Examination

The purpose of annual in-service examination is to determine whether any of the critical components of an course have deteriorated to an extent liable to cause danger (e.g. by corrosion, wear, fatigue or a failed component). Particular attention needs to be paid to those components which have been highlighted by the designer or design reviewer. This part of the annual in-service inspection may require some or all of the following:

- Visual examination of course and related components and/or systems
- Observing a operational cycle
- Physical participation (where applicable)
- Non Destructive Testing (NDT)
- Pneumatic Inspection
- Electrical examination and testing
- Hydraulic Inspection
- Control Systems Inspection
- Mechanical / Structural examination

Function Tests

The final part of the annual in-service inspection is to carry out functional tests to demonstrate that, at the time and place of the test, the course, element or component is still capable of performing to the design specification or previously known parameters in the absence of original design data. In particular the tests will seek to confirm, as applicable, the:

- correct corridor width and height for intended operational constraints (*patron clearance envelope*)
- correct harness or containment system and positioning of patron and proper operation of all locking systems
- correct working of control systems (if any)
- correct operating speeds (if relevant)
- correct operation of safety devices (e.g. anti-rollback systems where applicable)
- efficiency of the braking system and without noticeably changed passenger decelerations
- acceleration and deceleration under normal working conditions and in cases of emergency
- presence of emergency evacuation procedures and equipment
- observation of a program orientation

Written Reports

Qualified Inspectors (QI) should utilize standard forms or processes that are consistent for the different types of structures and operating systems when providing inspections.

All relevant inspection reports are required to clearly convey the extent and scope of an inspection and identify any areas within the defined scope where inspection was not undertaken and recommend necessary action.

Any limitations to the inspection, for example poor / limited access, should be recorded in the report, so that the owner/operator is made aware of the extent of inspection and any further work required in order to satisfactorily complete the inspection before the Certificate of Inspection can be issued.

Appropriate action, and the time within which any defects have to be remedied, should be specified. If a defect has been identified during the course of an annual in-service inspection, the QI should specify whether the defect requires immediate action before the course or element is used, or within a specified time.

On detection of a serious defect, which may present a danger to the public or members of staff, a written report should be given to the owner/operator, client or other inspection body as appropriate.

> This will need to take the form of an immediate instruction not to use the course or element, and Red Tagging the ride until the defect has been rectified, the re-inspected and a COI issued.
>
> Where practicable this notification should be received in writing, or failure to receive signature of delivery should be recorded.
>
> If the inspection body considers a defect has implications for other similar devices, this information should be passed on via the appropriate procedure.

Confidentiality

Inspection bodies should ensure confidentiality of information obtained in the course of its inspection activities. However, there is a need to provide some interpretation of this aspect of the standard in relation to the challenge course industry, bearing in mind the demands of the need to ensure safety.

It may be necessary to divulge information to the relevant regulatory bodies, other known users of an identical system or component and/or industry associations when it is considered to be of importance in terms of the safe use of the device. This is particularly true when an incident or accident has occurred that could conceivably occur on similar rides or with similar devices or components.

If the QI considers that they have not been allowed sufficient access to relevant reports (or other documents) they should notify the owner/operator that the COI cannot be issued.

Instructions for In-Service Annual Inspection

The operations manual should include information on the examination and testing of the device once in use, including reports of previous annual in-service inspections being available (or on file). Details should be included for all critical components and where relevant, estimates of their likely operational lifespan with the required inspection intervals. The information should include the type of techniques to be used and criteria for acceptance / rejection. Where appropriate, reference material relating to the original condition should have been included, e.g. the results of original NDT or measurements of the performance of critical components or systems.

The information included in the operations manual regarding inspection may need to be added to as a result of recommendations made in subsequent reports. Other sources could include safety bulletins from manufacturers, industry trade associations (ACCT, ASTM, CWA, NAARSO, etc.) and information received by the owner/operator or QI. For courses installed and operated prior to 2012, the adequacy of the related information about annual in-service inspection may have been confirmed or added to by an owner/operator's maturity based risk assessment rather than a design review.

If the information regarding annual in-service inspection, as specified by ACCT or ASTM (as is relevant), is not present in the operations manual, the appointed inspection body should inform the owner/operator, or their representative on site, that the COI cannot be issued.

Inspection should not be restricted to the areas specified in the manufacturer's information or the design review. The predictions of fatigue or operational life of components and structure may have been based on theoretical assumptions which can be affected by actual conditions such as:

- misaligned loads on eyebolts or cable terminations
- improper torque on bolts or clamps
- poor welding
- misalignment of joints
- included bark on trees
- root damage on trees
- deadfall on trees used for course or near course
- water ingress and frost damage
- corrosion
- Natural occurrences like flooding, high winds, lightning, or drought.

Any inspection requiring special techniques should have the procedures documented. e.g. instructions on how to perform tests such as over-speed, over-travel, block system tests, etc. If such information is not available the QI responsible for the tests should detail the technique used in the report.

Courses fitted with pre-engineered systems should have maintenance and inspection instructions in the operations manual. If such instructions are available, the QI may, if required to do so by the owner/operator, carry out this part of the inspection providing that they are competent to do so.

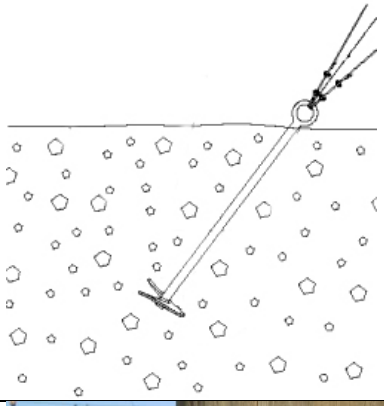
Service History

The appointed inspection body should consult the operations manual and related inspection history and maintenance logs to review the service history of the course, elements and equipment and any trends in deterioration of the devices or systems that may influence the way in which the annual in-service inspection is to be carried out. The owner/operator should also have kept this under review in the period since the last annual in-service inspection.

