Developed in partnership
with the
Health and Safety Executive

ADSC
Amusement Device Safety Council

Safety of Amusement Devices
2008
In Service Annual Inspection

ADIPS

Safety of Amusement Devices: Advice for Inspection

2008

Part 1

In Service Annual Inspection

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This guidance is issued by the ADSC on behalf of the industry associations listed in the Foreword. It is endorsed by the Health and Safety Executive. Following the guidance is not compulsory and you are free to take other action. But if you do follow the guidance you will normally be doing enough to comply with the law. Health and safety inspectors seek to secure compliance with the law and may refer to this guidance as illustrating good practice.

Foreword

1. This document is published by the Amusement Device Safety Council (ADSC)

2. The ADSC promotes safety within the Fairgrounds, Theme Parks and Attractions industries in the UK.

3. The following industry associations, together with the Health and Safety Executive (HSE) are represented on the ADSC:

The Amusement Catering Equipment Society (ACES)
1 Delamere Road, Turf Hill, ROCHDALE, OL16 4XD; Tel: 01706 869841

The Association of Independent Showmen (AIS)
P O Box 194, Wortham, DISS, IP22l PG; www.ais.me.uk

The Amusement and Leisure Equipment Suppliers of the UK (ALES-UK)
1st Floor, 74 Kilbury Drive, WORCESTER, WR5 2NG; Tel: 01905 360169; Fax: 01905 360172; www.ales.org.uk

The British Amusement Catering Trades Association (BACTA)
Alders House, 133 Aldersgate Street, LONDON, EC1A 4JA; Tel: 020 7726 9826; Fax: 020 7726 9822; www.bacta.org.uk

The British Association of Leisure Parks, Piers and Attractions (BALPPA)
Suite 12 Tanner Street, LONDON, SE1 3LF; Tel: 0207 7403 4455; Fax: 0207 7403 4022; www.balppa.org

Health & Safety Executive (HSE)
1st Floor Mercantile Chambers, 53 Bothwell Street, Glasgow G2 6TS; Tel: 0141 275 3000; Fax: 0141 275 3100; www.hse.gov.uk

The National Association for Leisure Industry Certification (NAFLIC)
PO Box 752, SUNDERLAND, SR31XX; Tel: 0191 5239498; Fax: 0191 5239498; www.naflic.org.uk

The Showmen's Guild of Great Britain (SGGB)
41 Clarence Street, STAINES, TW18 4SY; Tel: 0 178 461805; Fax: 0 178 461732; www.showmensguild.co.uk

The Society of Independent Roundabout Proprietors (SIRPS)
66 Carolgate, Retford, NOTTS, DN22 6EF. Tel: 01777702872; www.sirp.org.uk

Amusement Device Inspection Procedures Scheme (ADIPS)
Business & Innovation Centre, Wearfield, Sunderland Enterprise Park, SUNDERLAND, SR5 2TA; Tel: 0191 516 6381; Fax: 0191 516 6382; www.adips.co.uk

Introduction

- This guidance sets out the measures considered by the Amusement Device Safety Council (ADSC) to be appropriate for:
    - Designers, manufacturers, importers, suppliers and controllers of amusement devices in preparation for and during third party inspections; and;
    - Inspection bodies carrying out third party inspections
- This guidance relates to the in-service annual inspection of amusement devices in Great Britain.
- The guidance given in this document relates only to in-service annual inspection as described in paragraph 2.4. of this document and paragraph 124 of HSG175. Guidance on pre-use inspections of amusement devices (paragraphs 2.1, 2.2 & 2.3) will be drafted at a later date.
- The guidance should be read in conjunction with the latest edition of the Health and Safety Executive publication "*Fairgrounds and Amusement Parks - Guidance on safe practice (2007) HSG175* - referred to as HSG175 throughout the rest of this publication.
- A summary of the responsibilities of different duty holders under British safety law (e.g. designers, manufacturers, importers, suppliers, installers, organisers, controllers, operators, attendants, inspection bodies) is given in HSG175.
- The inspection scheme based on the requirements of HSG 175 and accepted by all trade associations for amusement devices used in Great Britain, is the Amusement Device Inspection Procedures Scheme (ADIPS). ADIPS is governed by the associations that make up the ADSC.
- If this guidance is followed you will normally be doing enough to comply with British health and safety law.
- The various chapters of this document outline the main disciplines of in-service inspection that are necessary to be carried out so that an ADIPS Document of Operational Compliance (DOC) may be issued. It may be necessary to employ additional, specialist inspections for disciplines that are not detailed; this is a decision to be made by the controller and AIB (see page 9).
- It should be noted that this guidance is not intended to cover the requirements of the BACTA Kiddy Ride Inspection Scheme, details of which can be obtained from BACTA. *www.bacta.org.uk*

Chapter 1 Inspection and Inspection Bodies

Types of inspection

1. The Provision and Use of Work Equipment Regulations 1998 and the Health and Safety at Work Act 1974 provide the legal requirements to inspect and maintain work equipment, including fairground rides and amusement devices so that they are safe for use by employees and others, including the public.

2. The amusement industry trade associations (see foreword) together with the Health and Safety Executive recognise four types of inspection for amusement devices:

2.1. **Design Review** - Appraisal of a design (and/or any safety-critical modification) to check the adequacy of a design specification and the validity of the assumptions on which it is based.

2.2. **Assessment of Conformity** - A check to confirm that a device is constructed to the reviewed design specification.

2.3. **Initial Test** - A test to check that the device operates safely in accordance with the reviewed design specification and the instructions are in place in the operations manual. This test should be carried out by, or on behalf of, the manufacturer, supplier or importer and witnessed by an inspection body.

2.4. **In-Service Annual Inspection -** In-service annual inspection (previously known as Thorough Examination) is for an independent (also known as third party) and competent registered inspection body or bodies to check, at regular intervals, on the fitness of an amusement device for continued further use.

3. The objective of the pre-use inspection is to provide a package of measures to ensure the integrity of a new, imported or modified amusement device. In-service inspection is carried out throughout the operational life of the device. Guidance on pre-use inspection is given in HSG 175 and it is intended to produce “Safety of Amusement Devices: Advice for Pre-Use Inspection” in the near future.

4. In-service annual inspection is an independent check on the safety-critical components of an amusement device to confirm that they have not deteriorated to an extent liable to cause danger.

5. In addition to the in-service annual inspection procedure, an amusement device should be subject to regular periodic inspections (daily, weekly, monthly, etc). The responsibility to have these carried out lies with the controller of the device. Guidance on these types of inspection is given in HSG 175.

6. The controller of an in-service amusement device is the primary duty holder and must ensure that the device is safe.

7. The frequency of some aspects of in-service inspections of amusement devices may need to be based on the condition of the ride. These inspections need to be at suitable intervals to detect any deterioration that could not be detected during the controllers routine maintenance and that might affect safety

Inspection bodies as defined in HSG175 (September 2007):

- **Appointed Inspection Body (AIB):** The AIB is responsible for confirming the completion of the pre-use inspection process and issuing the Declaration of Operational Compliance (DOC). In practice, the AIB may also provide all or part of the IB services.
- **Inspection Body (IB):** The Registered IB who carries out the inspection and testing services.

Independence of Annual Inspection

8. Independent Inspection refers to any of those types of inspection which is carried out by any person who is not the designer, manufacturer, supplier, installer, purchaser, owner, user or maintainer of the items which they inspect, nor the authorised representative of any of these parties.

9. The inspection body and its staff should not engage in any activities that may conflict with their independence of judgement and integrity in relation to their inspection activities. In particular they should not become directly involved in the design, manufacture, supply, installation, use or maintenance of an amusement device if they also intend to carry out in-service annual inspections on that device.

10. Inspection requirements for the leisure industry, from 1976 onwards *in Great Britain,* involve the use of third party inspection bodies, i.e. inspection bodies independent of designer, manufacturer and amusement device controller.

11. This has nowadays become a commitment of the industry associations represented on the ADSC. These associations are keen that it should be clear to everyone that all reasonably practicable steps are taken to ensure safety.

