DRAFT

BSR E1.70-202x
Selection and Use of manually operated Telescoping Lifts for use in the Entertainment Industry

Approved by the ANSI Board of Standards Review on _______________

Rig/2026-2008r0

[This is a placeholder for all front matter before the Table of Contents]

Table of Contents

1 GENERAL

1.1 Scope

This standard establishes minimum safety requirements for the selection and use of manually operated telescoping lifts for use in the entertainment industry. This standard does not address the design or manufacturing of these devices.

1.2 Purpose

The purpose of this document is to provide standards for the use of manually operated telescoping lifts in the entertainment industry. These standards are intended to reduce injury and provide for the protection of life, limb, and property.

1.3 Application

This standard applies to manually operated telescoping lifts used in the entertainment industry including, but not limited to, devices used in theatre, musical touring, film, trade show and television industries.

2 DEFINITIONS

2.1 Competent person: A person who is capable of identifying existing and predictable hazards in the workplace, and who is authorized to take prompt corrective measures to eliminate them.

2.2 Limits of use: The parameters under which the system is designed to operate (e.g. working load limit, speed of movement, duty cycle, environmental conditions, user skill level, availability of maintenance).

2.3 Load carrying device: The components of the system that connect a suspended load to the lifting media.

2.4 Load Hazard Zone (LHZ): The area underneath the load system where death or serious injury may occur as the result of a load system or a rigging failure.

2.5 Load securing device: A mechanical device that prevents unintentional movement in the system.

2.6 Locking mechanism: A mechanism used to lock the masts of the telescoping lift to prevent unintended movement during transportation.

2.7 Qualified person: A person who by possession of a recognized degree or certificate of professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter and work.

2.8 Risk: Combination of the probability of occurrence of harm and the severity of that harm.

2.9 Risk assessment (RA): The process of identifying, evaluating, and quantifying the potentially hazardous conditions, severity, and probability of occurrence of harm.

2.10 Risk reduction (RR): Mitigation of risk created by hazardous conditions.

2.11 Shall: A term used in this standard to indicate that an action is mandatory.

2.12 Should: A term used in this standard to indicate that an action is recommended under most conditions but is not mandatory.

2.13 Static load: The maximum force applied to a component of a hoist system resulting from normal intended operating conditions while the system is at rest. This includes the apportioned fractions of the working load limit (WLL) and self-weight, including that due to load carrying devices and lifting media. *(See Annex note.)

2.14 Support Surface: A level, load-bearing plane or structural component that supports a manual tower lift and transfers loads safely, ensuring overall stability and resistance to forces during operation.

2.15 Telescoping lift operator: An individual who is authorized and qualified to control the movement of the telescoping lift in accordance with the provisions of this standard and any other applicable standards or regulations. The operator shall be trained in the safe operation of the equipment and follow all applicable procedures, manufacturer instructions, and safety standards while operating.

2.16 Telescoping lift owner: The person or entity that has legal ownership of the telescoping lift. The owner is responsible for ensuring the equipment is maintained in safe operating condition and that inspections and records are kept in accordance with applicable standards.

2.17 Telescoping lift user: The person, department, or organization that arranges for the use of the telescoping lift. The user is responsible for ensuring that only qualified operators use the equipment, that equipment is used in accordance with manufacturer and regulatory requirements, and that required inspections are completed prior to use.

2.18 Working load limit: The maximum static load the user may apply.

3 Risk Assessment

3.1 General

A risk assessment shall be performed to determine what hazards are present and their severity. The risk assessment shall prioritize which risks are most in need of mitigation or elimination. The risk assessment should be performed for all possible stage conditions, including the unoccupied facility, load-in, load-out, and performance. The risk assessment may be one large document or multiple documents covering the different uses or operating modes of the machine.

It is preferable that risk assessment be performed by a group of two or more competent persons. When the risk assessment is completed by a single individual, that individual shall be a qualified person.

3.2 Identify the Affected Parties

The risk assessment shall identify all at-risk persons and the risk. Reasonable risk mitigation depends on who is at risk.

3.3 Identify the Hazards

Hazards should be identified on multiple levels.

- for the facility/venue/worksite
- for each department (Wardrobe, Props, Scenic Construction, Scenic Art, Stage, Front of House, etc.)
- for each production and the activities involved
- for the entire life cycle of the machine

There are many ways to identify hazards:

- walk around the worksite and look at how work is done
- ask crew members, technicians and performers at the venue what they consider unsafe
- think about what could possibly go wrong, being sure not to overlook things that people may have “worked around” for years
- review incidents that have occurred at the venue
- talk to others in the industry to find out what hazards they have identified or what sort of incidents they have had

In its simplest form, a hazard identification answers the question “What if...?”.

