, TW18 2AP, UK or an approved equivalent.

(b) Rope Properties

Only offers ropes that are already in use in counterweight installations elsewhere and have very low stretch qualities. Ropes shall be able to be easily marked for deads, shall not create splinters or be affected by use through a rope lock. Purchase rope in pre-cut lengths with spliced eye and thimble for connection to the cradle tie-off point or clew plate.

3.5.4 Wire Ropes

(a) General Specifications

Suspension wire ropes shall be of preformed flexible steel with a steel centre core. Unless the manufacturer recommends against it, all wire ropes shall be supplied pre-stretched. All wire ropes shall be coated with a protective coating of zinc to an agreed thickness by hot dip galvanising or similar process. All wire ropes shall be supplied against a detailed performance specification from a major supplier.

(b) Pre-Testing

All wire ropes shall be pre-tested in batches by an authorised testing house and supplied in clearly labelled pre-cut lengths with batch test certificates.

(c) Site Handling

Wire ropes shall be handled with care during installation and not kinked or damaged in any way. Damaged or deformed wire ropes will not be accepted. All cut ends shall be correctly finished to prevent unlaying or fraying.

(d) Installation

In normal operation of the equipment wire ropes shall not be allowed to rub on fixed or moving parts of the installation. Wire ropes used to operate remote mechanisms in locations where there is risk of damage or jamming shall be properly protected. Moving wire ropes used for hoisting or traction shall be guarded where

necessary to protect personnel. After installation the SEC shall specifically check that all wire rope fixings are secure and locked.

(e) Catenary Support

- 5 Wire ropes passing loft diverter pulleys, or in other situations where catenary support is necessary, shall be themselves supported on full diverter pulleys complying with the pulley specification unless otherwise specifically agreed.

3.5.5 Steel Bands

(a) Certification

- 10 Provide independent certification that the steel bands being offered exhibit the same strength and durability as a conventional wire rope. If required, provide the full test data on which the type approval certification was based to the
15 Consultant for further assessment by a third-party expert.

(b) Third-party Testing

- 20 If required, the SEC shall organise, at no additional cost to the contract, independent third-party testing of the steel bands being offered. The programme of destructive load and fatigue testing shall be decided by the Consultant and their expert advisors. The SEC is required to satisfy the Consultant and the expert advisors as to the suitability of steel band hoists in regard to strength, durability and ability
25 to withstand shock loads.

3.5.6 Standard Flying Suspension Beams

(a) Application

- 30 The details in this section apply primarily to multi-line suspensions as provided by counterweight, motorised suspension and Powered Flying systems. All bars, pipes, ladder beams and trusses shall be straight and true. Deformed or curved equipment will be rejected.

(b) Rigging

- 35 The centre of each bar shall be on the up-down centre-line of the stage. Bars shall be horizontal, parallel to stage floor and one another.

(c) Pipe Suspensions

- 40 Where load suspension pipes are specified, these shall be 48mm \pm 2mm outside diameter x 5mm wall thickness steel tube or other sizes as set out in the individual equipment specification. See also [ER \(T\) 3.5.6 \(f\) Pipe & Bar Joints](#).

(d) Rectangular Bar Suspensions

- 45 Where specified, the suspension bars shall be in rectangular hollow steel tube, nominally 50 x 100mm x 4mm wall thickness (approx. 9kg/m). See also [ER \(T\) 3.5.6 \(f\) Pipe & Bar Joints](#).

(e) Truss Suspensions

- 50 Where specified, trusses shall be constructed as welded ladders with two 48mm \pm 2mm outside diameter x 3mm wall thickness steel tube at 300mm centres separated by plates or tubes at approximately 1000mm centres. The centres shall be adjusted to provide separation tubes near each wire rope suspension but to be clear of the levelling adjustment clamps. A separator tube shall be fitted at the
55 ends of each truss. Removable end trusses shall plug into the end of the flown truss and be retained positively by captive pins or similar.