Mechanical / Structural / Civil Inspection

Example Areas of Inspection

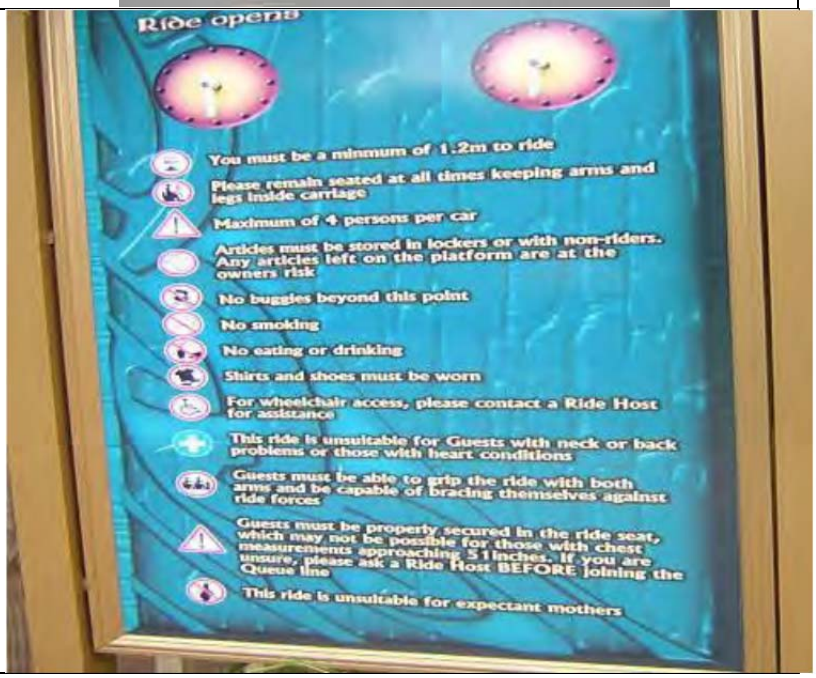
This section gives examples of areas requiring inspection (this is not exhaustive)

All fixing and fastening components (slew-ring bolts, holding down bolts, counterweight bolts, attachment pins, ball joints, etc.) Cracking; corrosion; integrity & alignment; correct fastening; mechanical damage.	
Welded joints Cracking; corrosion.	
Guy Systems Guy anchors, wires, clamps, tension, location, etc. Appropriate tensions, tightness of clamps, stability of anchor and surrounding soil.	
Columns and Poles • Class • Species • Year of Manufacture • Treatment • Thickness • Diameter Wood poles are stamped; steel columns will typically require the review of drawings or manufacture supporting documentation.	

Passenger containment • Structural components • Working mechanisms including protective coverings • Attachment areas Cracking; corrosion; wear; alignment; sharp edges; mechanical damage.	
Rotating components (rings, bearings, shafts etc.) Cracking; corrosion; wear; alignment; mechanical damage.	**Rotating D Rings, pulley shafts** 
Tracks and guided systems, areas where tracks quickly change direction Cracking; corrosion; wear; alignment; mechanical damage.	**Continuous Belay Systems**  
Structural components Cracking; corrosion; wear; alignment; mechanical damage; stress ratcheting (frost damage). Proper grade of fasteners, and their assembly	

Drive systems Attachment; cracking; corrosion; wear; alignment; sharp edges; mechanical damage, proper liberation.	
Anti-Rollback and catching protection systems Attachment; cracking; corrosion; wear; alignment; mechanical damage.	
Damping systems, shock absorbers, air bellows Correct attachment / placement; cracking / splitting; corrosion; wear; alignment; mechanical damage; correct functionality.	  
Brake components	

Cracking / splitting; corrosion; wear; attachment; alignment; mechanical damage; correct functionality.	
Foundations, bases, soil conditions, packing Cracking / splitting; corrosion; attachment; alignment; mechanical damage.	 
Emergency exits Correct placement of exit signage & lighting; attachment; relevance and effectiveness.	
Platforms Correct placement; attachment; fall from height hazards.	
Access stairways, Access Systems, etc. Correct placement; attachment; fall from height hazards. 42” tall, 3-3/4” openings.	

Wire ropes and chains Attachment; wear; corrosion; adequacy relative to application.	
Corridor or theming and/or other items with potential to encroach on the patrons motion envelope Attachment including secondary; Corrosion; Alignment; Sharp edges;	
Adequate passenger information signage **Correct placement; relevance; adequate to minimize risk of injury**	

Hydraulic and pneumatic systems **Proper air pressure** **Correct fluid levels** **Correct fluid being used** **Pulleys function properly** **Cable replacement schedule is maintained**	

Although several items are listed above, they are only examples, and all parts of all devices should be subjected to annual inspection.

Repairs and rework

Where areas are found to have deteriorated beyond safe usage, repair or replacement will be necessary.

If a component is to be repaired, the repair must be carried out by approved personnel to a method that has been assessed by the design review body and/or the manufacturer. The QI should take all necessary steps to ensure the repair has been carried out to a satisfactory standard.

If components are to be replaced, the QI should satisfy themselves that a “like for like” replacement has been carried out. This should include the final material specification.

