

Use of lifting equipment for performance, broadcast and similar applications —

**Part 1: Code of practice for installation,
use and removal of above stage
equipment (excluding trusses and
towers)**

ICS 53.020

Committees responsible for this British Standard

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- Association of British Theatre Technicians
- Broadcasting Entertainment Cinematograph and Theatre Union
- HSE — Health and Safety Executive
- Lifting Equipment Engineers Association
- Professional Lighting and Sound Association
- Safety Assessment Federation Ltd.
- Theatres Advisory Council

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Foreword

This part of BS 7906 has been prepared by subcommittee MHE/3/13. It does not supersede any previous British Standard.

BS 7906 *Use of lifting equipment for performance, broadcast and similar applications* is published in two parts:

- *Part 1: Code of practice for installation, use and removal of above stage equipment (excluding trusses and towers)*
- *Part 2: Code of practice for use of aluminium and steel trusses and towers*

The primary object of this code of practice is to ensure that lifting operations in entertainment and similar applications are carried out safely.

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

It has been assumed in the drafting of this British Standard that the execution of its provisions is entrusted to appropriately qualified and competent people.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Attention is drawn to the following statutory regulations:

The Lifting Operation and Lifting Equipment Regulations (LOLER) 1998 [3];

The Provision and Use of Work Equipment Regulations (PUWER) 1998 [4];

The Supply of Machinery (Safety) Regulations 1992 as amended [5];

The Management of Health and Safety at Work Regulations 1999 [6];

The Manual Handling Operations Regulations 1992 [7].

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 79 and a back cover.

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1 Scope

This British Standard gives recommendations for the safe use of lifting equipment used to lift and traverse equipment and personnel for the following applications:

- film;
- television;
- theatre and similar entertainment events;
- conference and exhibition.

The recommendations cover the supply, installation, use, maintenance and removal of components and systems, documentation and periodic inspection and thorough examination.

Additional requirements might apply to installations in cruise ships.

Lifts and elevators are not covered by this standard.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 1139-1.2, *Metal scaffolding — Part 1: Tubes — Section 1.2: Specification for aluminium tube.*

BS 2853, *Specification for the design and testing of steel overhead runway beams.*

BS 6521, *Guide for proper use and maintenance of calibrated round steel link lifting chains.*
[ISO 7592]

BS 7671, *Requirements for electrical installations — IEE Wiring Regulations — Sixteenth edition.*

BS 7905-1:2001, *Lifting equipment for performance, broadcast and similar applications — Part 1: Specification for the design and manufacture of above stage equipment (excluding trusses and towers).*

BS 7909, *Code of practice for design and installation of temporary distribution systems delivering a.c. electrical supplies for lighting, technical services and other entertainment related purposes.*

BS EN 39:2001, *Loose steel tubes for tube and coupler scaffolds — Technical delivery conditions.*

BS EN 697, *Fibre ropes for general service — Polyester.*

BS EN 698, *Fibre ropes for general service — Manila and sisal.*

BS EN 818-3, *Short link chain for lifting purposes — Safety — Part 3: Medium tolerance chain for chain slings — Grade 4.*

BS EN 818-7, *Short link chain for lifting purposes — Safety — Part 7: Fine tolerance hoist chain, Grade T (Types T, DAT and DT).*

BS EN 1261, *Fibre ropes for general service — Hemp.*

BS EN 1677 (all parts), *Components for slings — Safety.*

BS EN 10219 (all parts), *Cold formed welded structural hollow sections of non-alloy and fine grain steels.*

BS EN 12385-4, *Steel wire ropes — Safety — Part 4: Stranded ropes for general lifting applications.*

BS EN 13411-3, *Terminations for steel wire ropes — Safety — Part 3: Ferrules and ferrule-securing.*

BS EN 13411-5, *Terminations for steel wire ropes — Safety — Part 5: U-bolt wire rope grips.*

BS EN 20898 (all parts), *Mechanical properties of fasteners.*

BS EN 60204, *Safety of machinery — Electrical equipment of machines.*

BS EN ISO 898-1, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part: 1 Bolts, screws and studs.*

ISO 1835, *Short link chain for lifting purposes — Grade M(4), non-calibrated, for chain slings etc.*

ISO 3075, *Short link chain for lifting purposes — Grade S(6), non-calibrated, for chain slings etc.*

ISO 3076, *Short link chain for lifting purposes — Grade T(8), non-calibrated, for chain slings etc.*

DIN 15315, *Lift — Cable joints.*

DIN 56925, *Theatre engineering, stage machinery — Scenery hoist — Safety requirements and testing.*

3 Terms and definitions

For the purposes of this part of BS 7906, the following terms and definitions apply.

3.1

anchorage

fixture, forming the interface between the temporary or permanent supporting structure and other items of lifting equipment, by means of which the loads are transmitted into the supporting structure

3.2

attachment point

facility provided to enable the load to be connected to the lifting machine, usually by use of a lifting accessory

3.3

bar

length of tube or other section, usually steel or aluminium, to which loads are attached

NOTE Sometimes referred to as “barrel” or “pipe”. Trusses including ladder beams are dealt with in BS 7905-2 and BS 7906-2.