(f) Pipe & Bar Joints

- 60 Joints shall be minimised and shall be securely dowelled, and the two parts fitted together permanently without any external obstructions. Dowels shall be solid bar and a tight

fit in the tubes/bars. The ends of the tubes/bars shall be undercut, securely welded and ground flush. Removable jointing pieces shall only be supplied where specified, such
65 as on plug-in extensions.

(g) Conventional Levelling Adjustment

- 70 Suspension wire rope tie-off points shall be individually adjustable by means of clamps fitted to the tubes. The wire ropes shall be diverted to the clamps along the tube around suitable grooved quadrants plumb beneath each drop. The quadrants shall be securely clamped to the tube and shall restrain the wire rope without damage. The tubes shall be levelled by moving and locking the clamps.

(h) Levelling Adjustment using Wedge Anchors

- 75 If specifically permitted by the Employer's Requirements (Specific), this method has the operational advantage of not having a wire rope running along the top of the suspension beam. The wire rope shall be passed through the wedge device and levelled by adjustment before the wedge is pulled home. The eye on the wedge device shall
80 be clamped to the top member of the beam.

(i) Extension Tubes

- 85 Telescopic extension tubes of suitable diameter or section and specified length shall be provided in each end of each suspension pipe or bar or in the lower pipe of each truss. These shall be able to be pulled out and clamped in position using a captive bolt suitable of use with the Project Rigging Spanner or with a fitted knob for hand operation. The section of pipe to remain in the pipe shall not be less
90 than one third of the length of the extension and shall be finished bright RED.

(j) Tube Ends

The ends of tubes and of telescopic extensions shall be permanently fitted with brightly coloured plastic caps.

95 (k) Finishes

Unless otherwise specified, finish all suspension beams MATT BLACK.

(l) Beam Marking

- 100 Number each suspension beam at each end on the upstage side with at least 50mm high BLACK painted numerals on an approved WHITE plate or background. The set numbers are to be as shown in the drawings.

- 105 Mark the Safe Working Load (SWL) of each beam at each end on the upstage side in 25mm high YELLOW characters on an approved BLACK plate or background. The SWL shall be given as a uniformly distributed load, a maximum point load under each wire rope and a maximum point load between suspensions.

(m) Up-Down Stage Beams

- 110 Use similar beams for any up-down stage suspensions as for the across-stage multi-line suspensions, preferably with the same section length dimensions, but otherwise with the dimensions adjusted appropriately. They shall be similarly suspended, levelled and finished. Label and mark on the
115 offstage sides.

3.5.7 Non-Standard Flying Suspension Beams

(a) General

- 120 If required, develop non-standard suspension beams within the general parameters of [ER \(T\) 3.5.6 Standard Flying Suspension Beams](#). The sections shall be bolted together and easily assembled and disassembled. Different length end sections which can be attached to provide offstage extensions to the beams will be acceptable.

(b) Fabrication

Fabricate the suspension beams in standard sections, related to the wire rope suspension positions, to assist with spares holding and replacement in the event of damage.

5 There shall be no joints in the material forming any of the standard sections.

(c) Levelling Adjustment

The top of the beam shall include small limited-motion pulleys and horizontal tie-off points for the suspension wire ropes. Make suspension wire rope tie-off points individually adjustable by means of tested eyebolts fitted to clamping plates which lock in the top section of the suspension beam. Mount the limited-motion pulleys plumb beneath each wire rope drop. Fit these pulleys with all necessary 10 keeps and securely fix them to the beam so they restrain the wire rope without damage. Level the beams by adjusting the eyebolts. Ensure that at least 75mm of adjustment is available on the eyebolts. Fit the adjusters with Nyloc nuts and insert split pins through the ends of the threads. 20

(d) Beam Extensions

Provide only a limited number of extensions, equivalent to extensions for 15% of the installed across-stage beams. Ensure levelling, marking and extensions are compliant, 25 unless otherwise detailed.