12. Third Party (independent) inspection provides:

12.1. Reports with greater reassurance as to the safety of the amusement device.

12.2. Wider expertise on problems associated with amusement devices from different designers, manufacturers and controllers.

12.3. Identification of conditions where maintenance and in-service inspection could be improved / widened.

12.4. Access to technical data detailing specific and / or general information relating to amusement device safety.

Registration of Inspection Bodies

13. The Amusement Devices Inspection Procedures Scheme (ADIPS) is based on BSEN 45004:1995 / ISO / IEC 17020[1] and requires Inspection Bodies to be both independent of any interested parties and competent for the type of work that they carry out.

14. The registration of inspection bodies is a central part of ADIPS as it enables the industry to set an appropriate framework of standards. These standards are laid down in Rules for the Registration of Bodies performing Inspection of Fairground and Amusement Park Machinery and Structures.

15. The registration procedure requires each Inspection Body to compile a quality file containing details of staff qualifications, experience and other competencies.

15.1. Once the quality file has been completed, the inspection body declares on their registration form that the information contained in the file is accurate.

16. Following acceptance, the name of the inspection body is added to the register. Inspection bodies, and their individual inspectors, need to register afresh each year and a new registration number is issued accordingly. Registration runs from 1st January – 31st December each year.

17. Further information on the administration of the scheme can be obtained from ADIPS, Business & Innovation Centre, Wearfield, Sunderland Enterprise Park, SUNDERLAND, SR5 2TA.

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[1] *ISO / IEC 17020 - General criteria for the operation of various types of bodies performing inspection (this is identical to the British and European Standard numbered BS EN 45004)*

Chapter 2 Documentation and Procedures

Functions of In-Service Annual Inspection

18. In-service annual inspection (previously known as Thorough Examination) of an amusement device provides a thorough check on the fitness of an amusement device for further use.

19. There are four main functions of the in-service annual inspection:

19.1. Paperwork checks including records of modifications and any accident history.

19.2. Examinations.

19.3. Functional test.

19.4. Reporting.

Preliminary Paperwork - General

20. The AIB should confirm that the following are in the operations manual:

20.1. The original reports of design review, conformity to design and initial test, as required.

20.2. Any reports of design review, conformity to design and initial test relating to modifications.

20.3. The reports of relevant in-service inspections.

20.4. The report of functional test.

20.5. The NDT schedule.

20.6. Any information relating to accidents and incidents.

21. In relation to amusement devices that were first in use in Great Britain before 1997, there may not be a Report of Design Review. In the absence of a Design Review there should be a Maturity Risk Assessment (MRA) provided by the controller.

21.1. HSG175 states that “When ADIPS was introduced in 1997, it was recognised that there would be devices in use that had not been subject to pre-use inspections and did not have complete design documentation, but that were well-designed and maintained. An arrangement was reached to allow such devices to continue to operate. The controllers of these devices were given until 2004 to prepare an MRA that could be used to demonstrate safety through maturity of a device. This only applied to devices that had operated in Great Britain before 1997.”

22. IBs should note that whilst they are not required to assess the quality of any design review, or MRA, they will need to check the documents for any extra inspection requirements that the writers of the reports have identified.

23. An inspection body is not responsible for work carried out by other registered inspection bodies. The individual inspection bodies have a duty to ensure their work is both competent and diligent.

24. If any of the required reports (or MRA) are missing, incomplete or invalid, the AIB should inform the controller, or their representative on site, that in-service annual inspection cannot be completed and a DOC cannot be issued.

Preliminary Paperwork - Modifications

25. The IB should make all reasonable enquiries with the controller as to whether any modifications that may affect the safe operation of the device have been made since the previous DOC was issued and that the design review, assessment of conformity and initial test, as required, are in the operations manual. The name of the ride controller or his representative providing this information should be recorded on the DOC.

26. The responsibility for determining whether a modification is safety-critical lies with the controller and is not necessarily a matter for the appointed inspection body. However, the controller must be able to demonstrate competence with regard to the assessment of all modifications. If in doubt the controller should assume that every modification is safety-critical and the advice of a competent person should be sought (Para 184 HSG 175).

27. If the controller informs the appointed inspection body that modifications, which he considers to be not safety-critical, have been made, the IB should record this in his report.

28. Note that, under paragraph 186 of HSG175, a controller should not use a device after a repair until details of the repair and any relevant tests and inspections are recorded in the operations manual.

29. The IB should confirm that devices have been upgraded to avoid danger, where information is reasonably available to them and lies within the remit of the inspection they are carrying out. Sources of information would include safety bulletins from manufacturers, the trade associations, ADIPS, the Health and Safety Executive and information received by the controller.

Preliminary Paperwork - Safety-Critical Modifications

30. If the controller (or person acting on their behalf) states that safety-critical modifications have been carried out since the initial test or last in-service annual inspection, the AIB should check whether the relevant reports of design review, assessment of conformity to design and initial test have been placed in the operations manual. The AIB should also check to confirm that the NDT schedule has been updated accordingly.

31. The adequacy, or otherwise, of the new reports in the paragraph above is not a matter for the AIB.

32. If, having taken into account the preceding paragraphs, any of the required reports are missing, incomplete or invalid, the AIB should inform the controller, or his representative on site, that the annual in-service inspection cannot be completed, nor can a DOC be issued.

33. The AIB should also check with the controller and in the operations manual to see whether any safety-critical components have been replaced, modified or repaired since the issue of the previous DOC. If so, there may be a need for further inspection or actions as a result of this work.

Accident History

34. Paragraph 139 of HSG175 requires the appointed inspection body to check on the accident history of the device.

35. If the controller or his authorised representative states that any incidents, accidents or dangerous occurrences have occurred since the last DOC was issued, the AIB should check that the relevant details are in the operations manual. If this information is not in the operations manual, the AIB should inform the controller, or his representative on site, that the in-service annual inspection cannot be completed, nor can a DOC be issued.

Examination

36. The purpose of annual in-service examination is to determine whether any of the safety-critical components of an amusement device 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 in-service annual inspection may require some or all of the following:

- Visual examination;
- An assessment of civil engineering parts;
- Non Destructive Testing (NDT);
- Pneumatic Inspection;
- Electrical examination and testing;
- Hydraulic Inspection;
- Control Systems Inspection;
- Mechanical / Structural examination.

Function tests

37. The final part of the in-service annual inspection is to carry out functional tests to demonstrate that, at the time and place of the test, the amusement device 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 working of control systems;
- correct operating speeds;
- 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.

Reports

38. ADIPS provides standard forms that should be used for all the relevant types of inspection.

39. 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.

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

41. 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 in-service annual inspection, the IB should specify whether the defect requires immediate action before the amusement device is used, or within a specified time.

42. 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 controller, client or other inspection body as appropriate.

42.1. This may need to take the form of an immediate instruction not to use the amusement device until the defect has been rectified, the device re-inspected and a DOC issued.

42.2. Where practicable this notification should be receipted in writing, or failure to receipt should be recorded.

42.3. If the inspection body considers a defect has implications for other similar devices, this information should be passed on via the appropriate procedure.

Confidentiality

43. One of the requirements of ISO / IEC 17020 & BSEN 45004 1995 is that inspection bodies need to 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 amusement industry, bearing in mind the demands of the need to ensure safety.

44. It may be necessary to divulge information to the relevant 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 devices.

45. When an IB subcontracts, the SQSs require him to advise the client of the intention to subcontract part of the inspection to another party and to get the client's agreement to his choice. The exchange of information between IB and subcontracted IB is then permissible to the extent that it is necessary for the fulfilment of the respective contracts.

46. If the AIB considers that they have not been allowed sufficient access to relevant reports (or other documents) they should notify the controller that the DOC cannot be issued.

Instructions for In-Service Annual Inspection

47. The operations manual (see Appendix 3 of HSG175) should include information on the examination and testing of the device once in use, including reports of previous in-service inspections. Details should be included of all safety critical components and where relevant, estimates of their likely lives 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 safety-critical components or systems.