3.4 Assess and Rank the Risk

The risk assessment shall determine the severity and likelihood of a possible injury caused by the hazard. Risk is the product of the severity of a hazard and the probability of it happening.

Risk assessment and hazard determination are ongoing activities as conditions change. Hazards that were once unlikely may become probable as equipment or performers age or the equipment or scenery changes. Risk reduction solutions that were once impractical may become reasonable.

In its simplest form, a hazard assessment answers the question “What if...?”

- there isn’t a barricade or lanyard preventing access during non-working hours?
- the actors are late to their positions at the top of the act and rush onstage?
- the carpenters need to do last-minute touch-ups on the set using a personnel lift just before curtain?

●the electricians have to do a last minute refocus or relamp?
●the janitor has to access the supplies closet on stage left to service the toilets on stage right, and does this late at night after the show?

		Severity				
		Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Extreme (5)
Probability	Very Unlikely (1)	1	2	3	4	5
	Unlikely (2)	2	4	6	8	10
	Possible (3)	3	6	9	12	15
	Probable (4)	4	8	12	16	20
	Very Likely (5)	5	10	15	20	25

Sample Risk Assessment Table

Low risk 1 – 3
Moderate risk 4 – 8
High risk 9 – 14
Extreme risk 15 – 25

The above "Sample Risk Assessment Table" is one of many possible risk assessment tables. Different tables will have different number ranges and different criteria for separating different risk levels, but all serve the function of helping a person doing a risk assessment rank the risk levels of various hazards. The details of the table used matter little; what matters is that hazards are identified and ranked, so that risks can be addressed in reasonable priority. The risk ranking helps in developing an agenda for what needs to be mitigated.

As can often be the case at the inception of a new machine or machine use, there is little reliable accident data available to you. However, it is important to put forth a concerted effort to conduct risk assessments where needed. Leveraging past experience or simply approaching the process on an intuitive basis to assess how likely a slip, trip or fall is to occur or the damage that might result from an accident is often enough to allow an understanding of what must be done. Certainly, making no attempt to assess risk or to control it because too much is unknown would be to neglect a basic duty of care for workers and other people.
Additional sources of information can assist in identifying where a risk assessment is most needed or needs to be repeated. Sources such as internal incident and accident reports, OSHA 300 log data and insurance claim/loss information can all be sources that can be used to identify injury trends. This data may identify trends from both a frequency and severity of injury perspective.

3.5 Risk Mitigation

3.5.1 Take measures to reduce unacceptable risks.

3.5.2 Determine if the level of existing risks have been changed and whether new or additional hazards have been introduced.

3.5.3 Repeat the risk assessment and mitigation process until an acceptable level of risk is achieved.

3.6 Record the Risk Assessment & Mitigation

The risk assessment should be recorded in a format that is convenient and durable and that can be shared with the affected parties, those people who are at risk or those needing to carry out the risk remediation. Stating the

risk assessment in writing is an obvious and usually convenient format, but it might not be appropriate if some of the people needing access to the risk assessment cannot read. Audio or video recordings might be better media in some instances.
(See Annex A.)
(See Annex B.)
(See Annex C.)

4 Planning and Hazard Communication

4.1 The person(s) performing the RA/RR shall ensure that there is a plan for controlling access to the Load Hazard Zone (LHZ)

4.1.1 The RA/RR shall provide and communicate a means for emergency evacuation from LHZ.

4.2 The person(s) performing the RA/RR shall ensure that the following is communicated to the on-site lead:

- The roles and responsibilities required for event personnel to safely deploy and operate the telescoping lift system.
- The minimum number of event personnel required deploy and operate the telescoping lift system that will be used for the event.

4.2.3 The RA/RR documentation and any mitigating actions necessary for the safe deployment and operation of the system.

- The location and environmental conditions where materials will be handled, transported, installed, or used.
- The pathway through the venue including any restrictions or obstacles that the materials being handled will have to traverse.
- The potential hazards for materials that require special handling.
- The handling of hazardous materials as defined by national, regional, and local regulation
- Reasonably foreseeable hazards created by the equipment used to handle the materials.
- The loading of materials for transportation.
- The number of hours that material handling equipment operators can reasonably be expected to operate equipment safely when not already prescribed by national, regional, and local regulation.

5 SYSTEM REQUIREMENTS

5.1 General

In order to comply with this standard, the supported system, including the telescoping lifts, shall meet the following requirements:

- All components shall be used in a fashion approved by the manufacturer or in writing by a qualified person such as a registered design professional.
- The system design shall be such that the intentional operation of one or more telescoping lifts shall not overload any load system component.
- On systems with multiple telescoping lifts, all applicable load distribution scenarios for the planned operations shall be evaluated and accounted for. This information shall be given in writing to the telescoping lift user by a qualified person.