(e) Linear Scale

Prepare an approved laminated scale, giving clear dimensions along the beam, and attach this securely to the upstage side of the suspension beam. Establish the details of this scale with the Consultant before manufacture 30

3.5.8 Suspension Fittings

(a) Certificated Components

All springs, shackles, strainers, snap-hooks, karabiner-type hooks and other wire rope and fittings and lifting accessories shall be cadmium-plated or galvanised. All fittings shall be load tested by an authorised testing house and marked with a Safe Working Load and a unique identifying code. Test certificates shall be supplied. 35

(b) Lifting Applications

Unless specifically permitted, use only [ER \(T\) 3.5.8 \(f\) Wedge Sockets](#) or [ER \(T\) 3.5.8 \(c\) Ferrules](#) for wire rope terminations in lifting applications. Ferrule terminated wire ropes shall be supplied as pre-tested and certificated assemblies. 40

(c) Ferrules

Terminations shall be fitted in accordance with the manufacturer's instructions and in accordance with BS 7905-1:2001. Test the termination to **TWICE** the SWL, identify the termination with a unique mark and issue a test certificate. 45

(d) Thimbles

All thimbles and fittings shall be the correct size for the wire rope. Where wire ropes are fixed by means of grips, the correct number of approved and correctly-fitted grips shall be used for each fixing. A sample of the type of grip proposed for use shall be submitted with supporting data before purchase. Wire rope grips to BS 462 **shall not be used**. After fitting, excess wire shall be cut off and the end taped. 55

(e) Wire Rope Grips

All wire rope grips shall be to DIN 1142 and shall be fitted with the U-bolt fitted on the dead or tail side of the thimble. 60

The correct number of grips shall be fitted at the specified separation given in the Standard and the bolts greased and tightened using an appropriate torque wrench. The grips must be retightened in the period shortly after fitting in order to ensure the correct load rating and the SEC shall allow for carrying out this process. 65

(f) Wedge Sockets

70 Wedge sockets to DIN 15315 may be offered as an alternative to thimbles and grips to provide a simple method of adjustment of position. Symmetrical and asymmetrical wedge sockets shall be used in accordance with the manufacturer's instructions and in accordance with BS 7905-1:2001. The wire rope end shall be retained above the wedge by a single approved grip. This grip shall only retain the wedge in place under no-load conditions and shall not have any effect on the load carrying or levelling. The end of the wire rope shall also be taped to the drop. 75 80

(g) Turnbuckles

Where appropriate, adequately rated open-centre straining screws may be employed. All wire rope fittings to such screws shall be as specified and the straining screws shall incorporate split pins to prevent them coming apart under any circumstances. All straining screws shall also be wired or fitted with tightened locknuts on installation. 85

(h) Shackles

All shackles that form part of a permanent installation shall be wire locked. 90

(i) Long Link Chain

Such chain shall not be used for load suspension even when tested, as its failure cannot be predicted. However, where its use is essential in providing a preset adjustment of height, such chains may be used with a safety factor of TWENTY and with a tested safety bond fitted loosely through it as security. 95

3.6 Scenic Masking

3.6.1 General

(a) Fixings

Obtain approval for fixings to structure from the Client's Structural Engineer. 100

(b) Site Survey

The SEC is responsible for conducting a detailed site survey before preparing drawings and procuring tracks, curtains and other masking items. 105

(c) Tracks

Tracks to be suitably rated for the specified curtains or other loads, supplied complete with bobbins or roller trolleys and fixings to suit the load. 110

(d) Track Colour

Tracks to be BLACK unless stated otherwise.

(e) Reference Suppliers

All cloth materials shall be made up by an approved specialist theatre drapes supplier such as: 115

- Gerriets Ltd, 18 Verney Road, London, SE16 3VH, UK
- J.D. McDougall Ltd, 4 McGrath Road, Stratford, London, E15 4JP, UK
- Ken Creasy Ltd, 23 Phipp Street, London, EC2A 4NP, UK
- J & C Joel Ltd, Corporation Mill, Corporation Street, Sowerby Bridge, Halifax, HX6 2QQ, UK 120

3.6.2 Soft Masking

(a) General

Ensure all masking cloths are suitably protected from dust and dirt for transport and storage on site. Do not hang any masking until advised to do so by the Consultant or Managing Contractor when the site is clean and all major works are complete.