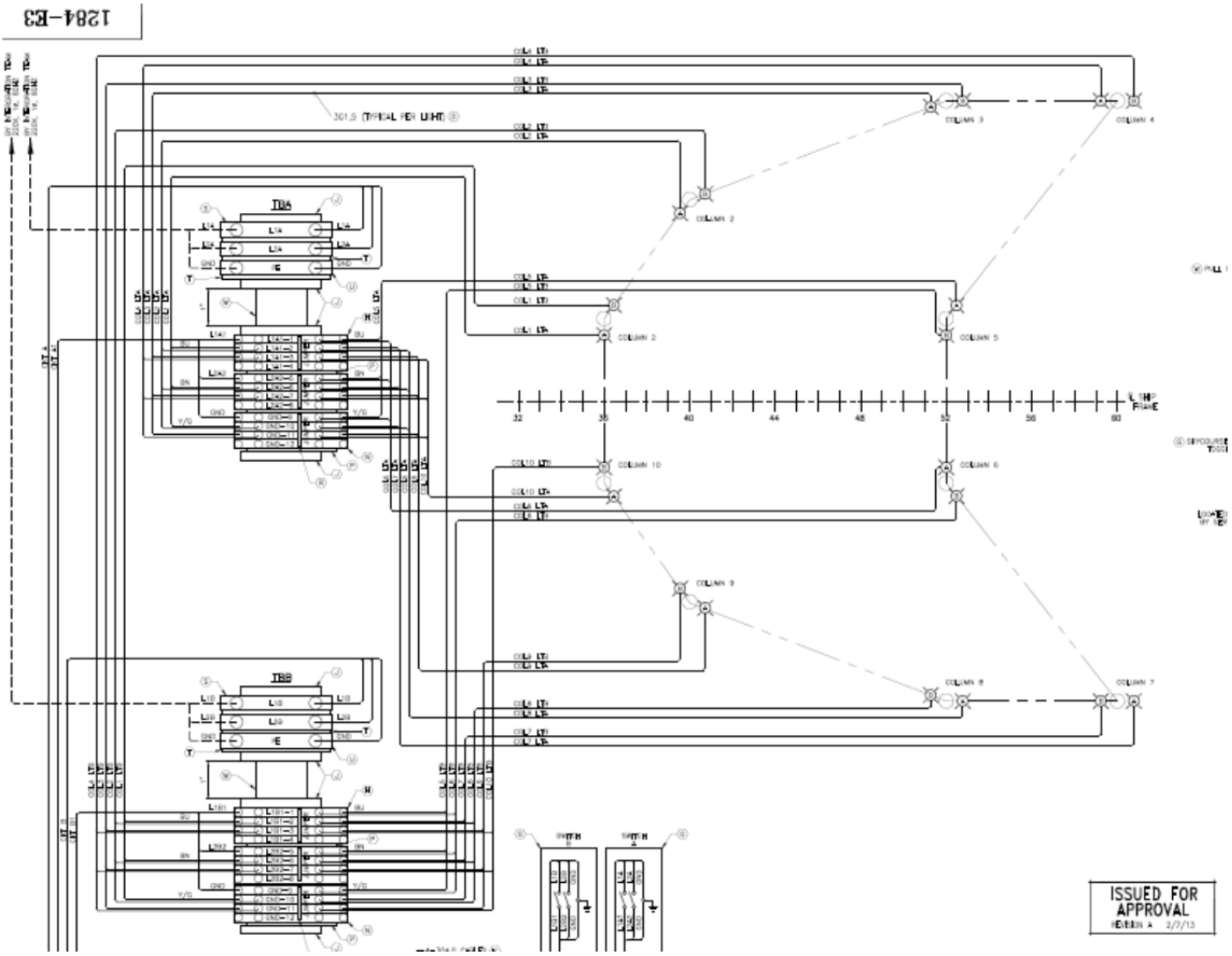
Some replacement components may require relevant inspection and documentation prior to use.

An in-service inspection report or reports should cover each discipline (mechanical, electrical, etc.) carried out, highlighting areas of repair, upgrade or other observations, as a means of passing information to the owner/operator. Details of any defects considered to have implications for similar devices should be provided to the industry and/or public for consideration and communication.

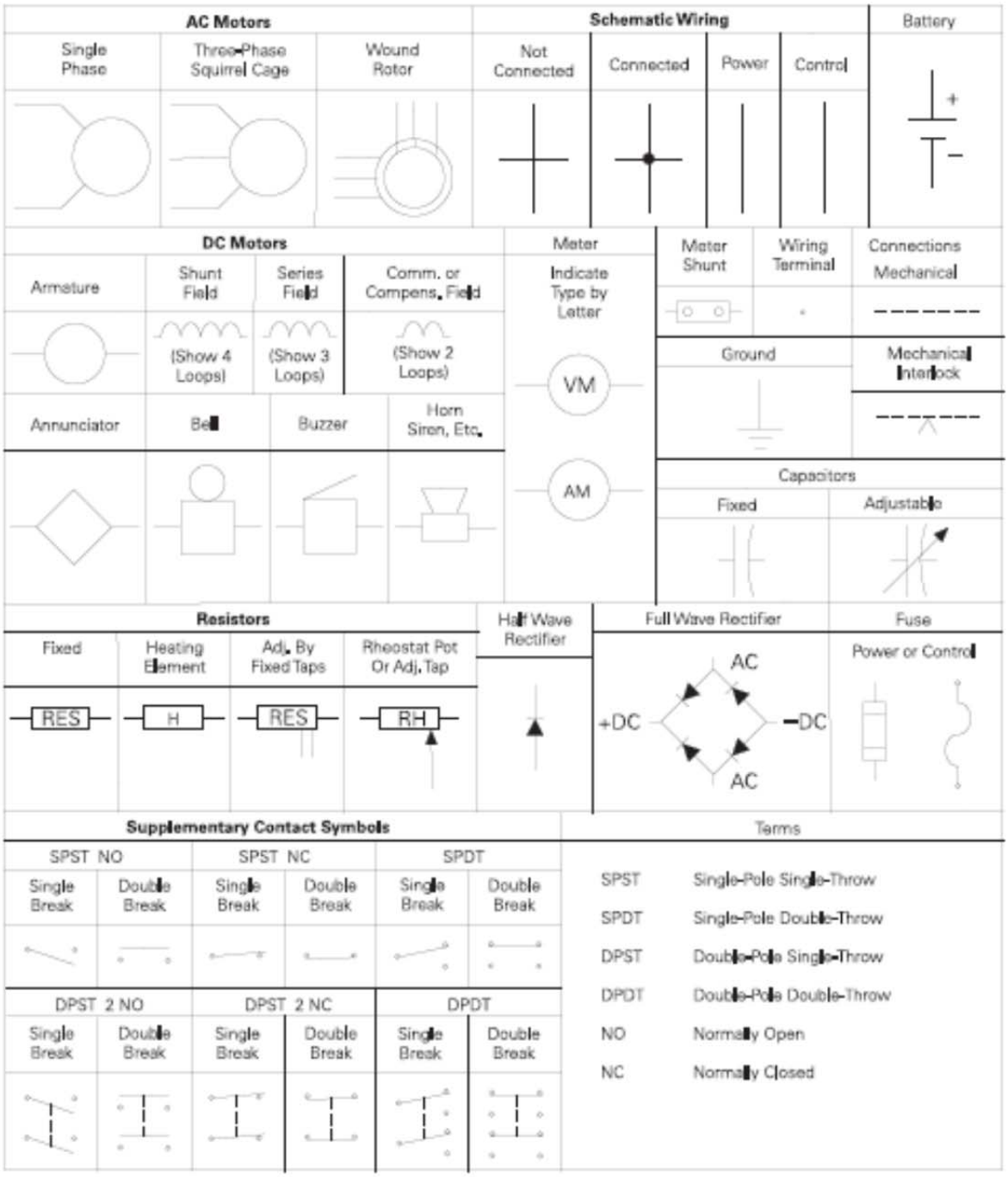
For some devices, it may be prudent to issue interim reports to enable the owner/operator to begin refurbishment in preparation for the next need to operate