3.4

certified

tested, identified and supplied with a certificate signifying compliance with the standard and/or capacity to carry a specified load

3.5

commissioning

final phase in the installation of equipment, when it is demonstrated to be compliant with all the specified criteria and to be fully operational

3.6

competent person

person who has such practical and theoretical knowledge and such experience as is necessary to carry out the work and is aware of the limits of his/her own competence, expertise and knowledge

3.7

controlled stop

stop at a pre-determined rate

3.8

D:d ratio

pitch circle diameter of the pulley or winding drum divided by the diameter of the rope

3.9

dead

prearranged position for a flown element; indication of prearranged position for example, marked on the hauling rope or electronically recorded

3.10

dynamic working coefficient

breaking load of a component divided by the sum of the maximum static and dynamic loads applied to that component

3.11**emergency stop**

device that causes a controlled stop as quickly as safely possible and which overrides all other controls

3.12**ferrule**

aluminium, copper or steel sleeve compressed by dies or swages onto a wire rope to form a permanent termination

NOTE Sometimes referred to as “crimp”, “swage” or “sleeve”.

3.13**fleet angle**

angle of deflection of rope as it leaves a drum or pulley

NOTE See Figure 12.

3.14**hoist**

lifting machine (including lighting hoist, chain hoist and winch)

3.14.1**Category A hoist**

chain or wire rope hoist intended by the manufacturer for entertainment industry use for lifting and suspending loads over people and conforming to BS 7905-1

3.14.2**Category B hoist**

chain or wire rope hoist not intended by the manufacturer for lifting or suspending loads over people

3.15**hook clamp**

lifting accessory used to support lighting and similar equipment hanging from bars

3.16**in-view flying wire**

wire that can be seen by the audience, and which for artistic reasons needs to be as thin as practicably possible without compromising safety

3.17**karabiner**

connector with a lockable, self-closing and load bearing gate

3.18**lifting accessory**

component or equipment separate from the lifting machine and placed between the lifting machine and the load or on the load to attach it

NOTE Lifting accessories are not capable of providing movement.

3.19**lifting machinery**

machine which is intended to raise, lower and suspend materials or persons

3.20**lifting system**

assembly of lifting machines and accessories

3.21**limit**

means for preventing further lifting and/or lowering

3.21.1**bottom limit**

means for preventing lowering below the working range of travel

3.21.2

top limit

means for preventing lifting beyond the working range of travel

3.21.3

ultimate limit

means for preventing further lifting or lowering in case of top or bottom travel limit failure

NOTE Sometimes referred to as “over-travel limit”.

3.22

load

suspended item or force related to mass

3.22.1

axial load

force in line with an axis, for example the axis could be the centre line of a hydraulic cylinder

3.22.2

dead load

force arising at any part of a system at rest due to mass in the system and excluding any forces due to live load

3.22.3

design load

maximum force intended by the designer

3.22.4

dynamic load

force arising at any part of a system due to acceleration or deceleration of mass

3.22.5

live load

mass attached to lifting system

NOTE Sometimes referred to as “payload” or “imposed load”.

3.22.6

load bearing

withstanding of force, e.g. a load bearing beam is a beam which withstands force due to loading

3.22.7

load capacity

amount of force sustainable by design

3.22.8

load path

assembly of items connected to one another to withstand force whereby each item is subjected to force due to the load considered

3.22.9

load testing

application of known force to assess integrity of equipment

3.22.10

minimum breaking load

MBL

applied force below which an item does not break

3.22.11

overload

suspended mass greater than the safe working load

3.22.12**point load**

force applied at one place

3.22.13**safe working load****SWL**

maximum mass that is permitted to be raised, lowered or suspended

NOTE The safe working load is not necessarily the same as the working load limit.

3.22.14**shock load**

force generated by sudden arrest

3.22.15**static load**

force imposed on any part of a system when at rest

3.22.16**uniformly distributed load****UDL**

force evenly spread over the force withstanding item

3.22.17**working load limit****WLL**

maximum permitted mass that equipment is designed to lift, as specified by the equipment manufacturer

3.23**permanent**

assembled by the manufacturer and not intended to be dismantled or decommissioned during the life of the product, except for servicing

NOTE Permanent items are often dedicated to one use. See 3.36 for definition of temporary.

3.24**performer flying**

lifting, lowering or suspension of an artiste in performance, to give the impression of levitation or flying

3.25**pitch circle**

pitch circle is the effective circle of rolling without slip between transmitting elements, see Figure 1

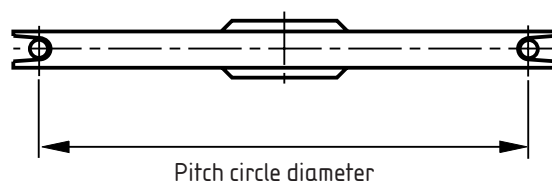


Figure 1 — Pitch circle

3.26**production file**

assembly of documents which together contain all the important information relating to the event

3.27**rope diameter**

diameter of the smallest circle that can encompass all strands of a rope

3.28

rope lock

device to hold a rope by means of friction

3.29

safety bond

form of secondary suspension capable of arresting the fall of an individual item of equipment in case of dislocation of its primary attachment to the lifting system

3.30

safety factor

minimum breaking load of a component divided by the maximum designed static load

NOTE Safety factor is also known as “working coefficient”.

3.31

sling

lifting accessory, usually a length of rope, chain or webbing assembled as an endless loop or provided with terminations to enable ready attachment of the load, for example to the hook of a lifting machine

3.31.1

leg

sling used as part of a multiple sling

3.31.2

drift

single legged sling

NOTE Sometimes referred to as a “flying wire”.