5.2 Support Surface

The support surface area shall be capable of supporting a load equal to or greater than the total of all anticipated loads applied to it.

5.3 Rigging system

All rigging system components shall have a design load capacity equal to or greater than the maximum anticipated load they will be subjected to.

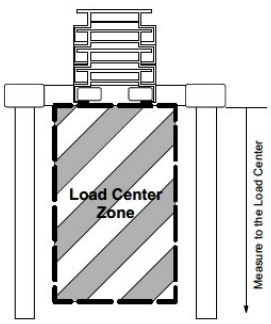
5.4 Lifting system (Telescoping Lifts)

In order to comply with this standard, all lifting system components shall meet the following requirements:

5.4.1 The capacities of telescoping lifts shall be equal to or exceed their anticipated loads.

5.4.2 Telescoping lifts shall be clearly marked with a load positioning table, enabling the operator to verify the load positioning capacity.

E5.4.2 EXPLANATORY Load Positioning Tables



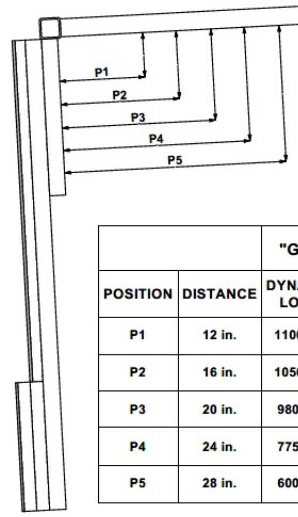
Maximum Load Center

(Measure from the front of the carriage)

Adjustable Forks: 24 in.

Load Capacity Chart					
Load Center					
Inches:		18	20	22	24
Model					
LIFT A	lbs	900	850	675	600
LIFT B	lbs	750	675	615	550

See Load Capacity Chart for maximum load centers for Adjustable Forks.



		"Generic" Crank Lift	
POSITION	DISTANCE	DYNAMIC LOAD	STRUCTURAL LOAD
P1	12 in.	1100 lbs	2600 lbs
P2	16 in.	1050 lbs	2000 lbs
P3	20 in.	980 lbs	1320 lbs
P4	24 in.	775 lbs	880 lbs
P5	28 in.	600 lbs	600 lbs

These graphics are for demonstration purposes only, please consult your user manual or manufacturer instructions for valid loading charts and position tables.

5.4.3 The attachment means to the load shall be properly designed to prevent unintentional disengagement.

5.5 Load system

In order to comply with this standard, all load system components shall meet the following requirements:

5.5.1 Load Positioning (Forks)

The load can be placed either above or below the forks depending on the application. The attachment method and type of media used shall be appropriate for the load's position.

5.5.2 Load Attachment Methods

5.5.2.1 Top mount fork attachments shall prevent the load from unintentional movement or disengagement. This type of attachment is not a part of the load path.

5.5.2.2 Bottom mount fork attachments shall be rated to meet or exceed the lift's capacity and shall prevent the load from unintended movement or disengagement. This type of attachment is considered part of the load path.

5.5.3 Applied Load Positioning

5.5.3.1 Load Center The applied load shall not exceed the rated capacity of the lift relative to the distance from the mast.

5.5.3.2 Horizontal Loading The applied loads shall impart vertical loading only.

5.5.3.3 Load Balance The force of the applied load shall align with the centerline of the mast.

E5.5.3.3 The load balance refers to the center of gravity of the item being lifted. It indicates the relative position of the load's center of gravity compared to the forks or carriage.

6 AREAS OF RESPONSIBILITY

6.1 Telescoping lift owner

The telescoping lift owner is responsible for all maintenance or repair of the telescoping lift.

6.1.1 The owner shall provide documentation of the most recent inspection when requested by interested parties.

6.2 Telescoping lift user

The telescoping lift user shall ensure the telescoping lifts are selected and used in accordance with the provisions of this standard.

6.2.1 Any visual inspections required on site shall be carried out by a qualified person selected by the telescoping lift user.

6.2.2 If maintenance is required on a telescoping lift, the telescoping lift user shall remove the telescoping lift from service until the telescoping lift owner, or their designated person has performed the required service.

6.2.3 If load verification techniques are used during lifting operations, such as load cells or dynamometers, the telescoping lift user shall be responsible for implementing the system, including verifying proper working condition and load distribution.

6.3 Telescoping lift operator

The operator(s) shall be designated by the telescoping lift user and trained in the proper operation of the lifting system, including any multiple telescoping lift systems.

6.3.1 The operator shall be trained to properly use the telescoping lift system, including pre-use inspection, deployment, safety protocols, and operation.