Electrical Inspection

An electrical Plan



Some Common Electrical Symbols



The primary objective is to determine that the electrical or control systems have not deteriorated since the last in-service inspection and to assess the significance of any deterioration that may have occurred. The results should be recorded on the inspection report form.

The assessment should be carried out by taking the following steps:

- Ascertaining history and determining if any changes or modifications have been made
- Visual inspection
- Measurement and test
- Functional test (one cycle of the course or element)

Where the course, element or device is powered from generators the examination should include not only the element or device but also the supply system and supply cables.

Where supplies are derived from a permanent source, access may not be permitted to substations or switch rooms; in this case the examination would then be limited to the element or device itself and the terminating apparatus of the supply cables. The limitation of the inspection should be noted in the report. These areas should be inspected by persons competent to do so as required in the written maintenance procedures.

It should also be noted that for courses with large elements incorporating workshop / garage areas, unlit or intentionally dark sections housed in buildings, theming, audio systems, lighting systems, stores located at the end of the exit and outside lighting and sockets situated in waiting lines, these areas should be included in the written maintenance procedures and tested per relevant industry standard.

Visual Inspection

A thorough visual inspection should be made of all electrical equipment which is not concealed and should include the accessible internal condition of a sample of the equipment. The external condition should be noted and if damage is identified or if the degree of protection has been impaired, this should be recorded. The inspection should include a check on the condition of all electrical equipment and material, taking into account where applicable any available manufacturer's information, with regard to the following:

- Corrosion
- Damage
- Excessive loading (overloading)
- Age
- External influences

A full visual assessment should be carried out. This may include opening up a sample of electrical panels, for the element or device, in the switch room and on the generator if applicable, but without dismantling equipment unless signs of deterioration are noticed. All specific items below may be the subject of random sampling, but the sampling rate may be determined according to the assessed risks.

The control system components should be inspected to ascertain that:

- Their condition has not deteriorated to such an extent that they would operate incorrectly;
- Any settings are as specified;
- They are operating correctly;
- No unauthorized or temporary links have been used;
- Connections are not obviously loose;
- Where obvious replacement of component parts has occurred, that they are of the correct specification;

Electrical Color Coding

RED	Source or Feed Voltage which is Hot ALL the Time; typically battery voltage, or could be a computer supplied voltage.
ORANGE	Switched Voltage; usually comes from an ignition switch, a relay or a computer (5, 9, 10, 12 or 13-15 volts)
YELLOW	Permanent or Hard Ground; examples include battery ground, alternator ground, chassis ground, or engine ground
GREEN	Switched Ground; a switch, relay or computer (e.g., sensor ground via a PCM) provides a path to ground

BLUE	Load; the load (relays, solenoids, lamps, resistors, etc) is what does the work or performs a function

- The type of supply should be ascertained, and entered onto the inspection report (ex.110 or 220 V a.c).
- Check that lockable isolating devices, situated appropriately and conveniently for the intended use, are provided for motors and that they function correctly. Where group isolation is provided, ensure that the isolating devices are correctly labeled to indicate the circuits that they switch.
- Check that where devices such as slip rings, live rails and pick-ups allow access to live exposed conductors they are protected against ingress of solid bodies and objects to a minimum standard.
- Check that any socket outlets that may be used to supply portable equipment or equipment outside the operational zone of the course, element or device are protected at some point in the system without adjustable time delays.
    - Check that all lighting, cables and electrical components:
        - Are securely fixed in place so that they cannot fall into the motion envelope of the elements or devices or onto users, passengers or persons using the course, element or device
            - Cannot be touched by users or passengers on the course, element or device, where such contact may present a risk of injury. Risks to consider may not only be from normal conditions, but may also be after an item such as a lamp cap has broken or fallen off
            - Are in good condition
            - Are connected together with mechanically sound, safe connections
            - Plugs and sockets are of a suitable type and rating
- Check that excess multiple adaptors are not being used, but with particular reference to operator's areas or pay boxes.
- Check that any portable equipment in the pay box or operator's station is wired appropriately using good practice. The owner/operator, as the duty holder, may need a Portable Appliance Test for such equipment.
- Check the point of supply / isolation area of the device for safe access including adequate lighting and general good housekeeping and that there is a firm, level and even floor.
- Where possible examine lighting assemblies which are made up in the form of series connected lamps to ascertain that the conductors within the lamp holders are sufficiently insulated and protected as to prevent access to live parts when the lamps are in the lamp holder.
- The cable connection side of multiple lighting units should be examined where they are not enclosed to check that there are no bare conductors or terminals.
- Check that all lighting assemblies, fittings (particularly plugs and sockets) and other connections are suitable for the environmental conditions in the area in which they are situated.

DC Systems

- If the system is not referenced to ground, confirm that suitably rated over-current protection such as a fuse or circuit breaker is provided in each pole of the supply to protect from overload and fault current. In addition, confirm that all switches, isolating devices and disconnecting devices for all equipment, including pay box lighting, display lighting, motors, etc., operate on each pole of the circuit.
- If the system is referenced to ground or another reference point, and is not a PELV system, confirm that grounding, bonding and protection against indirect contact arrangements as for a.c. systems are in place.
- Visually check that any resistance elements of motor starters and the like are adequately ventilated. The enclosure should be properly maintained, be robust and not be used for any other purpose.
- Where an interlock is required to prevent a knife switch being closed when the starting handle is not at the off position, it should be checked visually and function correctly.