3.31.3

bridle

two legged sling

3.32

static test

test during which machinery or a component is subjected to loading equivalent to the SWL multiplied by a static test coefficient

3.33

static test coefficient

factor applied during a static load test to allow for dynamic loading

NOTE Static test coefficient has the following minimum values:

- a) manually operated machinery and lifting accessories: 1.5;
- b) other machinery: 1.25.

3.34

swivel

device that enables one part to turn relative to the other part while axially loaded

3.35

swivel hook

hook and swivel combined

3.36

temporary

intended to be decommissioned and/or dismantled during the life of the product so the product can be reused

NOTE Temporary items may be reused for a similar or different purpose. See 3.23 for definition of permanent.

3.37

thimble

captive device to protect the eye termination of a rope and which maintains the shape of the eye

3.38**travel range**

designed distance between the highest and lowest positions

3.39**trim**

adjust a bar, scenic unit or other item so that it is parallel to the floor or positioned as required

3.40**whipping**

binding applied to the end of a rope to prevent fraying or unlaying

3.41**wire rope grip**

removable device that allows clamping two parts of wire rope together as in forming an eye at the end of a rope

4 Structural integrity**4.1 General**

The load-bearing capacity of building elements or structures should be checked to ensure that they are capable of bearing both the static and dynamic loads imposed by the lifting equipment before it is installed. This assessment should include checking the likely anchorages, and also the resulting local and overall effects.

NOTE The choice of method for the assessment of load-bearing capacity is outside the scope of this standard.

4.2 Outdoor applications

Whilst this standard gives recommendations for the safe use of lifting equipment for performance and similar applications which could be used outdoors, special factors such as ground conditions and profile, wind loading and water accumulation on temporary structures should also be taken into account.

NOTE Attention is drawn to *Temporary demountable structures* [1] published by the Institution of Structural Engineers and the HSE publication *The event safety guide* [2].

5 Safety**5.1 General**

Safety may be achieved by:

- a) designing and installing to avoid progressive collapse;
- b) allowing a sufficient margin between design loads and failure loads;
- c) adopting appropriate working practices.

5.2 Avoidance of progressive collapse and the use of safety factors**5.2.1 General**

Design/installation to avoid progressive collapse is intended to ensure that failure of any single component of the load-carrying system does not lead to failure of other components and the dropping of the flown load.

The margin between working loads (design loads) and failure loads is intended to allow sufficient capacity for “normal” overloading (including controlled dynamic loads such as braking) and for “normal” wear and tear so that permanent deformation of the load-carrying system is not caused in everyday use. This ratio of these loads is known as the safety factor.

Recommended safe working loads (SWLs) for a range of flying bars and rope spacings are given in this standard. The maximum loads are chosen so that, even if a rope breaks, the bar should not break, although it might be severely bent.

Different factors of safety are used for bars to those for ropes. This is a reflection of the different susceptibility to wear and tear of bars and ropes, of the degree of warning that each provides before breakage and of the way in which each fails. Ropes can suffer from visible defects, most of which are not suffered by bars. Ropes break suddenly, generally without warning, whereas bars bend and sag when overloaded.

A gradually applied load would have to exceed 8 times the SWL to rupture a rope or lifting accessory with a safety factor of 8; before that it would cause excessive bending of the bar. The safety factor is intended to mitigate the effects of shock loading, which is hard to quantify. If the load-carrying system has been designed and installed correctly, then a shock load which causes a rope or lifting accessory to break should not cause the progressive collapse of the lifting machine.

5.2.2 Selection of the appropriate safety factor

Most industrial equipment is not intended for lifting over people. Most equipment as supplied is certified using a safety factor of 5 or less.

This British Standard specifically relates to lifting over people. Therefore safety factors should be reconsidered when designing and selecting suspensions. Generally a safety factor of 8 should apply throughout the load path, including anchorage points, load attachment points, connectors and lifting accessories. However, different safety factors may be applied to bars, trusses, hoists and proprietary equipment provided they have been designed for lifting loads over people.

Details of recommended safety factors for different equipment are given in this British Standard and listed in Annex A together with other relevant data.

NOTE Attention is drawn to LOLER [3], PUWER [4] and the Supply of Machinery (Safety) Regulations [5].

5.2.3 Safe working load

It is essential that the SWL of every component including each lifting accessory is equal to or greater than the required SWL of the complete load carrying suspension.

The safety factor used to mark the SWL on individual components should be determined as most industrial lifting accessories are marked with an SWL based on a safety factor of 5 and may therefore need to be de-rated using the following equation:

$$SWL_R = SWL_5 \times 5/R$$

where

R is the required safety factor;

SWL_R is the SWL with a safety factor of R ;

SWL_5 is the SWL with a safety factor of 5.

The minimum breaking load (MBL) of rope should be reduced according to the terminations used prior to calculating the SWL of the completed rope assembly.

NOTE Some components are stamped with their Working Load Limit (WLL). This is the manufacturer's statement of the SWL of the equipment before it has been installed. It will generally need to be de-rated as above.

Where the weight of the load is not accurately known and a range of estimates based on differing assumptions has been made in accordance with 7.2.3, the highest value of estimated weight should be used when deciding the SWL rating required.

5.3 Operational safety

5.3.1 General

Hazardous conditions can occur during the installation of equipment, whilst suspending loads, during the run of the event, whilst dismantling the show and during removal of scenery and equipment. It should be emphasized to staff that even small objects can cause serious injury or even death if dropped from a high level.

LOLER [3] requires that all equipment is subject to an inspection and maintenance regime. All equipment should be maintained in accordance with the manufacturer's manual. Any changes in clearances, feel or evidence of wear or even squeaks should be reported to the responsible person and the causes investigated as they often indicate potential major faults.