6.3.2 The operator shall avoid overload or unintentional unloading situations during operation.

7 RISK MANAGEMENT

7.1 Requirement for a designated person

The telescoping lift owner shall designate a competent person to perform a risk assessment prior to any lifting operation.

7.1.1 The designated competent person shall have knowledge of the engineering documentation for the temporary structure's components and configurations in use. Deviations from the engineering documentation shall be permitted only with written approval by a registered design professional.

7.2 Requirement for a qualified person

Certain hazards or combination of hazards produce risks that require a qualified person to evaluate and reduce the risks. If the person making the assessment recognizes that the situation warrants a qualified person to complete the risk reduction process, the competent person shall notify the telescoping lift user of this requirement.

7.3 Assessment

Hazards associated with the lifting operation shall be identified and documented. See Section 3.4.3 of Risk assessment and risk reduction.

7.4 Evaluation

Once risk reduction procedures have been selected, a system evaluation shall be undertaken to determine that the residual risk has been reduced to an acceptable level.

7.5 Reduction

For each identified hazard, the risk shall be reduced to an acceptable level.

7.6 Implementation

Once the risk reduction procedures have been evaluated and defined, the procedures shall be implemented prior to the lifting operation.

8 Hazards

8.1 Personnel in the Load Hazard Zone (LHZ)

The presence of personnel in the Load Hazard Zone (LHZ) whether moving or static inherently increases risk. However, certain rigging tasks necessitate the presence of individuals within this zone. Only designated personnel who have received appropriate training and are qualified to perform these tasks should be allowed in the LHZ. These individuals are equipped to identify and appropriately respond to potential hazards, thereby helping to mitigate the associated risks.

8.1.2 All personnel must remain vigilant and free from any condition that may impair the proper execution of their duties.

8.2 Hazards Associated with Telescoping Lift Operations

E8.2 Multiple telescoping lifts in a lifting system increases risk.

8.2.1 The inadvertent operation of any telescoping lift in the rigging system.

Informative: Examples include, but are not limited to:

- Mislabeled telescoping lifts
- Ambient noise levels from unrelated activity or the operation of the telescoping lifts
- Determinate vs. indeterminate loading
- Mismatching lifts (brands, models, or manufacturers)
- Positioning alignment / planar alignment of multiple lifts
- Improper cadence (mismatching speed)
- Expansion of Load Hazard Zone (LHZ)

8.2.2 Multiple operators controlling the movement of one load system.

E8.2.2 Any noise can reduce the ability to respond to required signals during the telescoping lift operation.

8.2.3 The operator's limited ability to visually oversee the entire lifting operation of the multiple telescoping lifts.

E8.2.3 As the load system becomes larger and more complex the risk of an accident increases due to the reduced ability to visually monitor all portions of the system.

8.2.4 Overloading caused by load shifting hazards associated with load systems that are indeterminate structures.
When multiple towers are used in conjunction, the system is now indeterminate and shall be addressed in the Risk Analysis process.

8.3 Environmental Hazards

8.3.1 Environmental hazards that would create an increase in forces on the system.

E8.3.1 Accumulation of rain, ice, or snow loads on the system. Wind and seismic loads.

8.3.2 Environmental hazards that would degrade the system.

E8.3.2 Galvanic, ultraviolet light, ozone, corrosion, or heat degradation on the system.

8.3.3 Environmental hazards such as excessive noise.

9 RISK REDUCTION TECHNIQUES

9.1 Load calculation

Load calculation shall be required as a risk reduction technique for overload conditions of the telescoping lift , rigging system or support structure only in conditions where: (a) the weights of all the elements of the load system are known and accounted for, (b) an accurate calculation method is used for the proper distribution of the load system weight to the lifting system telescoping lifts s and (c) any load shifting during the lifting operation will not be of sufficient magnitude to cause an overload condition.

E9.1 In cases where the telescoping lift capacity is greater than the support structure, the risk can be reduced by calculating that the maximum anticipated load is less than the capacity of the support structure. Load calculation of an indeterminate structure can be affected by the rigidity of the load system, rigging system, and support structure. These calculations require sophisticated structural analysis in order to accurately consider such factors. In some cases, certain factors may not be available for consideration, such as the support structure rigidity for a touring set erected in various venues. Appropriate measures should be taken to ensure that each telescoping lift receives loads not exceeding its calculated load and/or the design shall include sufficient conservatism to accommodate an associated amount of load shifting.

9.2 Load verification

Load verification shall be permitted as a risk reduction technique for overload conditions of the support structure or any rigging, telescoping lift or load system component by the operator continuously monitoring and taking corrective action before an overload occurs.

E9.2 During lifting operations, load verification techniques are only effective as a risk reduction technique to the extent that the operator can monitor all telescoping lift loads and stop operation before the support structure or any rigging, telescoping lift or load system component becomes overloaded.