- Check that all cable terminations at starters, motors and at any connection point are properly made of and are shrouded with robust covers.

- Check that all contactor and electronic panels are enclosed, e.g. those used for flashing lights, etc.

- Check that all face plate starters, knife switches, fuses, links and terminals, when energized, are protected against inadvertent contact and short circuiting by substantial and suitable insulation or barriers.

- Check that all live electrical parts of d.c. systems working at voltage levels above 120 volts d.c.(typically 460 volts) are enclosed by insulating material to Class II standard, or are safe by position, or are in grounded metal enclosures that form part of an grounded bonding and automatic disconnection system. Alternatively, for non-referenced systems at these voltages, confirm the presence of and functionally test the monitoring device that indicates when a line to frame fault has occurred.

Cables and Connections

- Cables should be visually assessed to ensure that they are in good condition, with no hazardous damage to the insulation, and correctly secured where necessary.

- Connecting devices such as plugs and sockets should be checked to ensure that they are suitably rated, not damaged and are complete. Cables should be securely gripped by cable grips and the sheathing should not be pared back so far that the basic insulation is exposed. The continuity of the protective conductor across the joint should be ensured by using proprietary glands and similar components. The condition of these connections should be checked on a sample basis.

- Check that main power cables are suitable and correctly sized for their loads and that the overcurrent protective devices (fuses and / or circuit breakers) are correctly selected for the current carrying capacity of the cables.

- Cables should also be visually assessed to confirm that they are protected from mechanical damage and do not create a trip hazard by being for example:
    - Buried in a safe manner
    - Routed overhead at an appropriate height and well supported
    - Where applicable, provided with external mechanical protection
    - Self-protected, such as with steel wire armor, provided that the non-flexible nature of such a cable does not cause a danger
    - Where necessary, fixed securely
- Where any protection is provided using metallic systems, including armor and braid, it should be confirmed that the metal or conductive parts are grounded.

- Check that cables which are moved regularly or flexed due to the motion of the amusement device:
    - Are in good condition
    - Are flexible, with a tough outer sheathing, or are in suitable flexible conduit that is in good condition, with correctly fitted glands where necessary
    - Are suitably routed and restrained to prevent strain on the terminations where they enter or leave any panel or enclosure
- Visually check that cables or wires are not being subjected to chafing where they pass through holes in enclosures, etc. Where necessary, grommets or other means of protecting the cables should be used.

- Joints and terminations should be checked to ensure that:
    - They are protected against mechanical damage and other external environmental conditions
    - Strain relief is provided if necessary
    - There are no signs of overheating, or high resistance
    - There is good electrical contact and adequate mechanical strength at the joints
    - Terminations are shrouded and/or enclosed, or protected by barriers, so that accidental contact with live conductors cannot happen
    - Bolted terminations are insulated and further protected. Twisted wire joints are not adequate for joining cables

Grounding and Bonding

- The integrity of the grounding and bonding arrangements should be checked by inspection and testing.

- In systems in which the supply is not grounded, or where the a.c. voltage is below 25 v or where the peak d.c. voltage is below 60v, grounding may not be necessary, although bonding of exposed conductive parts may be necessary

- The main incoming ground terminal (and/or electrode) should be checked visually for good condition and the value of the external ground loop impedance measured using a loop impedance tester.

- All exposed metallic parts of current carrying electrical equipment should be connected to the main ground terminal. A sample of these connections will need to be confirmed by testing.

- Extraneous conductive parts will also require consideration. A judgment will need to be made regarding the bonding of extraneous metalwork of the complete course, element or device, but it should be confirmed that a satisfactory ground connection is being made to any metal lighting poles, barriers etc., on which control panels or any electrical devices are fitted, and to any metalwork within reach of these items.

- If visual assessment and sample tests demonstrate that any exposed conductive parts of the course, element or device are not satisfactorily grounded then testing should take place.

- Where slip rings are used to transmit power, an ground slip ring should be provided and used. Bearings are not suitable for providing connections to earth.

Electrical Enclosures, Components and Switchgear

A random visual sample check inside electrical enclosures and switchgear should be carried out, at the same time as the visual check outlined above. The general condition of the installation will help determine the depth of investigation.

- Check that any enclosures or switchgear are securely fixed in place
- Check that isolating devices, circuit breakers and fuses are not shorted out by links or wires and that their moving parts work freely and correctly
- Look for signs of burning or excess heat
- Check that all internal components are correctly fixed in place
- Check for presence of water, poorly fitting waterproof seals and rusted cabinets
- Check that items of switchgear are clearly labeled as to the circuit they are switching or protecting
- Where it is foreseeable that a person may need to gain access to the inside of an enclosure, e.g. for resetting of circuit breakers or adjustments, it should be confirmed that there is no possibility of contact with live parts. Check for finger-proof terminals, suitable barriers, etc.
- Visually check that all metallic doors of electrical enclosures are grounded using a flexible braid or wire and that this connection is sound
- Carry out a random sample check of circuit breaker ratings to ensure that they are correctly rated for the current carrying capacity of the electric cables and for the load current
- Carry out, where it is likely that changes have been made to the installation, a check to confirm that switches are not inserted into any protective conductor and no single pole switch is inserted into any neutral conductor. (A multi-pole switch which disconnects phase and neutral conductors is permissible)

- Check that electrical enclosures are to the correct IP ratings, complete and undamaged so as to prevent persons making direct contact with exposed live parts. The outer case of all electrical enclosures, and any circuit breaker apertures, should be inspected to confirm that there are no holes or gaps, except where necessary for cable access or ventilation.

- Check that where cabinets or enclosures are placed at positions which are accessible to members of the public or non-authorized staff, the doors or covers are fitted with lockable handles or fasteners which require a tool to gain access or are provided with a correctly functioning interlocking power disconnector.