5.3.2 *Potential hazards*

The following list of potential hazards is not exhaustive and other hazards might occur.

- a) Misuse of equipment:
 - overloading;
 - uneven loading of bars;
 - misalignment of rope or chain;
 - use of rope lock to hold load.
- b) Manual handling
 - handling of heavy, large or awkwardly shaped objects;
 - manual hauling of flying bars;
 - loading/unloading counterweight cradles;
 - pulling in pre-loaded counterweight sets;
 - controlling pre-loaded bars until in balance.
- c) Machinery hazards:
 - exposure to moving parts;
 - inadequate guarding;
 - inadequate arrangements for stopping.
- d) Electrical hazards:
 - damaged cables and equipment;
 - poor or missing earthing;
 - incorrect power rating.
- e) Falling objects:
 - badly secured loads;
 - inadequate connections;
 - loose parts not properly secured;
 - unstable loads;
 - break up of loads;
 - objects displaced by the movement of bars;
 - objects knocked off galleries;
 - tools or other objects dropped through grid floor;
 - weak parts of a flown object breaking off;
 - chain falling from bucket;
 - objects accidentally hooked onto a bar or piece of scenery;
 - dropping counterweights while loading cradles.
- f) Moving objects:
 - being struck by a moving bar;
 - being lifted by a rising bar;
 - being hit by a swinging rope, bar or item of scenery;
 - being hit by electrical cables being lowered;
 - whiplash from broken wires;
 - walking into the end of a bar.

- g) Working at height:
 - connecting or disconnecting scenery from a ladder or tower;
 - correcting misaligned ropes.
- h) People falling:
 - overreaching from galleries;
 - falling from ladder or work platform;
 - inadequate rigging of bosun's chair.
- i) Entrapment:
 - getting trapped below load;
 - getting trapped between moving and fixed objects;
 - being dragged into pulleys or drums by ropes.
- j) Loss of control:
 - multiple hoists;
 - load too heavy to sustain manually;
 - counterweight set running away during hanging;
 - slinging centre of gravity;
 - out of balance load on counterweights;
 - mechanical failure of winches;
 - electrical or electronic failure.
- k) Environmental:
 - asbestos and other substances hazardous to health;
 - temperature and humidity;
 - poor lighting;
 - failure to use appropriate personal protective equipment.

6 Planning and installation

6.1 Types of installation

6.1.1 *Permanent installations*

Permanent installations include fixed hoists or an entire flying system, which is installed as a facility and has many potential uses. Existing permanent equipment might be modified or new equipment, which is installed to meet an artistic need for a specific show, may be intended to continue to be used after the initial show has ended. Installation of such equipment should be regarded as a permanent installation and the appropriate procedure adopted.

6.1.2 *Temporary installations*

Temporary installations fall into two types:

a) Type A

The attachment of scenic items onto existing permanent lifting equipment should be considered a temporary installation. Each alteration to the load carried by permanent lifting equipment should be treated as a separate event of temporary installation.

b) Type B

This includes lifting equipment installed specifically for the show. Temporary installations involving the assembly of lifting equipment from components should be commissioned as a permanent installation in accordance with **6.5**.

Table 1 gives examples of the types of installation, including temporary installations.

Table 1 — Examples of the types of installation

Permanent installation	Temporary installation	
	Type A	Type B
A flying system intended for long-term use in many shows or, installed specifically for one show but which is intended to remain in use after the closure of that show.	—	A show specific flying system (which might be removed when the show closes.)
A long-term scenic item such as a front-cloth or house tabs used for many productions.	A show specific scenic item attached to an existing theatre flying system.	A show specific scenic item attached to a counterweight set installed specifically for the purpose.
Category A hoists (see 3.14.1) used as a long-term multi-purpose lifting facility attached to certified anchorages.	Category A hoists (see 3.14.1) installed for a specific show attached to certified anchorages and removed after the show.	Category B hoists (see 3.14.2) installed for a specific show and/or attached to anchorages, which should be tested.

6.2 Specification of requirements

For permanent installations a written Specification of Requirements should be prepared by a competent person giving as much detail as possible about the proposed installation. The Specification of Requirements should be agreed with the user prior to installation of the equipment.

For a temporary installation, for example hanging a chain hoist or scenic item, a similar process should be undertaken, possibly not written down. It is essential that information is gathered about the equipment or scenic item to be installed and the nature of its contribution to the show and a rigging scheme prepared.

Table 2 should be considered when specifying an installation and preparing a specification.

Table 2 — Recommended actions when specifying an installation

Action	Permanent installation	Temporary installation
Assess purpose	Assess the performance criteria (e.g. loads, speeds, acceleration rates, accuracy, duty cycle, noise). Consider the operational facilities necessary to meet the most likely future use including growth and changed methods of operation.	Assess the loads, specific artistic requirements in terms of speed, noise, accuracy, operational modes, special effects, and other artistic criteria such as visual appearance of rigging etc.
Assess time constraints	Establish time available for installing the equipment.	
Assess site	Assess constraints due to access, building structure and environmental concerns (visual appearance, noise, heat, humidity etc.).	Assess available lifting equipment and whether it is capable of meeting the requirements or do resources need to be brought in. Consider whether external contractors and/or additional staff are necessary.
Assess implications of regulations	Assess the implications of LOLER [3], PUWER [4], the Supply of Machinery (Safety) Regulations [5], the Management Health and Safety at Work Regulations [6], BS 7905 and local licensing requirements.	
Assess operational requirements	Assess the level of training and competency of prospective operators and implications in terms of manpower and skills provision.	
Assess maintenance and support requirements	Assess the availability of maintenance support throughout the envisaged life of the installation. Consider manufacturer support, local skills and manpower.	Assess arrangements necessary for routine inspection, repair and adjustment as applicable. Longer-term maintenance and support is not a major consideration.
Assess implications of life cycle	Assess the length of service, level of reliability expected, failure modes, provision of back-up, de-commissioning and removal.	
Prepare specification	Write a Specification of Requirements.	Establish a rigging scheme including lists of equipment necessary and of personnel and the levels of skill required.