48. 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, the trade associations, ADIPS, the Health and Safety Executive and information received by the controller or IB. For equipment first used in Great Britain before October 1997, the adequacy of the safety-related information about in-service annual inspection may have been confirmed or added to by a controller's Design Maturity Risk Assessment rather than a Design Review.

49. If the information regarding in-service annual inspection, as specified in Appendix 3 of HSG175, is not present in the operations manual, the appointed inspection body should inform the controller, or their representative on site, that the DOC cannot be issued (see figure 2.1).

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

- Poor welding;
- Misalignment of joints;
- Water ingress and frost damage;
- Corrosion.

51. 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 IB responsible for the tests should detail the technique used in the report.

52. Amusement devices fitted with lifting equipment such as hydraulic cranes or winch systems should have maintenance and inspection instructions in the operations manual. If such instructions are available, the IB may, if required to do so by the controller, carry out this part of the inspection providing that they are competent to do so.

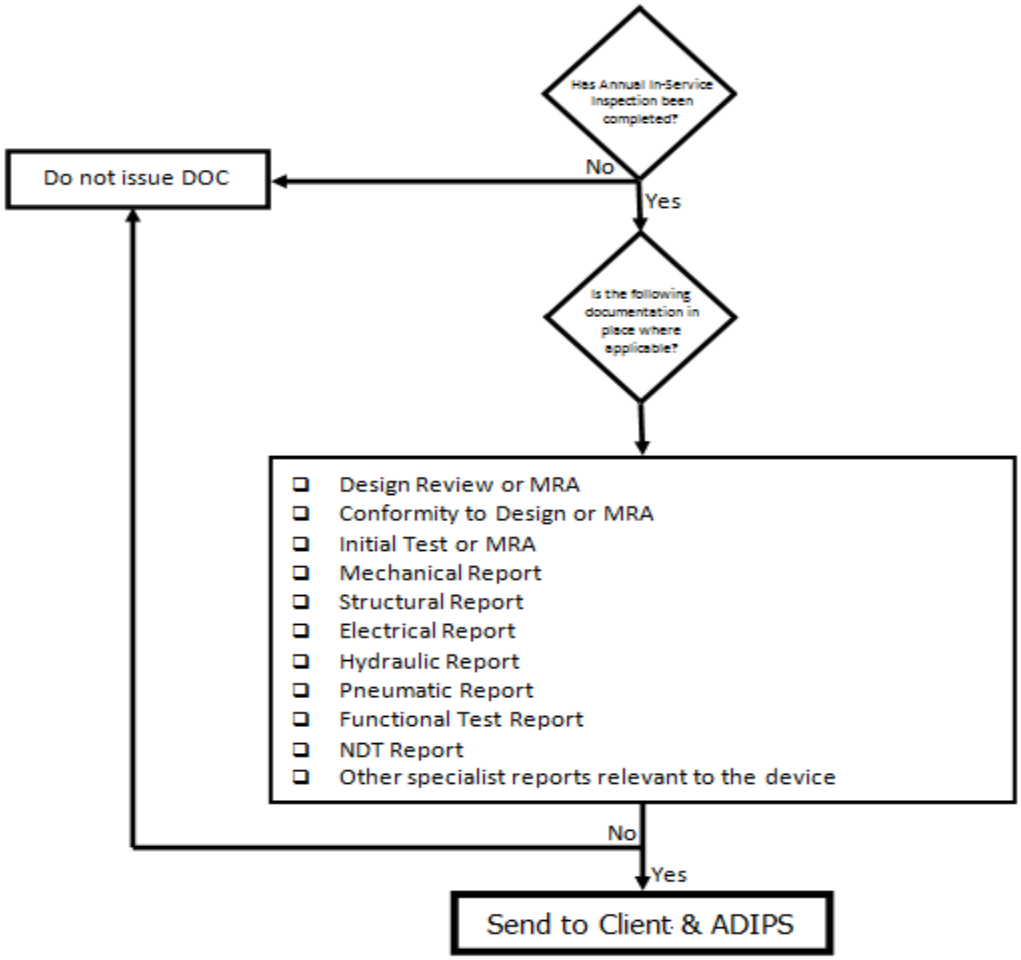


Fig. 2.1 - Method for carrying out issue of a DOC (the client will normally be the controller)

Service History

53. The appointed inspection body should consult the operations manual to review the service history of the device and any trends in deterioration of the device that may influence the way in which the annual in-service inspection is to be carried out. The controller should also have kept this under review in the period since the last in-service annual inspection.

Chapter 3 Pre-inspection considerations

54. This chapter gives practical advice to all persons associated with in-service annual inspection. This includes the controllers, their representatives and inspection bodies.

Considerations for visual examination

55. Before the commencement of any inspection, a number of factors must be taken into account. These factors include such things as:

- Ambient conditions.
- Condition and accessibility of components / structures.
- Equipment.
- Physiological and psychological considerations.
- Training.

Ambient Conditions

56. Little or no control can be exercised over ambient conditions, so their effects should be managed and minimised. Examples of conditions affecting inspection are:

57. *Light* – the amount of light falling upon an inspection surface must be controlled. Too much or too little light will impede inspection; the accepted norm at an inspection surface is 1000 lux (taken from the Personal Certification for Non Destructive Testing (PCN), for visual inspection).This is approximately equivalent to a 100w tungsten filament bulb at a distance of 1 metre.

58. *Temperature* – the temperature at which an inspection is carried out has a major effect upon the efficiency of inspection. If the inspector feels uncomfortable owing to either excessive or inadequate temperature, he will lose concentration. This requires management. Extremes of temperature may also impede inspection by masking defects via metal expansion or distortion of the air.

59. *Adverse weather* – no one likes to be out in foul weather and consequently loss of the inspector's concentration is to be expected, often in a comparatively short time. Management of break periods is essential to minimise the effects.

60. *Noise* – excessive background noise will lead to fatigue and loss of concentration. The effects need to be minimised either by the use of hearing protection or noise reduction.

Condition and accessibility of components / structures

61. The condition of any item under inspection obviously has a bearing on its inspectability. Account should be taken of any factors that could inhibit inspection. These could include:

61.1. *Dirt and grease* – due regard must be given to the potential for faults to be masked by dirt, etc., although in some circumstances it may be advantageous to also inspect prior to cleaning.

61.2. *Poor access* – it is essential that adequate, safe access is provided for the inspector. If the inspector's mind is focussed on poor or insecure access, his concentration will be reduced for the task at hand.

61.3. *Colour* – the colour of the surface to be inspected must be regarded. Some surface colours give higher definition to flaws than others. An awareness of the detectability of defects in particular colours is useful.

61.4. *Mechanical damage* – whilst mechanical damage is often an indicator of a problem, inspectors must also be aware that it can mask defects.

Equipment

62. It is essential that inspectors have access to all equipment necessary to undertake an in-service annual inspection. The equipment required will vary, but may include:

- Access equipment.
- Personal protective equipment.
- Lighting.
- Visual aids.
- NDT equipment.
- Local cleaning equipment.
- Measuring equipment.

Physiological and psychological considerations

63. A number of physiological and psychological factors need to be considered:

63.1. *Eyesight* – an inspector needs to have good eyesight to enable him to carry out his function. The current regulations for a PCN inspector (refer to NDT chapter for further information) are that they be able to read Jaeger J1 (N4) lettering at no less than 300mm, corrected or un-corrected, and that this be tested once every 12 months. Colour vision should also be assessed once every 12 months, to ensure any colour deficiencies do not impinge upon the inspection methods.

63.2. *Stress and fatigue* - stress in the workplace and in the home environment may affect the performance of the inspector. Likewise, fatigue (e.g. caused by heavy workload, travelling long distances) can be a major factor in inspector performance. To minimise its effects, regular breaks in routine are considered essential. It is essential that the effects of stress and fatigue are recognised and managed.

63.3. *Distractions* – inspectors must be aware of the dangers of being distracted. The leisure industry can be a highly diverting environment and steps should be taken to minimise outside influences.

63.4. *Alcohol, drugs and medication* – inspectors and inspection supervisors must be aware of the potential hazards posed by drugs and alcohol. Prescription medicines must be checked to find any adverse side effects.