- Confirm that, where provided, any interlocking power disconnector is installed and is working correctly.

Measurement and Test

Tests carried out during the in-service inspection are at the discretion of the inspector and will be based on experience and previous history with the course, element or device. However, unless otherwise stated, it is normal for tests to be carried out at the origin of the supply, at all distribution boards and on a sample of final circuits, e.g. motors, pumps, sockets and lighting.

- The accepted sampling rate should be provided by the manufacturer and may include up to 10% but if any faults are found the sampling rate should be increased accordingly

- The areas / components sampled should be varied from one examination to the next and their identities documented so as to ensure that over a number of inspections all similar components have been inspected

Both a.c. circuits and d.c. circuits require tests such as insulation resistance between positive and negative conductors, continuity of circuit protective conductors, polarity, etc.

- The measured value of the circuit protective conductor resistance should be sufficiently low, taking into account the overall required ground loop impedance value for the protected circuit and the disconnection time of the associated fuse or circuit breaker

Unless there are records of previous tests, polarity checks should be carried out at the following locations:

- Origin of the installation
- Distribution boards
- Accessible socket-outlets
- Extremity of radial circuits

However, where a loop impedance tester has already been used, that has confirmed correct polarity at a particular location; the tests will not need to be repeated.

Earth fault loop impedance should be measured, during which a check of the polarity and grounding of the circuits can be made. The values of loop impedance should be checked against the relevant values set out in current standards or data obtained from the manufacturer of the protective device.

Generators AC

Check that the frame of the generator is connected to the following:

- The star point of the generator output windings (neutral)
- An appropriate ground electrode
- The protective conductor from the element or device to the generator

Visually check that a suitable ground rod or alternative ground connection is in place and that the connection to it is sound. If a suitable position for an ground rod is not available, or is proved unreliable, one of the following may be used on their own, together or in addition to the ground rod:

- The ground terminal of an adjacent fixed installation
- Permanent structural steelwork
- Exposed reinforcement bars in concrete foundations or structures
- A suitably grounded metallic structure
- A ground mat

An exception to the above may be where small single phase generators are used as unreferenced isolated supplies in which case all the following criteria should be confirmed:

- The output cable should be short (not more than 10 metres)
- The generator should be used to supply single elements and devices such as portable zip lines, etc.
- The cable should be suitably protected against mechanical damage
- Exposed metalwork of the course, element or device should be bonded to the frame of the generator
- Any switches or isolators are double poled

Visually check that the generator output panel is equipped with an isolating device or devices, which are of adequate current and voltage rating.

Confirm that any fuses or circuit breakers are correctly rated in order to ensure over-current and short circuit protection of each individual outgoing supply cable and meet the specified disconnection times.

Generators DC

- Check that the generator output panel is equipped with isolating switches, one in each pole of the various supplies (these may be ganged units). The isolating switches must be of adequate current and voltage rating and function correctly.

- Check that isolating switches, knife switches, terminals, conductors and fuses are not exposed and are shrouded with robust covers of insulating material, so that adjacent poles cannot inadvertently be shorted and inadvertent contact with live parts cannot be made.

- Confirm that any fuses or circuit breakers are installed in each pole of the supply (provided that the output is not referenced to ground) and correctly rated in order to ensure over-current and short circuit protection of each individual outgoing supply cable.

- Where d.c. and a.c. generators are used in conjunction or located close together, check that the combined cross sectional area of protective conductors from the generators to the course, element or device is at least equal to ½ the cross sectional area of the largest system conductor of either generator and that the chassis of both generators are also connected together with a similar size conductor.

Emergency Lighting (where applicable)

- Emergency lighting should be illuminated and visually checked to confirm that there is generally adequate lighting to escape the course, element or device safely, should there be an emergency and loss of normal lighting. This should only be regarded as a visual test that light levels are reasonable.

- The switching of emergency light fittings should be tested to confirm that they illuminate on loss of supply to the normal lighting that would be used, in that particular area, during an emergency.

- It should be confirmed that emergency lighting can remain illuminated at a sufficient level to allow the area to be safely evacuated.

Functional Test

- The checks and tests in the following paragraphs should be carried out and any unexpected results investigated to determine if any safety critical degradation has occurred since the previous examination.

- The operations manual should be consulted for this discipline of the inspection to determine if any special tests such as over-speed, over-travel, weighing systems, block system, etc., are required.

- Interlocking and other control devices which are part of any safety related system should be examined for mechanical wear or damage and proven to operate correctly. Consultation with the manual should determine if these items are functionally checked at routine intervals by the owner/operator, in which case it may only be necessary to witness the correct functioning of the system. The areas of concern may include, amongst others:
    - Moving platforms where the platform position is critical with regard to the course, element or device motion envelope
    - Moving theming, which is detected as being in a safe position by the control system
    - Systems for confirmation of locking of barriers and gates
    - Position detection sensors, such as rope switches on chairlifts, etc.
    - Brake detection sensors
    - Weighing devices

- Where automatic detection of unrevealed faults is not carried out by the control system, for example in series interlock circuits, each individual switch or contact or sensor should be proven to be working correctly.

- All safety critical interlocks relating to seat restraint systems should be checked individually, both visually and by functional test, to determine that they are working correctly.

- It should be checked that “no volt release” systems are in place and working correctly. This check should be carried out by removal of power at the main incoming supply and at any relevant downstream circuit breakers.

- The emergency stop system should be tested during a ride cycle, or different parts of the ride cycle as necessary, to determine correct function at all times. It must be confirmed that the device halts as quickly as necessary, in the correct place or places and with minimal risk to participants. Where the time taken for a device to come to a halt is critical, this time should be recorded. The test should be repeated for all emergency stop actuators.

    - In some instances, however, it may only be advisable or necessary to confirm that the main emergency stop relay is dropped out, without running the complete device, so that components such as braking systems, anti-roll backs, etc., are not subjected to undue stresses.

    - It should be noted that some emergency stop systems are complex and the original design risk assessments may have indicated a need for unusual results of emergency stop actuation; in such cases the manual should be consulted.