In cases where the operator will not be able to see the display and visually monitor the load system during the move, an audible alarm or extra personnel will be required.

For the use of load limiting control devices that verify telescoping lift loads and control the telescoping lift operation, see Section 7.5.5. For overload warning devices, see section 7.6.3.

9.3 Load reduction

It shall be permissible to reduce risk by reducing the load.

E9.3 In many cases simply removing portions of the load system will reduce the forces in the entire system to an acceptable level.

9.4 Controlling personnel access to LHZ or load system

9.4.1 Restrict or eliminate access to suspended loads.

9.4.2 Restrict or eliminate access to the LHZ.

9.4.3 Provide a means for emergency evacuation from suspended loads.

9.4.4 Provide a means for emergency evacuation from LHZ.

9.5 Reducing load shifting effects

9.5.1 Elimination of indeterminate structures where possible.

9.5.2 Reduction of load system rigidity.

9.5.2.1 Introduce hinges to increase the system flexibility.

9.5.2.2 Use dampers to reduce the speed of load shifting.

9.5.2.3 Use flexible construction materials or structures.

10 PRE-OPERATION PRECAUTIONS

Prior to operation under load the following precautions shall be taken by the telescoping lift operator.

10.1 The telescoping lift operator shall adhere to the manufacturer's recommended pre-operation inspection and functional test checklists before each use of the equipment. *

E10.1 Example pre-operation and functional test checklist

Pre-Operation Inspection Checklist

Manually Operated Telescoping Lifts

- ☐ Verify the operator's manual is completely legible and in the storage container located on the machine.
- ☐ Locate all safety decals and verify they are legible.
- ☐ Ensure all locking pins and retaining pins are present if applicable.
- ☐ View the following components to ensure proper condition and installation
  - ☐ Winch and related components
  - ☐ Base components
  - ☐ Outriggers, outrigger screw jacks, outrigger foot pads and outrigger casters
  - ☐ Mast columns
  - ☐ Exterior plastic shim for safety brake
  - ☐ Cable anchor
  - ☐ Cables and pulleys
  - ☐ Carriage hold-down latch
  - ☐ Wheels and casters
  - ☐ Adjustable forks
  - ☐ Nuts, bolts and other fasteners
  - ☐ Cable (check for kinks, frays, abrasions)
- ☐ Ensure entire machine is free of dents, damage, corrosion / oxidation, or cracks in welds or other structural components.
- ☐ Ensure all locking pins operate freely and are returned to the locked position if applicable.
- ☐ Ensure all structural and other critical components are present, and all associated fasteners and pins are in place and properly tightened.
- ☐ Verify there are a minimum of 4 wraps of cable around the winch drum when the carriage is fully lowered.
- ☐ Perform functional tests (up and down) after initial setup to ensure the winch and mast operate smoothly, free of hesitation or binding.

10.2 The telescoping lift user shall ensure they have the RA/RR plan and all necessary resources to properly follow it.

10.3 The telescoping lift user shall conduct a worksite inspection to verify current conditions and identify potential hazards in accordance with the RA/RR form. This inspection shall be performed prior to use, as site conditions may have changed since the initial setup.

11 OPERATION

11.1 General operating practices

While performing any lifting operation, the telescoping lift operator shall adhere to the following general operating practices.

11.1.1 Only operate the telescoping lift within the manufacturer's specification.

11.1.2 Focus full attention on the lifting operation.

11.1.3 There shall be a designated person controlling the cadence of the operators performing the lift.

11.1.3.1 The designated person shall oversee the system lift from a viewpoint where they can see the entire operation.

11.1.3.2 While performing the lift, the designated person shall ensure that the system lift is progressing in the intended manner and rate of speed.

11.1.3.3 The telescoping lift operators shall respond to GO signals from a designated person only.

11.1.4 All personnel shall respond to a STOP signal from anyone.

11.1.4.1 In the event of an unintended STOP, a competent person shall evaluate the situation and implement corrective action(s) before moving the load system in any direction.

11.1.5 Periodic stops should be implemented throughout the lift to ensure the load remains level.

11.1.6 The designated person shall control access to the Load Hazard Zone (LHZ) in accordance with the RA/RR.

11.1.7 After the final system assembly, the system shall be secured with a load securing device to prevent unintended lifting or lowering.

12 Specific operating practices

In addition to the above general operating practices, any specific practices identified by the risk reduction process shall be implemented.

13 Engineered lifting operations

During the risk reduction process, if a qualified person is deemed necessary, any risk reducing factors identified shall be implemented. The operator shall follow written or other instructions provided by the qualified person.