6.3 Selection of equipment

Equipment, including lifting accessories, should be selected to best meet the specification for the installation; different solutions should be considered and decisions made in accordance with Table 3.

Table 3 — Recommended actions when selecting equipment

Action	Permanent installation	Temporary installation
Consider specification of requirements	Assess the ability of the supplier to comply with the Specification of Requirements.	Consider whether the available equipment can meet the requirements of the rigging scheme.
Consider safety	Compare risk assessments of the ability of alternative equipment to enable a safe system of work throughout the life of the equipment.	Carry out a risk assessment of the rigging scheme. Consider ability of personnel to install the selected equipment.
Consider cost	Compare costs of competing alternative equipment throughout the life of the equipment.	Likely to be using mainly existing equipment. Seek competitive quotations to compare alternative costs if using purchased/hired-in equipment.
Consider certification	Confirm that the equipment conforms to BS 7905-1. See Note 1.	Confirm reports of inspection for all equipment are available. See Note 1.
Consider quality	Ensure an appropriate system of manufacture, installation and support is utilized. See Note 2.	Ensure equipment is inspected by a competent person prior to installation.
Consider installation and commissioning	Consider the cost, management, warranty and certification complications which can arise if a third party installer is used.	Ensure personnel with the necessary skills are available. Decide who is to carry out the work and confirm their competency for the task.
Prepare a specification of equipment	Select the equipment. Carry out a risk assessment. Prepare a written justification of the chosen equipment.	Identify the sources of appropriate equipment and personnel. Confirm the rigging scheme is safe and consider whether it should be written down.
NOTE 1 Attention is drawn to the Supply of Machinery (Safety) Regulations as amended [5] and related harmonized standards regarding CE marking of products.		
NOTE 2 <i>Assessed capability</i> . Users of this British Standard are advised to consider the desirability of quality system assessment and registration against the appropriate standard in the BS EN ISO 9000 series by an accredited third-party certification body. Users of this British Standard requiring equipment incorporating software are advised to consider the desirability of quality system assessment and registration against the TickIT Rules and Procedures.		

6.4 Installation plan

For permanent installations a Method Statement should be drawn up covering arrangements such as scheduling and detailing the step by step procedures of installation.

For temporary installations a Rigging Method should be prepared. If the competent person who devised the Rigging Method is not expected to supervise the complete installation, that person should ensure that written instructions are provided detailing how the equipment should be installed.

Site conditions and local working conditions should be considered. The allocation of supervision, lines of responsibility and responsibility for final inspection should be established.

After completing the installation plan, a risk assessment should be carried out to confirm that the proposed methods are safe and that installation may commence.

6.5 Commissioning of the installation

Commissioning of a permanent installation should be planned and carried out by the installer of the equipment in the presence of a competent person with the authority to accept the equipment as appropriately installed. The extent of inspection and testing should be agreed by all parties before commencement.

Where the temporary installation includes the modification or assembly of a lifting system from individual components, for example installing a temporary counterweight set or wire rope winch, testing should be completed and the results recorded.

If there is any cause for concern with the equipment or any test fails, corrective measures should be taken and the complete inspection and testing process repeated. This process should be fully documented and copies provided to all parties concerned.

Table 4 shows the sequence and the procedures to be carried out as part of commissioning an installation.

Table 4 — Sequence and procedures for commissioning an installation

Procedure	Permanent installations	Temporary installations	
		Lifting machinery	Flown item
Visual inspection	The installer and the competent person should both carry out thorough visual inspections before testing. It is essential that safe access is provided to all parts of the installation.		It is essential that the competent person carry out a thorough visual inspection to ensure that the rigging method has been implemented correctly.
	All components and systems should be undamaged and marked in accordance with 8.3 .		
Safety	Ensure all movement of the equipment is unobstructed and any risk to people as the result of any operation is minimal.		
Electrical testing	Carry out testing in accordance with BS 7671 or BS 7909 and BS EN 60204.		
Functional testing	Establish whether the specified performance and operability are satisfactory, including the operation of any travel limits, safety sensors (overload, slack wire, safe-edges etc.) and emergency stop system.		Establish whether operation is satisfactory (e.g. noise, speed, clearances). Check the operation of any safety sensors and whether an emergency stop can be achieved safely.
Load testing and certification	Carry out a static test. Static proof load values are established by applying a static test coefficient to the system SWL. The recommended static test coefficient in accordance with BS 7905-1 for manually operated machinery (e.g. counterweight flying systems, hand winches, manual chain hoists monopoies) is 1.5. For other machinery (e.g. powered winches, powered chain hoists, power assisted counterweight systems) the recommended static test coefficient is 1.25.		Carry out such load testing as determined by a competent person.
	Load testing should determine whether the SWLs given in the operating instructions are accurate. Ensure that all test loads are safely secured to the lifting system.		
	Operate the complete installation at full design load.		Operate the system as installed.
	Harnesses used for performer flying and flying props should be tested in accordance with 9.2 .		
	Check deflections in structure(s), movements of fixtures and unexpected noises during and after testing.		
Apply for any approvals required by local licensing authorities.			
Set-up	Configure the equipment to suit the intended purpose.	Set deads, cue speeds and sequences for the scenic item or system.	
Documentation	Complete testing certification. Complete risk assessments and indicate whether equipment is ready for use. Ensure all documentation is available on file.	Complete risk assessments and indicate whether scenic item/system ready for use. Ensure all documentation is available in the Production File.	