- It should be confirmed that resetting any part of the emergency stop system does not, by itself, carry out any restart of motion.

- The device should be run in both manual and any available automatic modes and watched to see if the control system performs correctly.

- Where relevant to safety, the speed, cycle time and any other relevant parameters should be measured, compared with existing data and recorded. If there is any discrepancy between existing data and recorded readings the cause should be investigated and assessed.

- Accelerations and decelerations should be observed and if noticeably higher than expected, may need to be investigated. It may be necessary to take measurements and compare them with existing data.

- If possible a power fail condition should be simulated and the performance of the device assessed. Any special evacuation or recovery control systems should be confirmed as available and operable. In some situations it may not be possible to remove power, or evacuation procedures may be too complex, or may damage equipment. In such cases other means such as document review or audit of standard operating procedures may be able to confirm readiness of such systems.

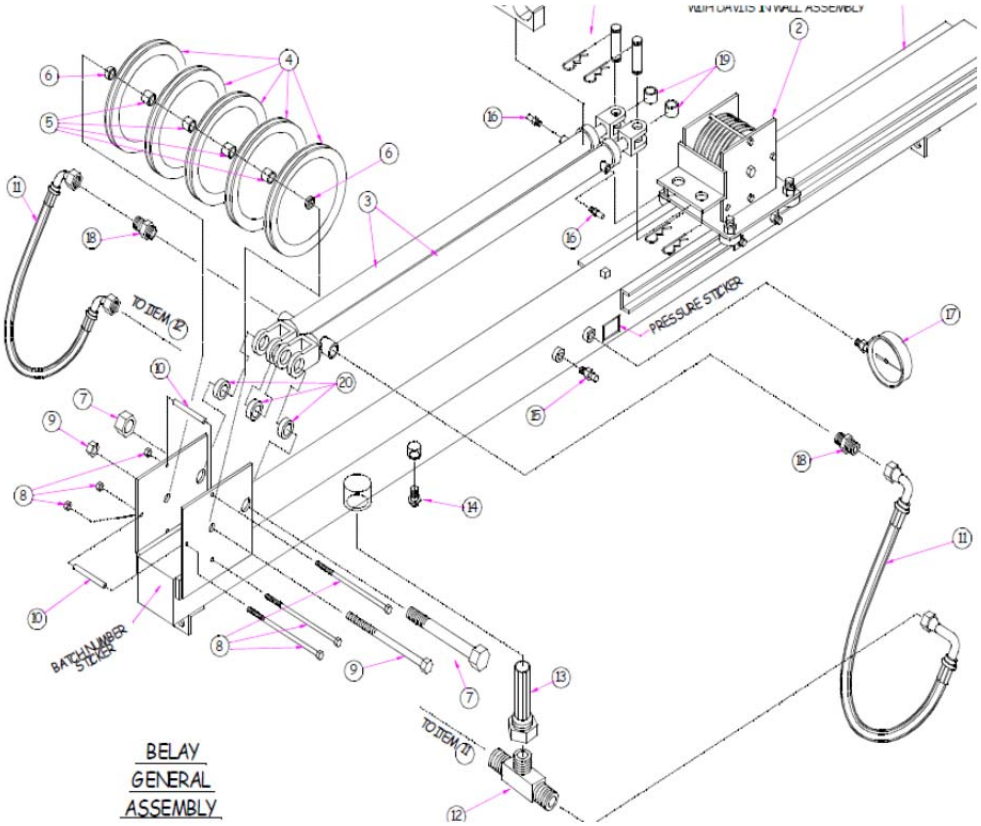
- Positional detection systems should be subjected to a functional check that proves all critical sensors and any anti-collision systems. If the designed logic does not detect unrevealed faults, then tests should be carried out in such a manner that normally un-revealed faults are discovered. The tests should take into account both primary and secondary redundant or diverse systems.

- A functional check should be made of any braking systems to ensure that devices of all types come to a halt in a appropriate manner and in line with any manufacturer’s recommendations.

- Any systems designed to ensure that the course, element or device does not inadvertently start (i.e. unexpected start up) whilst passengers are embarking, should be assessed to determine that they are still in place and functioning correctly.

- Functions designed to ensure the course, element or device operates within set limits should be tested to ensure they still operate correctly and within the designer’s specifications. Typical examples are over-speed, over-travel, weighing systems, chain tension, belt tension, etc. The operating manual should be consulted to find the correct test methods.

Pressure System Inspection



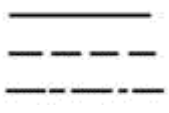
- The primary objective is to determine that the pressure systems have not deteriorated since the last in-service inspection and to assess the significance of any deterioration that may have occurred. The results should be recorded on the inspection report form.

- Owners/Operators should have a suitable written plan for examination in place before the system is operated. This plan should be provided by the manufacturer. The pressure system shall be inspected as specified by the manufacturer.

- Inspectors should ensure that a written inspection plan is in place before carrying out an inspection on any pressure system. If such a plan or documentation from the manufacturer is not available one should not continue with the inspection and note the deficiency. The owner/operator shall be informed of the deficiency.

Common Pressure System Symbols

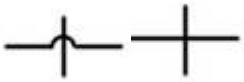
Line, Working (Main)
Line, Pilot (For Control)
Line, Enclosure Outline



Direction of Flow - Hydraulic

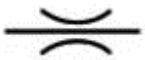
Direction of Flow - Pneumatic

Lines Crossing



Lines Joining

Line with Fixed Restriction



Line, Flexible

Station, Testing, Measurement or Power Take-Off

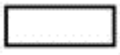
Variable Component (Run Arrow Through Symbol at 45°)

Pressure Compensated Units (Arrow Parallel to Short Side of Symbol)

Temperature Cause or Effect

Reservoir Vented

Reservoir Pressurized



Line, to Reservoir Above Fluid Level

Line, to Reservoir Below Fluid Level

Vented Manifold

PUMPS (Hydraulic)