14 TRANSPORTATION AND HANDLING

14.1 Transportation considerations

14.1.1 Manufacturers guidelines shall be followed when transporting the equipment.

14.1.2 The telescoping lift shall be secured in transit to minimize the likelihood of damage.

14.1.3 Locking mechanisms shall be employed during transit if available to prevent unintended movement of the masts.

14.2 Handling considerations

14.2.1 Manufacturers guidelines shall be followed when handling the equipment.

14.2.2 If the telescoping lift is equipped with a reclined or transport position, it shall be used when moving the equipment.

14.2.3 Any telescoping lift that has sustained impact or damage shall be immediately removed from service and shall not be returned to operation until it has been inspected and approved by a qualified person designated by the lift user.

14.2.4 Any telescoping lift failing an inspection shall be removed from service, tagged and returned to the owner.

13 Maintenance, Repair, and Inspection

15.1 The owner of the telescoping lift is responsible for ensuring all maintenance, repairs, and inspections are performed as required to maintain safe operation.

15.1.1 Inspections, maintenance, and repairs shall be performed by a qualified person designated by the owner or an authorized representative, in accordance with the manufacturer's recommendations.

15.2 Repairs shall be performed by qualified persons with the appropriate training and expertise to assess and correct issues in accordance with the manufacturer's specifications.

Annex A, Examples of hazards and hazardous situations

This annex is not part of the requirements of this standard. It is included for informational purposes only. Defined examples may or may not be directly applicable to this standard.

1.0	**Mechanical hazards:**
	a) Size and shape of hoist system
	b) Relative location
	c) Mass and velocity of elements in controlled and uncontrolled motion
	d) Inadequacy of mechanical static structural components
	e) Inadequacy of mechanical components to resist repetitive elastic stresses
	Component checklist for failure mode analysis:
	a) Motor capacity
	b) Primary braking capacity
	c) Secondary braking capacity
	d) Suitability of lifting medium
	e) Attachment of lifting medium
	f) D/d value of sheaves and drums (if used)
	g) Shaft size and design including hollow components and keyways
	h) Secondary drive mechanisms (chains, belts, etc.)
1.1	Crushing hazard
1.2	Shearing hazard
1.3	Cutting and severing hazard
1.4	Entanglement hazard
1.5	Drawing in or trapping hazard
1.6	Impact hazard
1.7	Stabbing or puncture hazard
1.8	Friction or abrasion hazard
1.9	High pressure fluid injection or ejection
1.10	Exposure to hazardous materials used in the manufacture or operation of the hoisting machine
2.0	**Electrical hazards:**
2.1	Contact of persons with live parts (direct contact)
2.2	Contact of persons with parts that have become live under faulty conditions
2.3	Approach to live parts under high voltage
2.4	Electrostatic phenomena
2.5	Low frequency, radio frequency, microwave interference
2.6	Failure of power supply
2.7	Failure of control circuit
3.0	**Environmental hazards:**
3.1	Burns and other injuries due to contact with objects that achieve high operating temperatures
3.2	Damage to hoist or hoist system or personnel due to hot or cold working environment
3.3	Additional loads due to wind
3.4	Damage to hoist or hoist system due to excessive moisture
3.5	Inadequate access for maintenance
3.6	Inadequate local lighting for maintenance and operation
3.7	Fire or explosion hazards
4.0	**Noise hazards:**
4.1	Hearing loss (deafness) and other physiological disorders (e.g. loss of balance or awareness)
4.2	Interference with speech communication, acoustic signals, etc.
5.0	**Vibration hazards:**
5.1	Personnel exposure to machine vibrations
5.2	Damage to hoist or hoist system due to environmental or self-imposed vibrations
6.0	**Control system hazards:**
6.1	Human error, human behavior
6.2	Inadequate design or location of local controls
6.3	Inadequate design location of programmable controls
6.4	Improper use of E-stop
6.5	Inadequate limit over-ride procedures

6.6	Software errors
6.7	Operational ergonomic concerns
6.8	Mental overload (e.g. due to number of channels controlled at one time)
6.9	Mental underload stress (e.g. due to repetitive tasks)
6.10	Control system position feedback errors
6.11	Simultaneous motion of multiple hoists
7.0	**Unexpected startup, unexpected overrun/overspeed due to:**
7.1	Failure/disorder of the control system
7.2	Restoration of energy supply after an interruption
7.3	External influences on electrical equipment
7.4	Software errors on startup/restart
7.5	Operator error
8.0	**Emergency hazards:**
8.1	Mechanical failure during operation
8.2	Failure of emergency stop devices, interlocks
8.3	Impossibility of stopping the hoist or hoist system
8.4	Combination of hazards

Annex B, Risk assessment and risk reduction example

This annex is not part of the requirements of this standard. It is included for informational purposes only. Defined examples may or may not be directly applicable to this standard.