(b) Flameproofing

All curtains forming part of this contract shall be either inherently flameproof or shall be materials which can be durably flameproofed by an acknowledged proprietary method which complies with EN 13773. The SEC shall provide flameproofing certification for all the materials offered. Materials requiring flameproofing shall be so durably flameproofed before curtain manufacture and the test certificate shall state the date of flameproofing and the particular batch used.

(c) Material

Unless stated otherwise, all curtains, legs and borders shall be BLACK light-proof high-quality wool serge of minimum weight 500g/m², similar to "Super Wool Serge" supplied by J & C Joel (www.jcjoel.com).

(d) Curtains

Curtains shall have strong 50mm wide flame-retardant webbing along top and be fitted with eyelets and strong ties at 300mm centres. The curtains shall also be fitted with suitable snap-hooks for use with curtain track bobbins at 300mm centres and an additional pair at 75mm separation at both the leading and trailing edges. Sides of curtains shall be hemmed. The bottom shall be fitted with a pocket and shall have a suitable galvanised weighting chain in a Bolton Twill sleeve sewn in 50mm above the bottom hem. The bottom hem shall be replaceable when worn.

(e) Borders

Borders shall have strong 50mm wide flame-retardant webbing along top and be fitted with eyelets and strong ties at 300mm centres. Hem sides of borders and fit bottom with pocket for 25mm outside-diameter weighting pipe.

(f) Legs

Legs shall have strong 50mm wide flame-retardant webbing along top and be fitted with eyelets and strong ties at 300mm centres. Hem sides of legs and fit bottom with pocket for a 25mm outside-diameter weighting pipe and fit a suitable galvanised weighting chain in a Bolton Twill sleeve sewn in 50mm above the bottom hem. The bottom hem shall be replaceable when worn.

(g) Tie Tapes

Tie tapes shall be at least 620mm long x 20mm wide cotton webbing tape so that when fitted correctly through the eyelets each tie end shall be approximately 300mm long. The ties shall not be sewn under the header webbing. The centre tie of each heading shall be coloured RED. The eyelets shall be plated heavy-duty steel.

(h) Labels & Storage

Each traveller curtain, leg or border shall be indelibly labelled on each top offstage corner on reverse side of material with its description, size, hanging position (on-stage or offstage, stage left or stage right), project name, material and date of manufacture / supply. Each item shall be supplied in a strong, high-quality, soft canvas bag similarly labelled and fitted with carrying handles, eyelets and draw cord for closing.

3.6.3 Hard Masking (Tormentors & Headers)

(a) Panel Frames

To be of rectangular and square hollow sections fully welded and ground flush.

(b) Panel Front Face

Unless stated otherwise, clad with 12mm Fireproof Class 0 hardwood plywood; fixings to be stainless steel screws flush with or recessed below surface. If required, radius edges to prevent damage to covering material.

(c) Fix Cladding

Fix cladding at not greater than 500mm centres. Use sufficient fixings to ensure joints between adjacent panels are totally smooth.

(d) Softwood Battens

Softwood battens to be fitted to all four sides of frame at rear using countersunk fixings for fixing of finish fabric using staples.

(e) Track Bracing

Ensure the suspension track is adequately braced to prevent up / down stage movement at the top of the Tormentors.

(f) Floor Guides

If required, fit a proprietary roller and channel guide, or similar, in the floor to guide the base of the hard masking and to allow for an off-axis centre of gravity when a panel is folded. Minimise the slot in floor required for guide track. Finish each side of the slot in floor with black nylon strip 5mm thick. Supply this to the Flooring Contractor for installation.

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