Training

64. The IB should ensure that they are qualified and experienced in the disciplines required to carry out the inspection. The IB must also be adequately trained to use any equipment required to carry out the inspection (e.g. access equipment, PPE, etc.).

Chapter 4 Mechanical / Structural / Civil Inspection

65. The aim is to determine whether components have deteriorated since the last in-service inspection and to assess the significance of any deterioration that may have occurred. The purpose of this assessment is to determine the fitness of an amusement device for continued further use for a specified period. The inspection will include, but not be limited to, all areas that are accessible to, or could affect, members of the public, including queue lines, viewing galleries, etc.

66. The IB carrying out the assessment should:

66.1. Ascertain the history of the device and determine if any changes or modifications have been made.

66.2. Check that the device has been adequately disassembled as required and cleaned appropriately. It is recommended that an inspection regime is agreed between the controller and the IB prior to the inspection.

66.3. Obtain any inspection or maintenance guidance available from documents such as the operations manual, design review, NDT schedule, etc. If this information is insufficient then evaluation including visual inspection and an assessment of the ride whilst operational may be necessary to determine the scope of the inspection.

66.4. Make sure that all personnel carrying out the works are competent in the relevant inspection methods.

66.5. Carry out relevant functional tests (refer to Functional Test, Paragraphs 159 – 174).

66.6. Make a thorough visual inspection of all areas of the device, whether or not concealed. Remote inspection equipment and/or suitable means of access should be used to enable inspection of difficult areas. Where specified or as deemed appropriate, visual inspection must be supplemented by other forms of NDT.

66.7. Make sure the condition of the device is recorded and if deterioration is identified this should be assessed. Where deterioration is identified an appropriate course of action should be agreed between the IB and the controller. In doing so, it may be necessary to make reference to available information, e.g. manufacturer's and design reviewer's documentation, industry technical bulletins, etc.

66.8. Having determined the scope of the inspection, the next step is to assess the general condition and standard of maintenance. Areas identified as giving cause for particular concern should be identified for further investigation.

67. It may be necessary to inspect structures before and after cleaning. An inspection before cleaning should be carried out to enable fretting, paint cracking, etc., to be identified and the area cleaned to enable a more in-depth inspection of the area to be carried out.

68. The inspection should be carried out in a methodical way in order to ensure that the device is fully inspected. Particular attention should always be given to changes in section, welded connections, welded reinforcements and other high stress areas.

69. Where evidence of any un-notified modifications, repairs, replacements or alterations are seen, this must be discussed with the controller to ensure that the correct level of design verification and control has been exercised.

70. It is recommended that all results be recorded at the time of inspection; photography could be useful in this process. For some devices, layout or component drawings can be useful in compiling the report.

71. If sampling of components is considered appropriate, the sample size and frequency must be justified by the inspection body.

Example areas of inspection

72. 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.	
Chassis, vehicles, passenger compartment integrity Cracking; corrosion; alignment; sharp edges; mechanical damage.	
Passenger containment • Structural components • Working mechanisms including protective coverings • Attachment areas Cracking; corrosion; wear; alignment; sharp edges; mechanical damage.	

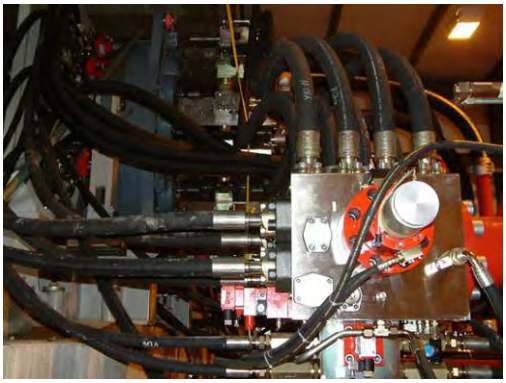
Rotating components (slew rings, shafts etc.) Cracking; corrosion; wear; alignment; mechanical damage.	
Tracks and guided systems, areas where tracks quickly change direction Cracking; corrosion; wear; alignment; mechanical damage.	
Structural components Cracking; corrosion; wear; alignment; mechanical damage; stress ratcheting (frost damage).	
Drive systems Attachment; cracking; corrosion; wear; alignment; sharp edges; mechanical damage	

Tyres Wear; alignment; adequacy; splitting; punctures; pressures.	
Roll-back 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.	
Buildings that may affect the integrity of the device	
Emergency exits Correct placement of exit signage & lighting; attachment; relevance and effectiveness.	
Working platforms Correct placement; attachment; fall from height hazards.	

Device platforms, access stairways, etc. Correct placement; attachment; fall from height hazards.	
Wire ropes and chains5.2 Attachment; wear; corrosion; adequacy relative to LOLER where applicable.	
Running and retaining wheel components	
Operator control cabin / area Structural integrity; correct pla5.2cement; visibility for operator.	

Water condition and levels in log flumes, etc.	
Queue lines, fencing, barriers, platforms, waiting & observation areas, etc. Attachment; corrosion; alignment; sharp edges; trip & fall hazards.	
Theming and other items with potential to encroach on the motion envelope Attachment including secondary; Corrosion; Alignment; Sharp edges;	
Adequate passenger information signage **Correct placement; relevance; adequate to minimise risk of injury**	

Hydraulic and pneumatic systems (See appropriate section)	

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

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

74. 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 the manufacturer. The IB should take all necessary steps to ensure the repair has been carried out to a satisfactory standard.

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

76. Some replacement components may require relevant inspection prior to use.

77. Where the repair is deemed a modification, paragraphs 25-33 should be referred to.

78. 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 controller. Details of any defects considered to have implications for similar devices must be given to ADIPS for consideration and communication.

79. For some devices, it may be prudent to issue interim reports to enable the controller to begin refurbishment in preparation for the next operating season.

Chapter 5 Electrical Inspection

80. 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 ADIPS electrical report form.

81. 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.

82. Where the amusement device is powered from generators the examination should include not only the amusement device but also the supply system and supply cables.

83. 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 amusement 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 planned preventative maintenance procedures.

84. It should also be noted that for amusement parks with large rides incorporating workshop / garage areas, dark rides housed in buildings, animatronics, themeing, audio systems, lighting systems, shops situated at the end of the exit and outside lighting and sockets situated in queue lines, these areas should be included in the planned preventative maintenance procedures and tested to BS7671.

85. BS 7671:2008 Requirements for Electrical Installations was issued on 1st January 2008 and came into effect on 1st July 2008.

85.1. Whilst there are general changes in the main body of the document, a new section 740 has also been introduced which applies specifically to temporary electrical installations for structures, amusement devices and booths at fairgrounds, amusement parks and circuses.

85.2. IBs should be aware of the new requirements of BS 7671:2008 and from the introduction paragraph of that document note that “Installations designed after 30th June 2008 are to comply with BS 7671:2008.”

Visual Inspection

86. 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.

87. A full visual assessment should be carried out. This will include opening up a sample of electrical panels, at the 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.

88. 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 unauthorised 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;
- If applicable, the check sum for the PLC has not changed.

89. The type of supply should be ascertained, and entered onto the report. It should be noted that for nominal 230 / 400 V a.c. amusement devices only TT, TN or IT systems are allowed.

90. 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 labelled to indicate the circuits that they switch.

91. 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 of IP2X except when rails, conductive floors and ceilings are part of a Protective Extra Low Voltage (PELV) or Separated Extra Low Voltage (SELV) system. For 110v dc systems, see paragraph 114.

92. Section 740 of BS7671:2008 requires that “Automatic disconnection of supply to the temporary electrical installation shall be provided at the origin of the installation by one or more RCDs with a rated residual operating current not exceeding 300 mA. The RCD shall incorporate a time delay in accordance with BS EN 60947-2 or be of the S-type in accordance with BS EN 61008-1 or BS EN 61009-1 where necessary to provide discrimination with RCDs protecting final circuits.”