The following example is based on the risk assessment and risk reduction process (see figure 6 and table 1) and guidelines established in ANSI B11.TR3-2000.

The example below includes only an abbreviated list of the limits of use, the tasks, and the associated hazards.

The estimated severity of harm and probability of occurrence of harm was quantified using table 1 in the example.

Although not shown explicitly, the following factors were considered when estimating the probability of the occurrence of harm:

1. Exposure to the hazard
2. Personnel who perform the tasks
3. Machine / task history
4. Workplace environment
5. Human factors
6. Reliability of safety functions
7. Possibility to defeat or circumvent protective measures
8. Ability to maintain protective measures

The method used to identify the risk value (R) associated with a hazard is to multiply its probability (P) by its severity (S). (R = P * S). The criteria for acceptable risk is shown in table 1.

		Probability				
		Unlikely	Unlikely but Possible	Likely	Highly Possible	Certain
Severity	**Trivial injury**	**1**	**2**	**3**	**4**	**5**
	Minor injury	**2**	**4**	**6**	**8**	**10**
	3-day injury / loss of work	**3**	**6**	**9**	**12**	**15**
	Major injury	**4**	**8**	**12**	**16**	**20**
	Death	**5**	**10**	**15**	**20**	**25**
1-4: Acceptable risk; 5-8: Acceptable only if risk is as low as is reasonably practicable; 9-25: Unacceptable risk						

Table 1 Hazard risk rating table

It is possible that a hazard (e.g. falling objects) can have a multitude of causes (e.g. lift line or brake failure), and each cause needs to be evaluated separately.

Although not necessarily shown in the example below, the supporting design data used for producing the initial probability, severity, and mitigation values for more complex design changes (e.g. drawings and calculations) should be recorded with the documentation of the risk assessment and risk reduction.

Risk assessment and risk reduction is an iterative process that is repeated until the risk is at an acceptable level. An abbreviated schematic of the process is shown in figure 10.

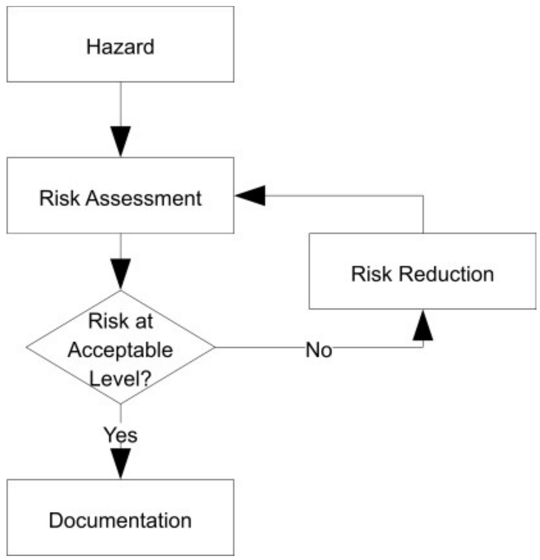


Figure 10: Risk assessment and risk reduction flow chart

Example risk assessment and risk reduction
Sections in "*italics"* are not actual parts of the example.

The following risk assessment and risk reduction was conducted using the procedure established in ANSI B11.TR3-2000.

This is an examination of what has the potential to cause harm to people as considered during the design and manufacture of a typical hoist. Support documentation, drawings and calculations would be supplied in a separate document.

This assessment is designed to assess the risk of injury to the following people:
1. Hoist system installation personnel
2. Maintenance personnel
3. Hoist operators
4. Stage performers and technical personnel
5. Visitors

It identifies the severity of potential hazards and probability of occurrence as per table 1 and documents steps taken to minimize the risk.

Limits of Use
This is a partial list of typical limits of use for this example.

Hoist capacity (working load limit)...........340 kg (750 pounds)
Maximum speed......................................Maximum 0.914 m/s (180 feet per minute)
Duty cycle..Maximum 2 complete cycles under full load followed by 15 minutes of rest
Mounting..Adequately mounted to the grid that is suited to support the hoist
User...Operated by qualified users only

Operating environment............................Indoor use only
Temperature: 4°C - 49°C (40°F-120°F)
Humidity: 20% – 85% non-condensing
Power supply...480V, 3 Phase, 20A

Some anticipated tasks throughout the life of the product
More additional tasks exist than are shown in this example.

1. Installation
    1. Unpacking
    2. Hoisting
    3. Attaching to the building
    4. Connecting power and control
2. Usage (including reasonably foreseeable misuse)
    1. Performing movements in normal operating conditions
    2. Attaching loads to the load carrying device
    3. Move and suspend the attached load
    4. Overloading hoist (foreseeable misuse)
3. Test and Maintenance
    1. Troubleshooting
    2. Annual Inspection
        1. Gaining access to the machine or other parts of the system
        2. Test brakes
        3. Test limit switches
        4. Test E-stop system
        5. Inspect wire rope
        6. Inspect loft blocks
    3. Replace wire rope

List of hazards
Refer to table 1 for (S) and (P) values.