6.6 Acceptance and hand-over

Completion of a permanent installation should involve a formal hand-over from the installer to the user, whereby the user accepts that the installation fulfils the Specification of Requirements, and has been installed correctly and successfully commissioned.

There may be a less formal hand-over process for a temporary installation. However it is essential that intended users are instructed in the operation of the installation and informed of specific safety hazards.

The acceptance and hand-over of both permanent and temporary installations should include verification of the following.

a) *Training*

Operational staff have completed the necessary training.

Staff are trained to maintain the equipment.

Personnel have been informed of safety considerations and hazards.

All relevant staff have been made aware of the relevant risk assessments.

b) *Warning notices*

All necessary safety and operational warning notices have been displayed in accordance with BS 7905-1:2001, Clause 11.

c) *Documentation*

As installed drawings have been provided for permanent installations.

Comprehensive and accurate operating and maintenance instructions have been supplied in accordance with BS 7905-1:2001, Clause 12.

Arrangements for routine inspection and maintenance, as applicable, are set-up and recorded.

Following the assessment for acceptance and hand-over of the installation:

- the equipment is deemed safe and functional, with documented maintenance and inspection arrangements;
- all operational and maintenance staff are trained and training sessions are documented.

6.7 Operational life

The planning required for a satisfactory installation does not end at the acceptance stage. Planning should continue throughout the operational life of the equipment.

Both permanent and temporary installations should undergo periodic inspection. The inspection regime should be based on the manufacturer's manual, insurer's requirements and licensing requirements. The type and frequency of maintenance activities should be established.

NOTE Attention is drawn to LOLER [3] and PUWER [4] regarding inspection and maintenance of equipment.

Reviews of the inspection and maintenance regimes should address operational experience. The following should be considered:

- frequency of operation of the equipment;
- loading/wear patterns;
- the effect of a breakdown on a performance;
- opportunities for withdrawal of the equipment for inspection and maintenance.

Inspection and maintenance regimes should be documented, and the results of all inspection and maintenance activities should be logged. This is to aid future fault-finding and review of the maintenance regime, for example intervals between inspections might need to be altered or, more preventative maintenance carried out.

The following regimes should be maintained throughout the life of both permanent and temporary installations.

a) Inspection and maintenance regimes

Establish inspection and test procedures and their frequency (where applicable).

Establish a system for recording inspections and tests and initiating maintenance activity where deficiencies are found.

Establish a preventative maintenance regime if appropriate.

Establish a system for recording maintenance activities.

Ensure that competent staff are available for inspections and that competent staff are available for maintenance activities.

Ensure procedures are set up, as applicable, for:

- safe access to the equipment;
- provision of appropriate personal protective equipment;
- availability of manuals and drawings;
- withdrawal from service;
- spares and tools;
- re-commissioning.

b) Incident reporting

Establish a reporting procedure for incidents, operational difficulties and break-downs. The procedure should address:

- defect investigation and inspection;
- repairs and re-commissioning;
- review of operating procedures to prevent future occurrences, for example by inhibiting certain functions;
- operational staff training;
- system modification if required.

6.8 Equipment dismantling and removal

Consideration of the work required to dismantle and remove permanently installed equipment should be a part of installation planning. This can have implications for the design of the equipment and method of installation. A simple Method Statement for dismantling, removal and disposal of equipment should be prepared in response to a risk assessment. See **8.7**.

The dismantling of a temporary installation should be considered when planning the installation, the De-rigging Method is often the reverse of the Rigging Method, and a risk assessment should be completed for the de-rigging process. The procedures given in **6.4** are applicable.

Items which are likely to be re-used for future installations should be inspected prior to being returned to stock. The inspection records should be updated accordingly.

Items which are not suitable for re-use because of their condition or service life should be destroyed prior to being discarded, for example steel wire rope slings should be cut up.

7 Attachment of loads

7.1 General

This clause gives guidance on the attachment of loads to lifting machinery. The load can be lighting equipment, sound equipment, scenery or any item that it is necessary to lift in an entertainment environment and which might be over people.

It is essential that prior to carrying out any lifting operation, the load and the lifting system are assessed and a lifting method devised which meets the criteria imposed by both.

7.2 Assessment of the load

7.2.1 General

Wherever possible the manufacturer should be consulted to obtain all relevant information relating to the strength, weight and the recommended lifting method for the load.

The load should be assessed with regard to strength, quality of construction and the provision of suitable attachment points which can be used to attach the load to the lifting equipment. It is essential to assess the following:

- a) total weight;
- b) weight distribution;
- c) location of the centre of gravity;
- d) the number and distribution of attachment points and the lifting capacity required for each.

7.2.2 Integrity

The following questions should be considered with regard to the integrity of the attachment of the load.