93. Section 740 of BS7671:2008 also requires that “All final circuits for lighting, socket outlets rated up to 32A, and mobile equipment connected by means of a flexible cable or cord with a current carrying capacity up to 32A, shall be protected by RCDs having the characteristics specified in regulation 415.1.1.” (415.1.1 - RCDs with a rated residual operating current ($I_{\Delta n}$) not exceeding 30mA and an operating time not exceeding 40mS at a residual current of 5 x $I_{\Delta n)}$

94. Check that any socket outlets that may be used to supply portable equipment or equipment outside the equipotential zone of the amusement device are protected at some point in the system by 30mA RCDs without adjustable time delays.

95. Check that all lighting, cables and electrical components:

- Are securely fixed in place so that they cannot fall into the motion envelope of the amusement device or onto passengers or persons using the device.
- Cannot be touched by passengers on the amusement 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.

96. Check that excess multiple adaptors are not being used, but with particular reference to operator's areas or pay boxes.

97. Check that any portable equipment in the pay box or operator's cabin is wired safely using good practice. The controller, as the duty holder, may need a Portable Appliance Test for such equipment.

98. 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.

99. Check that any neon or gas discharge lighting is placed so as to be inaccessible when in use and the transformer and cables are placed out of reach and are protected from the weather. Also check that higher voltage versions have a dedicated isolating device or fireman's switch on the low voltage side that is easily accessible at all times when the device is powered.

100. 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.

101. 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.

102. 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.

103. Confirm that all labels, as set out in BS 7671 Section 514, are in place where necessary for example:

- Unexpected presence of nominal voltage exceeding 230 V, such as 400V supplies whether a.c. or d.c.
- Nominal voltage exceeding 230 volts between simultaneously accessible equipment.
- Presence of different nominal voltages in the same equipment.
- Safety electrical connection - do not remove – located at the main earth terminal.
- Identification labels for switchgear, so that it is easy to identify circuits.
- Labels showing the correct function of all operator controls and actuators.

DC Systems

104. If the system is not referenced to earth, 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.

105. If the system is referenced to earth or another reference point, and is not a PELV system, confirm that earthing, bonding and protection against indirect contact arrangements as for a.c. systems are in place.

106. Track rides and similar using 110 Volt d.c. systems with bare pick-ups or conductors, should be in constant view of the operator, or switched off when accessed by public or normal operating staff.

107. Confirm that the special considerations for dodgems in relevant guidance material (including industry technical bulletins and Advice on Design) are complied with. In particular, confirm that where there are a.c. systems, such as lighting used within or fixed upon the dodgem structure, the relevant exposed metalwork of the dodgem system is earthed, including the floor, any metallic uprights and any exposed conductive parts of the a.c. equipment.

108. 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.

109. 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.

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

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

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

113. It is possible that older amusement devices may not be able to satisfy the requirements in paragraph 91, in which case the voltage should not exceed 110 V d.c., with a maximum ripple content of not more than 10%. It should be noted that it is unlikely that a transformer / rectifier fed from a single-phase AC supply will be able to satisfy this requirement.

114. 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 earthed metal enclosures that form part of an earthed equipotential 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

115. 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.

116. 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.

117. 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.

118. 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 armour, provided that the non-flexible nature of such a cable does not cause a danger.
- Where necessary, fixed securely.

118.1. Where any protection is provided using metallic systems, including armour and braid, it should be confirmed that the metal or conductive parts are earthed.

119. 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.

120. 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.

121. 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.

122. It should be checked that plugs and sockets that may be subjected to damp or dusty conditions are suitable for use in their environments. Check that all sockets are purpose built devices with an ingress protection level of not less than IPX4 when used for 220 / 400 V a.c. systems outdoors or in damp conditions.

123. Domestic 13A socket outlets, plug tops or extension leads with domestic 13A outlets must be protected by an RCD (not exceeding 30mA) and should not be used outdoors or in damp conditions.

124. Plugs and sockets should be checked to ensure that live pins are not exposed when disconnected. This means that supply cables and supply sockets should be fitted with female sockets, whilst power-receiving plugs should be male. Plugs and sockets should be keyed or otherwise designed to ensure correct connectivity between live conductors, neutral conductors and circuit protective conductors. Plugs and sockets should only be used in the designated voltage range as specified in BS EN 60309.

Earthing and Bonding

125. The integrity of the earthing and bonding arrangements should be checked by inspection and testing.

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

- Reference should be made to BS 7671 Section 413 for detailed requirements relating to electrical separation and extra low voltage systems.
- Reference should also be made to this standard for detailed requirements relating to earthing and bonding of TT and TN systems and the associated requirements relating to automatic disconnection under fault conditions.

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

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

129. Extraneous conductive parts will also require consideration. A judgement will need to be made regarding the bonding of extraneous metalwork of the complete amusement device, but it should be confirmed that a satisfactory earth 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.

130. If visual assessment and sample tests demonstrate that any exposed conductive parts of the amusement device are not satisfactorily earthed then testing should take place.

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

Electrical Enclosures, Components and Switchgear

132. 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 labelled 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 earthed 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).

133. 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.

134. Check that where cabinets or enclosures are placed at positions which are accessible to members of the public or non-authorised 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.

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

Measurement and Test

136. 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 amusement 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 is 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.

137. 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 earth loop impedance value for the protected circuit and the disconnection time of the associated fuse or circuit breaker.

138. 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.

139. The insulation resistance should be measured in accordance with the following table and shall be considered satisfactory if the main switchboard and each distribution circuit tested separately, with all its final circuits connected but with current-using equipment disconnected, has an insulation resistance not less than the value given in the table.

Circuit nominal voltage (V)	Test voltage d.c. (V)	Minimum insulation resistance (MΩ)
SELV & PELV	250	≥ 0.5
Up to and including 500V with the exception of SELV & PELV	500	≥ 1.0
Above 500V	1000	≥ 1.0

140. Where residual current circuit breakers are used to provide supplementary protection against direct contact or rapid disconnection in TT systems or protection of sockets, they should have a trip setting no greater than 30 mA and should be tested by applying a current of 150 mA and confirming that the devices trip within 40 ms and in accordance with BS7671:2008. The test button should also be operated after the test to ensure that the tripping mechanism remains free.

141. Earth fault loop impedance should be measured, during which a check of the polarity and earthing 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.

142. For TT systems the value of earth electrode resistance should be below 200 Ω and it should also be confirmed that a suitable RCD is being used at the supply.

143. Where ripple free d.c. is required to provide protection against shock, the voltage should be measured to confirm that it is lower than 60 V or, in the case of older equipment or dodgem sets, 110 V and the superimposed ripple voltage is less than 10% of the nominal voltage. The ripple content may be measured using a true rms meter set to a.c. attached directly across the d.c. supply.

144. Confirm that any SELV supplies, that are used to protect against electric shock, do not have any connection between the output connections and any protective earthing circuit, even accidentally. The maximum voltage is 25 V a.c. or 60 V d.c. with a maximum ripple of 10% rms.

145. Confirm that any PELV supplies, that are used to protect against electric shock, are also restricted to a maximum voltage of 25 V a.c. or 60 V d.c. with a maximum ripple of 10% rms and they are only used in dry locations and when large area contact of live parts with the human body is not expected, unless the maximum voltage is restricted to 6 V a.c. or 15 V d.c. If there are any earth monitoring systems installed these should be tested and confirmed to be functioning correctly.

Generators AC

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

- The star point of the generator output windings (neutral).
- An appropriate earth electrode.
- The protective conductor from the amusement device to the generator.

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

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

148. 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 generator should be rated at less than 4 kVA.
- The output cable should be short (not more than 10 metres).
- The generator should be used to supply single amusement devices such as bouncy castles, etc.
- The cable should be suitably protected against mechanical damage.
- Exposed metalwork of the amusement device should be bonded to the frame of the generator.
- Any switches or isolators are double poled.

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

150. 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.

151. All enclosures must meet the requirements of paragraph 132 - 135.

Generators DC

152. 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.

153. 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.

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

155. 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 amusement 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)

156. Emergency lighting should be illuminated and visually checked to confirm that there is generally adequate lighting to escape the amusement 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.

157. 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.

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

Functional Test

159. 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.

160. 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.