Phase of life: Usage
Task: Move and suspend the attached load.

Hazard / cause	Hazard Severity (S)	Probability (P)	Risk Rating (S * P)	Mitigation technique	Hazard Severity (S2)	Probability (P2)	Residual Risk (S2 * P2)
Crushing hazard, load falls after catching on HVAC duct close to pipe end	5 Falling objects can kill people	3 As currently designed, pipe ends within 6 inches of ductwork	15	Shorten pipe to maintain clearance.	5	1	5
Crushing hazard, operator cannot see load in motion	4 A fast moving pipe can severely injure a person	4 Upstage sets can not be seen from the control location	16	Supply an enable switch in a location from which the upstage sets can be seen	4	1	4
Crushing hazard, unauthorized user lowers pipe on person	4 A fast moving pipe can severely injure a person	3 Controls system in public space	12	Supply control system with keyswitch	4	1	4
Many additional hazards may exist that are not shown in this example.							

Phase of life: Maintenance
Task: Troubleshooting

Hazard / cause	Hazard Severity (S)	Probability (P)	Risk Rating (S * P)	Mitigation technique	Hazard Severity (S2)	Probability (P2)	Residual Risk (S2 * P2)
Electrocution due to touching live parts	5 Electrocution can kill a person	1 All electrical component s touch safe in a fully enclosed cabinet in locked room	5	Not required	5	1	5
Many additional hazards may exist that are not shown in this example.							

Conclusion
Significant hazards have been identified and satisfactory mitigation techniques have been introduced so that the risk is reduced to an acceptable level. Please refer to engineering drawings and documentation for additional details.

Annex C, Risk assessment publications

The following publications do not address the field of entertainment machinery and controls specifically, but they can add insight into the field of risk assessment and can serve as guidance to teams and individuals in creating risk assessment and risk reduction procedures. ANSI B11.TR3-2000 is of interest to the entertainment industry due to its accommodation and recommendation for input from the end user.

Standards publications

ANSI B11.TR3-2000 Risk Assessment and Risk Reduction - A Guide to Estimate, Evaluate and Reduce Risks Associated with Machine Tools.

ANSI/RIA R15.06-1999 American National Standard for Industrial Robots and Robot Systems - Safety Requirements (revision of ANSI/RIA R15.06-1992)

ANSI/ISO 12100-1:2007 Safety of machinery – Basic concepts, general principles for design – Part 1: Basic terminology, methodology

ANSI/ISO 12100-2:2007 Safety of machinery – Basic concepts, general principles for design – Part 2: Technical principles

ISO[1] 12100:2010 Safety of machinery – General principles for design – Risk assessment and risk reduction

ISO[2] 14121-1:2007 Safety of machinery - Risk assessment - Part 1: Principles

ISO[3] 14121-2:2007 Safety of machinery - Risk assessment - Part 2: Practical guidance and examples of methods

ISO[4] 13849-1:2006 Safety of machinery – Safety related parts of control systems – Part 1: General principles for design

ISO[5] 13849-2:2006 Safety of machinery – Safety related parts of control systems – Part 2: Validation

IEC[6] 61508-1 through 7 Functional safety of electrical/electronic/programmable electronic safety-related systems

Reference publications

Main, Bruce W.
Risk Assessment: Basics and Benchmarks
Publisher: Design Safety Engineering Inc. (2004) Oxford, UK
Hardcover: 485 pages
Language: English
ASIN: B0025YG7U6

Smith, David and Simpson, Kenneth G.L.
Functional Safety" - A Straightforward Guide to Applying IEC 61508 and Related Standards
Publisher: Butterworth-Heinemann; 2 edition (August 10, 2004) Ann Arbor, MI

---

[1] International Organization for Standardization www.iso.org

[2] International Organization for Standardization www.iso.org

[3] International Organization for Standardization www.iso.org

[4] International Organization for Standardization www.iso.org

[5] International Organization for Standardization www.iso.org

[6] International Electrotechnical Commission, IEC Central Office 3 rue de Varambé, P.O. Box 131, 1211 Geneva 20, Switzerland www.iec.ch/

Hardcover: 280 pages
Language: English
ISBN-10: 0750662697
ISBN-13: 978-0750662697

Abkowitz, Mark D.
Operational Risk Management
Publisher: Wiley (April 4, 2008) Hoboken, NY
Hardcover: 278 pages
Language: English
ISBN-10: 0470256982
ISBN-13: 978-0470256985