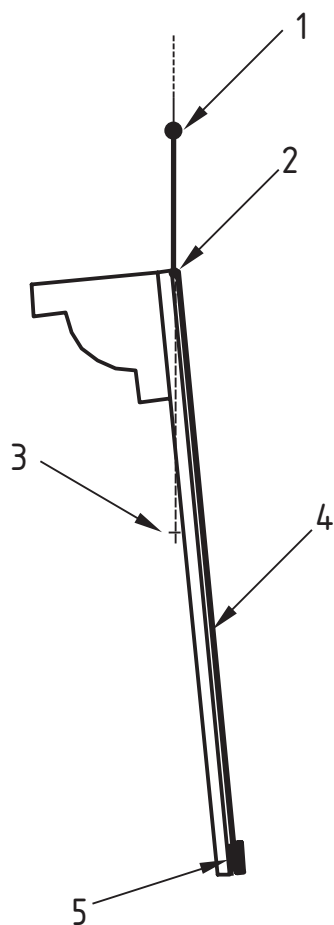
- Is the load designed to be lifted? When possible confirm that the load is certified in terms of being fit for purpose by a competent person and conforms to local licensing requirements. For example, the standard of joints and welding, quality of materials used and strength calculations detailing the behaviour of the load when lifted are all important factors when planning to lift an item.
- Does the load have inherent strength? Is it necessary to provide strengthening within the structure or external to it? For example, extra bracing or stiffening struts.
- Is the load sufficiently strong to withstand the stresses of the lifting process? For example, a large flat which is perfectly stable in the vertical position might break if lifted from a horizontal position, i.e. lying on the floor without sufficient bracing or additional support during the lift.
- The load might not have been designed to be suspended and in this case it is desirable to seek guidance from the manufacturer and/or designer when devising a lifting method. Alternatively, guidance should be sought from an appropriately qualified person, such as a chartered engineer.

7.2.3 Weight distribution and centre of gravity

It is important to know the total weight of the load as well as the weight distribution and location of the centre of gravity. Weight distribution affects the lifting capacity required for attachment points. For example, it might be necessary to add extra attachment points or use a bar or truss to spread the weight depending on the capacity and location of the lifting machinery.

It is essential that the centre of gravity is known so that the load can be suspended in a stable manner without risk of tipping or, more seriously, flipping over when lifted. For example, a flat with heavy moulding on the front face leans forwards if suspended solely from the back, see Figure 2. Figure 3 gives examples of possible methods of hanging the flat vertically.

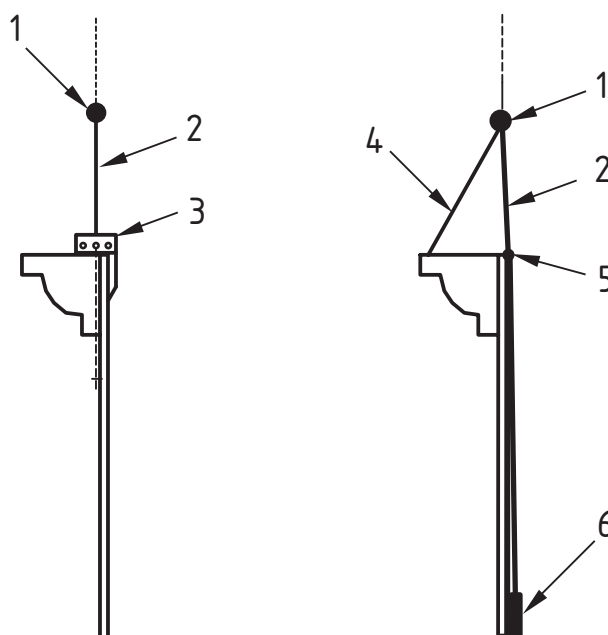
It is essential that long suspension ropes used to support loads from the bottom are captured at or near the top of the load so that the load cannot fall forward. The method of capture should allow the suspension rope to pass freely, for example a tall flat with hanging irons on the bottom edge and with grommets along the top edge.



Key

- 1 Lifting accessory.
- 2 Grommet.
- 3 Centre of gravity.
- 4 Suspension rope.
- 5 Hanging iron.

Figure 2 — Centre of gravity of a flat with a heavy top cornice



Key

- 1 Lifting accessory.
- 2 Suspension rope.
- 3 Trimming bracket.
- 4 Extra suspension rope.
- 5 Grommet.
- 6 Hanging iron.

NOTE 1 The top bracket allows variable positioning of the attachment point. This method is especially suitable for metal flats which do not need to be hung from the bottom.

NOTE 2 Create a bridle by attaching an extra suspension to the front of the cornice. Ensure that the top rail of the cornice is strong enough to withstand the bridle forces and that the attachment points are load bearing.

Figure 3 — Methods of hanging a flat vertically

When determining the weight distribution and centre of gravity the following guidance applies.

a) *Loads where the weight is known*

— Some items of scenery might have their weight marked on them and detailed on design drawings.

NOTE Attention is drawn to the Manual Handling Operations Regulations [7] for information on marking of weight.

— Items of equipment are usually marked with their weight or the information is provided in the documentation accompanying the equipment.

— Where the load consists of two or more elements connected together, marked weights often apply to the marked element only. The total weight is ascertained by adding all the individual marked weights or from drawings and documentation.

— Check whether marked weights include texturing and other effects applied after construction, often they do not. Plywood facias, plaster texturing etc. can add significant weight and alter the centre of gravity.