161. 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 control logic, 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 amusement device motion envelope.
- Moving themeing, 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 safety switches on chairlifts, etc.
- Brake detection sensors.
- Weighing devices.

162. 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.

163. 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.

164. 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.

165. 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 amusement device halts as quickly as necessary, in the correct place or places and with minimal risk to passengers. Where the time taken for a device to come to a safe halt is critical, this time should be recorded. The test should be repeated for all emergency stop actuators.

165.1. 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.

165.2. 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.

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

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

168. 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.

169. 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.

170. 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.

171. Positional detection systems should be subjected to a functional check that proves all safety critical sensors and any anti-collision logic. 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.

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

173. Any systems designed to ensure that the amusement 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.

174. Functions designed to ensure the amusement 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.

Chapter 6 Inspection of Pressure Systems

Pressure Systems Safety Regulations 2000

175. The Pressure Systems Safety Regulations 2000 came into force on 21st February 2000. Users and owners of pressure systems (e.g. hydraulic, pneumatic, steam) are required to demonstrate that they know the safe operating limits, principally pressure and temperature, of their pressure systems, and that the systems are safe under those conditions.

176. Systems with accumulators over 250bar/litre are subject to the Pressure Systems Safety Regulations 2000.

177. Controllers should have a suitable written scheme of examination in place before the system is operated. They also need to make sure that the pressure system is examined in accordance with the written scheme of examination.

178. IBs carrying out inspection of pressure systems should confirm that a written scheme of examination is in place before commencing an inspection and if such a scheme is not available should not continue with the inspection. In such cases the controller should be informed and the DOC should not be issued by the AIB.

The Written Scheme of Examination

179. A written scheme of examination is a document containing information about selected items that form a pressure system, operate under pressure and contain a "relevant fluid." The term "relevant fluid" is defined in the regulations and covers compressed or liquefied gas, including air, at a pressure greater than 0.5 bar (approximately 7 psi) above atmospheric pressure, pressurised hot water above 110°C and steam at any pressure.

180. Typical contents of a written scheme of examination include:

- Identification of items within the system.
- Those parts of the system which are to be examined.
- The nature of the examination required, including the inspection and testing to be carried out on any protective devices.
- The preparatory work needed for the item to be examined safely.
- The maximum interval 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 name of the competent person certifying the written scheme of examination.
- The date of certification.

181. An item from the pressure system should be included in a written scheme of examination 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 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?

182. The following pressurised systems might require a written scheme of examination:

- A compressed air receiver and the associated pipework, where the product of the pressure in bars multiplied by the internal capacity in litres of the receiver is equal to or greater than 250 bar litres.
- A steam boiler and associated pipework and protective devices, i.e. a steam locomotive.

183. The following pressurised systems may not require a written scheme of examination:

- A pneumatic cylinder in a compressed air system.
- A portable compressed air receiver and the associated pipework, where the product of the pressure in bars multiplied by the internal capacity in litres of the receiver is less than 250 bar litres.
- Any pipeline and its protective devices in which the pressure does not exceed 2 bar above atmospheric pressure.
- A pneumatic tyre (for example drive wheels, forwarding wheels and bumper boats, etc.)

184. The controller of a pressure system has a legal responsibility to ensure, before operation of the system, that a suitable written scheme of examination has been prepared by a competent person. A competent person should be able to demonstrate the necessary breadth of knowledge, experience and independence. In judging levels of competence, controllers may wish to know that a national accreditation scheme has been developed by the United Kingdom Accreditation Service (UKAS) for bodies that provide services of this nature.

185. Guidance on the selection of competent persons is given in the two freely available HSE leaflets “Pressure systems- Safety and you” (INDG 261) and “Safety of pressure systems” (INDG 178).

186. The written scheme should generally cover all items within a self-contained pressurised 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 scheme, *i.e. one system, one scheme.*

187. The written scheme of examination 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 or type. It is the controller’s responsibility under the regulations to ensure that the content of the written scheme is reviewed at appropriate intervals by a competent person to determine if it remains suitable.

Hydraulic & Pneumatic Systems - Common Inspection Requirements

188. Some systems or parts of systems may need inspection in accordance with a written scheme of examination, as required by the Pressure Systems Safety Regulations 2000.

189. The controller or his representative should be consulted to ascertain the following and take appropriate measures, as required in the modifications chapter of this guidance:

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

190. The controller or his representative should further be consulted to ascertain if any faults or failures of the system have occurred since the last inspection and it should be determined if these are safety critical. Inspection requirements may need to be modified or added to if information obtained demonstrates a necessity.

191. Before carrying out any inspections the amusement device manufacturer’s manual should be consulted for any relevant information.

192. Safety critical systems and any safety critical components that might, under failure conditions, present a danger should be identified and listed. This list should form the basis for an inspection schedule. A schedule of this type should be provided with the controller's documentation. However, if not in place, it will need to be drawn up by the IB.

193. A list of safety critical systems or components (hydraulic or pneumatic) might include:

- Accumulators.
- Elements of the passenger restraint system.
- Braking systems.
- Drive motors, particularly those with brakes incorporated.
- Launch systems.
- Themeing that is actuated by hydraulic or pneumatic systems.
- Control gates.
- Lifting and lowering (lifting cylinders, bellows, etc., and associated valves).
- Hoses, pipelines and any other component that
    - o may present a danger to the system under failure conditions, or
    - o may present a danger during the process of failure, e.g. whipping of hoses, spraying of fluid, etc.
- Any other component whose failure could cause a hazard.
- Any safety 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.

194. The schematic drawing for the system should be checked to confirm that it correctly represents the system to be inspected.

195. For all accumulators over 250bar/litre capacity the test certificates should be checked to ascertain that they cover the requirements of the written examination scheme provided in accordance with the Pressure Systems Safety Regulations 2000

196. The following checks and tests should form part of the inspection where relevant:

- Filters should be checked for condition and suitability (i.e.to manufacturers' specification).
- A check for leaks.
- Listening for unusual noises during operation of the machine.
- Checking the correct installation of any replaced components.
- Inspection of pipes, hoses and fittings.
- A check that valves and ancillary equipment are securely mounted.
- Filtration systems.
- Gauges where fitted.

197. The amusement device 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.

198. It is far better to monitor the performance of actuators and ensure that they are working correctly.

- This can be done by checking that cylinders and 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.

Hydraulic Systems – Specific Inspection Requirements

199. The objective of a hydraulic system may be to extend and retract a hydraulic cylinder or actuator, or lock a cylinder in one place, e.g. as in restraint systems or to drive a hydraulic motor to carry out a useful and sometimes safety related task.

200. Redundant safety features should be self-revealing when they fail, e.g. hose burst valves.

201. Equipment used for the erection and dismantling of amusement devices should be included, as these systems often form part of the main hydraulic circuit.

202. Having established the safety critical systems and safety critical components, the following actions are required before inspection of the ride:

- Check that where required the system has had a laboratory assessed oil sample in the last month and determine that it meets the standard set for the machine. (If not, be prepared to take a sample in accordance with ISO 4021 -1992)
- Check whether the oil has needed to be replenished since the last inspection.

203. The following checks can now be carried out on the ride:

- Look for leaks and check oil levels.
- Inspect pipes, hoses and fittings in accordance with EN 982 guidelines.
- Inspect any hydraulic motors and pumps to ensure they are not loose nor their integrity reduced in any way. All drive belts should be correctly aligned and tensioned.
- Operate the amusement device and time each safety critical hydraulic function. Record the times, pressures and the ambient temperature. Compare these with previous records.
- Fully test any safety critical operations to ensure they meet their design function (i.e. passenger restraint must restrain for longer than the ride duration against a strong passenger). Where the trapping capability should be limited (e.g. closing pressure on a passenger restraint) this should be physically tested. (Record relevant system pressures during this test.)
- Where hydraulic interlocks are provided it should be checked that they function correctly.

Hydraulic Oil

204. A method of checking the internal condition of the system, without any dismantling, is to monitor the oil by taking an annual oil sample for analysis. This sample will need to be taken using the procedure defined in ISO 4021:1992 *Hydraulic fluid power -- Particulate contamination analysis -- Extraction of fluid samples from lines of an operating system.* It is expected that this procedure is carried out as part of the controller's routine maintenance.