Fixed Displacement

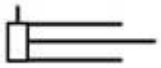
Variable Displacement

MOTORS AND CYLINDERS

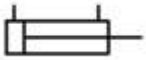
Hydraulic Motor Fixed Displacement

Hydraulic Motor Variable - Displacement

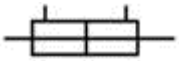
*Cylinder, single acting



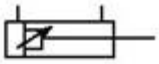
*Cylinder, Double Acting - Single End Rod



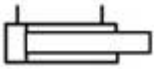
*Cylinder, Double Acting - Double End Rod



*Cylinder, Double Acting Adjustable Cushion - Advance Only



*Cylinder, Double Acting Differential Piston



* Cylinder symbol shown in simplified version

MISCELLANEOUS UNITS

Electric Motor

Accumulator, Spring Loaded

Accumulator, Gas Charged

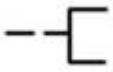
Heater

Cooler

Temperature Controller

Filter, Strainer

Pilot Pressure - Remote Supply



Pressure Switch

Pilot Pressure - Internal Supply

Pressure Indicator

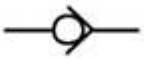
Temperature Indicator

Component Enclosure

Direction of Shaft Rotation (Assume Arrow on Near Side of Shaft)

VALVES

Check

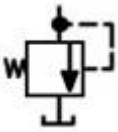


On-Off (Manual Shut-Off)

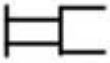
METHODS OF OPERATION

Spring

Pressure Relief

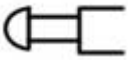


Manual



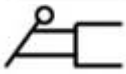
Flow Control, Adjustable-Non Compensated

Push Button

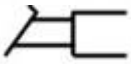


Flow Control, Adjustable (Temperature and Pressure Compensated)

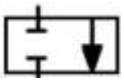
Push-Pull Lever



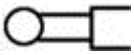
Pedal or Treadle



Two Position
Two Way

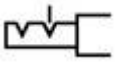


Mechanical



Two Position
Three way

Detent

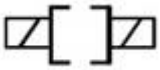


Two Position
Four Way

Pressure Compensated

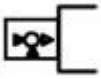
Three Position
Four Way

Solenoid, Single Winding



Two Position
In Transition

Servo Motor



Valves Capable of Infinite Positioning (Horizontal Bars Indicate Infinite Positioning Ability)

Written Inspection Outline

- A written outline or manual for inspection and maintenance is a document containing information about selected items that form a pressure system, operate under pressure and contain a relevant fluid (or compressed or liquefied gas, including air at a pressure greater than 7 psi above atmospheric pressure, which includes pressurized water above 110^0 C and steam at any pressure.

- A typical manual for Inspection of a pressure system includes:
    - Identification of items within the system
    - All parts of the system that shall be examined
    - The nature of the inspection requires, including the inspection and testing to be carried out on any protective devices.
    - The preparatory work needed for the item to be inspected safely.
    - The maximum intervals between examinations
    - The critical parts of the system which, if modified or repaired, should be examined by a competent person before the system is used again.
    - The date of last inspection and inspector.

- An item from the pressure system should be included in a written form if its failure could unintentionally release pressure from the system and the resulting release of stored energy could cause injury. Each system is likely to be unique, but the following questions may help inspectors to arrive at some decisions.
    - Do the manufacturers of the pressure system give guidance, instruction and the precautions to take for proper and safe operation of the system?
    - Could failure of any part of the pressure system cause someone in the vicinity to be injured by the release of pressure, fragments or steam?
    - Does the pressure system contain any protective devices?
- The written inspection procedures should generally cover all items within a self-contained pressure system which may give rise to danger. If you have more than one self-contained pressure system, you will probably need more than one written plan.

- The written plan of inspection must be suitable throughout the lifetime of the device, so it should be reviewed and, when necessary, revised. For example, as the age of the device increases you may need to carry out more frequent examinations or change their content of the written plan is reviewed at appropriate intervals by a competent person to determine if it remains suitable.

Hydraulic and Pneumatic System Inspection Requirements.

Some systems or parts of systems may need inspection in accordance with a written plan of inspection. The owner/operator or their representative should be consulted to determine the following and take appropriate measures as required for major modifications.

- Have any faults or failures of the system occurred since the last inspection
- If any critical modifications have been made since the previous inspection.

- The owner/operator should further be consulted to ascertain if any failures of the system have occurred since the last inspection and it should be determined if these are critical. Inspection requirements may need to be modified or added to if information obtained demonstrates necessity.

- Before carrying out any inspections the manufacturers manual should be consulted for any relevant information. Critical systems and critical components that might, under failure conditions, present a hazard should be identified and listed within the manual. This list should form the basis for an inspection schedule. A schedule of this type should be provided with the owner/operators documentation. However, if not in place, it will need to be drawn up by the QI or sought from the manufacturer.

- A list of critical systems or components (hydraulic or pneumatic) might include
    - Accumulators
    - Elements of the passenger restraint system
    - Braking Systems
    - Drive motors
    - Launch Systems
    - Theming
    - Control Gates
    - Lifting and lowering systems (cylinders, bellows, valves, etc.)
    - Hoses, pipes, and any other component that
        - May present hazards to the system under failure conditions
        - May present a danger during the process of failure, e.g. Whipping of hoses, spraying of fluid.
    - Any other component whose failure would cause a hazard
    - Any critical components that have been removed for testing or replaced since the last inspection should be identified and listed for inspection. An inspection should be made of such items to confirm that they have been installed correctly.

- The Schematic Drawing for the system should be checked to confirm that it correctly represents the systems to be inspected.

- The ride or element should be observed operating in all available modes to ensure correct operation of the pneumatic or hydraulic systems.
    - The number of components in a system will vary, the pressures and the complexity of control systems will vary. Trying to identify the exact role of each component can be difficult.
    - Attempting to test individual components can be impossible without removing them from the system.

- It is far better to monitor the performance of the actuators and ensure that they are working correctly.
    - This can be done by checking that cylinders and the other components are moving at the correct speed and generating the correct forces.
    - Where interlocks are provided these should be tested for correct function.
    - Where appropriate record the times, pressures, and the ambient temperature. If necessary compare these with previous records.