— A careful judgement should be made, based on the weights of the various elements of the load, as to where the centre of gravity is likely to lie and therefore the distribution of the attachment points required.

b) *Loads where the weight is not known*

— Estimate the weight and weight distribution for the load. Table 5 gives details of the weight of various common materials.

— Where practicable weigh the load or consult the manufacturer and/or design drawings and estimate the weight of the materials used in construction including any texturing or other effects which add weight.

— Where appropriate, seek expert advice, in order to make an informed estimate based on knowledge and experience.

c) *Important factors affecting both known and unknown loads*

— It is common practice to add other equipment such as lighting, speakers or other scenery to suspended scenic items. The weight of these items affect weight distribution and centre of gravity.

— Standard equipment might have had accessories added or have been modified in such a way as to affect the overall weight and centre of gravity. The centre of gravity should be vertically below the attachment point and if the centre of gravity has been changed this can create instability. For example, a luminaire with a heavy projection effect lens added might cause the lighting bar to rotate.

Weight, weight distribution and centre of gravity should be recorded in the production file. If the load is likely to be rigged and de-rigged often this information should be marked on the load, for example for touring productions. It is helpful also to note the number of counterweights required.

Table 5 — Typical weights of materials commonly used for scenic construction

Material	Size/Type	Weight Kg
Timber — Typical softwood	75 mm × 25 mm PAR per m	0.81
Plywood — Far Eastern	4 mm 8 ft × 4 ft flame retardant	9.52
	12 mm 8 ft × 4 ft	23.2
	18 mm 8 ft × 4 ft	34.8
Mild steel	1.5 mm sheet per m ²	11.77
	3 mm sheet per m ²	23.54
	Per m ³	7 850
Steel tube	Scaffold tube (48.3 mm d. × 4.0 mm wall) per m	4.46
	25 mm × 1.6 mm square tube per m	1.18
	18 mm conduit per m	1.2
Aluminium	1.5 mm sheet per m ²	4.1
	3 mm sheet per m ²	8.2
	Per m ³	2 710
	Scaffold tube (48.3 mm d. × 4.47 mm wall) per m	1.67
Scenic fabric	NDFR Scenic flax: ordinary per m ²	0.32
	NDFR Scenic flax: heavy per m ²	0.35
	NDFR Scenic canvas per m ²	0.32
	NDFR Wool serge per m ²	0.53
	NDFR Filled cloth per m ²	0.25
	NDFR Scenic gauze per m ²	0.04
	NDFR Sharkstooth gauze per m ²	0.1

7.2.4 Attachment points

Most items of standard equipment which are intended to be lifted incorporate specific attachment points and/or have suspension methods specified by the manufacturer.

Items of scenery, designed to be suspended, often incorporate attachment points; however, this is not always the case. Scenery incorporating attachment points is preferred.

Different considerations apply depending upon whether the loads incorporate attachment points.

a) Loads with attachment points incorporated

- 1) Establish whether the attachment points are marked or documented for capacity and permitted angle of lift. If not, the manufacturer should be asked for this information.
- 2) Ascertain whether any parts, which appear to be capable of use as attachment points, are capable of suspending the load. Features of the equipment that look as though they would provide good attachment points for lifting accessories might not be suitable for the purpose. Refer to documentation and/or the manufacturer.

b) Loads without attachment points

- 1) Consider whether the load is designed to be suspended and whether it can be safely suspended. For example, scenery built for standing on the floor is not necessarily suitable for suspension. A safe method of lifting should be devised using available knowledge, experience and, where necessary, expert advice. The manufacturer and/or the drawings should be consulted.
- 2) Ascertain where the load-bearing members are located and confirm that the proposed method of attachment, such as drilling holes to fit hanging irons, does not affect the structural integrity of the load before installing attachment point(s).

The number and distribution of attachment points should then be assessed in accordance with the following:

1) *Structural integrity and weight distribution*

Establish whether the number and distribution of the attachment points are adequate considering lifting capacity and weight distribution. Take into account any intended additions to the load, such as electrical equipment or scenic textures.

2) *Centre of gravity*

Establish whether the number and distribution of attachment points enable a stable lift in the correct attitude.

3) *Duality*

Assess the likelihood of failure of any attachment point on the load and whether this would lead to a dangerous situation. If so, consider adding extra attachment point(s) to provide redundancy.

4) *Lifting machinery*

Establish whether the lifting machinery has the necessary capacity and distribution to provide for the number and distribution of attachment points.

If the lifting machinery has the necessary lifting capacity but not the necessary distribution of suspension points to match the attachment points on the load, then bridle techniques may be used to combine two or more attachment points to one suspension point. In this case careful consideration should be given to the structural integrity of the load and the forces acting through the structure of the load between attachment points. See **8.15**.

5) *Visual appearance*

Artistic demands can result in pressure to reduce both the number and visible “size” of the suspension:

- It might be possible to reduce the overall number of suspensions by increasing the weight carried by others.
- Careful siting of suspensions, for example by alignment with structural members, might help.
- Careful choice of materials might help diminish visibility. For example, suitably blackened wire rope is thinner than PVC coated wire rope of the same SWL and is virtually invisible against dark backgrounds.

However, it is essential that the criteria given in items 1) to 4) take precedence over visual appearance, item 5).

7.3 Assessment of the lifting machinery

7.3.1 General

The available lifting machinery should be assessed in terms of:

- a) lifting capacity;
- b) location relative to the attachment points on the load;
- c) type of lifting machinery, which might affect the attachment method;
- d) ability to move the load safely and meet artistic demands.