205. Taking an oil sample and having it analysed by a suitable laboratory for contamination, water, acid and lubricity levels will indicate the following in respect of the system condition:

- Whether the maintenance of the system has been carried out correctly.
- If results demonstrate that contamination levels are too high then filters may not have been changed, replenishment oil has not been filtered and air breathers might have been left off.
- Whether the system is running at the correct temperature. The oil will be oxidised if it has run consistently at high temperature and it will continue to degrade until it is so aggressive that it will cause component and fittings failures.
- Water ingress which will reduce lubricity and aid oxidation.

Pneumatic Systems – Specific Inspection Requirements

206. Examples of components that should be inspected in a pneumatic system are:

- Compressors / cylinders / storage tanks.
- Piping valves and gaskets.
- Safety devices and valves.
- Cylinders and actuators.
- Air dryers.
- Tank drains.
- Lubrication systems.

207. Compressors and pumps should be inspected to confirm that they are not loose nor their integrity reduced in any way. All drive belts should be correctly aligned, tensioned and adequately guarded.

208. Test any safety critical operations to ensure they meet their design function. Where any trapping capability should be limited (e.g. closing pressure on a gate) this function should be physically tested and the system pressure at the time of the test recorded.

Chapter 7 Inflatable Play Equipment

209. BS EN 14960: 2006 Inflatable play equipment – Safety Requirements and Test Methods should be followed by IBs inspecting inflatable devices. All checks listed below should be carried out to confirm compliance with this standard

210. The inspection should include all parts of the inflatable and any ancillary equipment which may affect safe operation of the device and should be carried out using the most appropriate method, e.g. measurements, visual examination and practical tests.

211. The documentation of the ride should be checked to confirm that the following is in place and the inspection should take account of any relevant information therein:

- Information provided by the supplier / importer / manufacturer.
- In-service Annual Inspection.
- Records of in-service inspection.
- Record of maintenance.
- Records of alterations / modifications.
- Records / Certificate of electrical inspection and test of the electrical blower unit(s) in accordance with the IEE In-Service Inspection and Testing of Electrical Equipment (PAT).
- Records / Certificate of inspection and test of electrical installations to conform to BS7671.
- Records of testing for emergency lighting.
- Accident reports.
- Risk Assessments and operational / training manual.

212. The IB should confirm that the inflatable is, clearly and legibly, permanently marked with at least the following:

- Type and size.
- Unique identifying number.
- Year of manufacture.
- Name and address of the supplier / manufacturer.
- Number and date of the European Standard.

213. For devices manufactured before 30th March 2007 all of the above may not be in place, but it is still essential that all such equipment is uniquely identifiable.

214. If the inflatable is erected at its place of use, it should be in a clear area free from any obstacle that could cause any danger to users. Refer to 4.2.8 of BSEN 14960: 2006.

215. The internal air pressure in the bouncing area and at the step / front apron should be sufficient to give reliable and firm footing without grounding out the inflatable (Refer to Annex C of BSEN 14960: 2006 for the test method for grounding).

- Walls and towers (when fitted) should be checked for firmness and uprightness. Refer to 4.2.2 of BSEN 14960: 2006.
- The pressure at the time of inspection should be recorded.

216. Anchorage systems should be examined for wear, rips or chafing; type and number of ground anchors or ballast, for conformity with design specification.

- Every inflatable should have at least six anchor points. Refer to 4.2.1 and Annex A (calculation of number of anchor points) of BSEN 14960: 2006.

217. Walls should have correct heights and integrity, run out lengths should be sufficient for slides and should conform to BSEN 14960: 2006.

218. Zips should withstand air pressure and tension generated within the structure. They should also be able to be operated from inside and outside when used on emergency exits. Zips used for deflation purposes should be hidden from view.

219. The following areas should be included in the inspection:

- Fabrics and netting for wear, rips or chafing.
- Stitching and internal ties for damage or deterioration.
- The complete device for sharp or hard edges - as in 4.2.6 BSEN 14960: 2006
- Independent support structures that are used for lighting, speakers, etc.

220. A visual check should be undertaken to confirm that there are no areas of entrapment. Particularly head, neck, clothing, fingers and body. Refer to 4.2.5 and Annex D (test methods for entrapment) of BSEN 14960: 2006.

221. The maximum fall-off height on any open side should be no greater than 630 mm.

222. Any hard landing surface should be covered by soft landing material such as dense gym mats or equivalent material of at least 25 mm thickness but not more than 125 mm, extending for a distance of at least 1.2 m from the open side. Refer to 4.2.3 of BSEN 14960: 2006. All mats used indoors should be fire retardant and meet current fire safety regulations.

223. If the device or any part is enclosed there should be suitable ventilation.

224. The inspection should include a deflation test. Deflation time should be sufficient to allow users of the inflatable to be evacuated safely.

- For structures designed for more than 15 people, more than one exit should be provided and be clearly marked.

225. The blower unit should be inspected to confirm that:

- It is able to be positioned at least 1.2m from a walled side and 2.5m from an open side, with a connection tube long enough to allow this.
- If the blower unit is sited inside the inflatable, it can be situated at least 2.5m from the playing area, safety apron, step and / or ramp.
- If the device is erected at its place of use, the blower unit and associated electrical cables are not accessible to the public.
- The blower impeller and fan casing have not deteriorated to a level that would cause a danger, and that all bolts and screws are properly secured.
- The mesh guards at the inlet and outlet of the blower do not have apertures larger than 8mm and conform to the appropriate IP Ratings.
- There is, where necessary to prevent danger, a non-return flap in the outlet nozzle to increase deflation time.

226. If an internal combustion driven generator / blower is used it should be placed in a well-ventilated area away from the inflatable, so that fumes cannot enter the device.

227. Any associated electrical equipment should be examined to confirm that:

- Electrical installations conform to IEE Wiring Regulations 17th Edition BS7671:2008.

- Electrical equipment is protected from the elements as required by current standards or is located inside a weatherproof hut or cabin.
- Cables, connectors, plugs, sockets and switches are suitable for the intended use, free from deterioration and have sufficient mechanical protection.
- Electrical blowers are supplied via a RCD rated at not more than 30mA.
- For totally enclosed structures, emergency lighting is provided to allow sufficient lighting in the event of a failure of the lighting system. The discharge period should be sufficient to allow for safe evacuation. Refer to BS 5266-1/BSEN 1838.

Chapter 8 Non Destructive Testing (NDT)

General Principles

228. Non-destructive testing (NDT) is the inspection of materials, for surface and internal flaws or metallurgical condition, without interfering in any way with the integrity of the material or its suitability for service. It may be performed during manufacture as part of quality assurance procedures to ensure that a structure or component is free from significant defects and conforms to the design specification. It can also be used as part of the in-service annual inspection to determine whether structures or components have deteriorated to an extent that they are no longer fit for continuing service.

Written NDT Schedule

229. The controller should have a written schedule available for each device (where NDT is required) that specifies method, location and the frequency (this can be measured in either time and/or ride cycles as appropriate) as well as defect acceptance criteria.

230. The NDT schedule should be drawn up by a suitably qualified mechanical/structural engineer in conjunction with a person suitably qualified in the NDT techniques to be used.

- The mechanical/structural engineer should identify the parts of the device that require inspection, the frequency of examination and the extent of disassembly and preparation required to gain access to them.
- The NDT practitioner should specify the appropriate test methods and techniques to be used. These must be reliable and repeatable, so that results can, if necessary, be compared to previous results.

NDT Inspection Report

231. The NDT practitioner should provide a written report to the controller of the parts tested and the results obtained.

232. The types, size, locations and orientations of defect indications should be written into this report and given to the relevant inspection body who should decide upon the action to be taken.

233. The IB will need to assess these results when preparing the report of inspection. An NDT report must include at least the following information (Refer to EN 473):

- Confirmation that the examination has followed the written schedule, inspection techniques and procedures, any further tests carried out and any restrictions to inspection.
- The date of examination.
- The inspector’s name, ADIPS registration number and their qualifications.
- The parts examined.
- The results of examination.

234. Copies of NDT reports should be kept with the device for its lifetime.

235. The IB must keep reports for a minimum of 10 years.

236. When assessing the reports, the IB should be:

- Competent to distinguish between original manufacturing flaws and those which have developed during service. Reference should be made to the reports of previous NDT in the operations manual.
- Competent to classify the indications. This will require a sufficient understanding of:
  (i) The manufacturing methods used and the types of flaws likely to be introduced during manufacture.
  (ii) The significance of the type, size and orientation of the flaw with regard to the geometry, material and loading of the component.
  (iii) The limitations of the NDT method used.

NDT Qualifications and Competence

237. NDT practitioners must hold current approvals for the techniques to be used.

238. There are three main qualifications commonly used in this country: ASNT (American Society for Non-destructive Testing); PCN (Personal Certification in Non-destructive Testing) and CSWIP (Certification Scheme for Weld Inspection Personnel) welding inspector. Reference should be made to the following documents: SNT-TC- 1A, EN 473 & ISO 9712.

239. A person qualified under ASNT is able to carry out a certain type of examination that is specified in a written practice. They are not normally qualified outside that document, which is specific to an NDT method and a specified employer. Before a person claiming compliance with ASNT is engaged, enquiries should be made about the scheme and syllabus of that person's training and whether it is within the scope required to inspect an amusement device.

240. PCN is a recognised worldwide scheme under EN 473 and ISO 9712. An approval issued under the scheme is valid for a maximum of 5 years and may be withdrawn at any time by the issuing authority. The NDT practitioner must hold an approval in the NDT method to be applied. For example, within the ultrasonic sector, a practitioner approved to inspect weldments may not inspect wrought products. The scheme has three levels of competence:

- *Level 1*: an inspector working under supervision by a person qualified at least to Level 2.
- *Level 2*: the main level of practitioner. They can prepare written instructions from appropriate NDT standards and evaluate the results.
- *Level 3*: an inspector competent to write and validate NDT procedures - usually needs 5 years' experience.

241. A welding inspector is qualified to inspect the welding process as well as the finished weld. This qualification can be issued by either PCN or CSWIP. A person holding this qualification can inspect existing welds and any remedial work in progress, as well as the finished result. He may also evaluate the qualifications of the welder and assess the weld procedure. However, in the absence of other qualifications, a welding inspector might not be competent to undertake other forms of NDT.

NDT techniques used in the inspection of amusement devices

Visual Inspection (VT)

242. Visual inspection involves looking for defects using direct or indirect viewing. Direct viewing can include the use of a single mirror or magnifying glass, indirect inspection will involve more complicated equipment such as multiple mirrors, borescopes and video probes, etc., to enable access and inspection in greater detail of the subject area. This technique can be useful as part of an overall examination of an amusement device, but will not be sufficient to complete an adequate inspection of most amusement devices.

Dye Penetrant (PT)

243. PT is useful in detecting surface-breaking flaws in non-ferromagnetic parts. A disadvantage is that it is restricted to surface-breaking flaws and the presence of paint on the test piece can adversely affect detection of flaws.

244. Penetrant inspection requires careful preparation and pre-cleaning to ensure that there are no contaminants in the flaw that would prevent the penetrant entering it. The components to be examined are painted or sprayed with a visible or fluorescent dye solution and left for a period of time (usually 5 to 30 minutes). The excess is removed and a developing compound is applied. This draws the trapped penetrant out of flaws that are open to the surface. The developed image is often viewed immediately and again after a period of time. Using visible dyes, vivid colour contrasts (usually red and white) between the penetrant and developer make the flaw easy to see. With fluorescent dyes, ultraviolet light is used to make the flaw visible.

Magnetic Particle Inspection (MPI)

245. Magnetic particle inspection (MPI) is a method used for detection of surface- or near-surface-breaking flaws (the depth of sub-surface flaw detection is dependent on the technique used). These break the magnetic field and concentrate iron oxide particles near imperfections, giving a visual indication of the flaw. This test is carried out by inducing a magnetic field in a ferromagnetic material and then applying iron oxide particles (either dry or in suspension). The technique is used widely in both in-service and in-manufacture inspection. The resulting image can be viewed in either colour contrast (black and white) form or by using fluorescent particles which will be visible under ultra-violet light.

246. It must be remembered that the component to be inspected must be made of a ferromagnetic material capable of being magnetised to a level that will allow the inspection to be effective.

247. With magnetic particle inspection the flaw indications generally look like the actual flaw. Where the flaw is a surface breaking crack it will appear as a sharp line. Unbroken, tightly adhered paint layers up to about 0.05 mm (50 microns) do not normally impair detection sensitivity. See EN 9934-1[39] for further details.

Eddy Current (EC)

248. Eddy current (EC) is used for the detection of surface or subsurface flaws - the paint does not need to be removed. The depth to which defects can be located can be ascertained by calculation. Eddy currents can be produced in any electrically conducting material when it is subjected to an alternating magnetic field. Passing an alternating current through a coil, which is wrapped round a ferrite rod and placed on the surface to be examined, generates the field. When a flaw occurs in the product surface the eddy currents must travel further around the flaw and this is detected by a measured change of the impedance in the coil.

Ultrasonic Testing (UT)

249. In UT high-frequency sound waves are passed into the test object and reflections are returned to a receiver from internal or surface flaws and from the part's geometrical configuration. This technique is widely used in the fairground industry and is a highly efficient method of detecting sub-surface imperfections. It is important that the interpretation of results is carried out thoroughly. As with all other test techniques it has limitations, for example:

- If the test area is rough, irregular in shape or small, it can be difficult to detect flaws.
- Cast iron and other coarse-grained materials are difficult to inspect due to high attenuation and signal noise.
- Linear defects oriented parallel to the sound beam may go undetected; correct techniques must be utilised to minimise this effect.

Radiography (RT)

250. Radiographic testing (RT) is used to detect internal flaws in metals. X-rays or gamma rays are transmitted through the material and are differentially absorbed by the material through which they pass. An image is produced on a photographic film or digital receiver placed on the opposite side. It requires access to both sides of the component. It is not normally used for surface-breaking flaw detection and does not give an indication of the depth of a flaw from the surface. Whilst it has been shown that suitably trained operatives can use radiography successfully, on parts of amusement devices (for example parts that are hidden underneath strengthening plates) the expense and detailed procedures that are required mean that it is not commonly used.

Relevant Standards & Other Publications

The following list gives examples of Standards and Guidance that may be relevant to those carrying out in-service inspection of Amusement Devices. The list is not exhaustive and is provided for reference purposes only.

- HSG175: Fairgrounds and Amusement Parks, Guidance on Safe Practice, (2007) - HSE Publication.
- BS EN 13814:2005, Fairground and Amusement Park Machinery and Structures – Safety.
- Safety of Amusement Devices: Design (2006) - ADSC/ADIPS.
- Technical bulletins as published on the NAFLIC website. (www.naflic.org.uk).
- BS EN 60204-1:2006, Safety of Machinery - Electrical Equipment of Machines, Part 1: General requirements.
- BS EN 954-1:1997, Safety of Machinery – Safety-Related Parts of Control Systems - General principles for design.
- BS EN 13849-1:2006, Safety of Machinery - Safety-Related Parts of Control Systems, General principles for design.
- BS EN 1050:1997, Safety of Machinery – principles of risk assessment.
- BS EN 1088:1996, Safety of Machinery – Interlocking devices associated with guards – principles for design and selection.
- PD 5304:2005, Guidance on the safe use of machinery.
- BS EN 418:1992, Safety of Machinery – Emergency stop equipment, functional aspects - principles for design.
- BS EN 1037:1996, Safety of machinery – Prevention of unexpected start-up.
- BS EN 62061:2005, Safety of Machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems.
- IEE Wiring Regulations 17th Edition BS7671:2008, Requirements for electrical Installations.
- BS EN 1838:1999, Lighting applications. Emergency lighting.
- BS 5266-1:2005, Emergency lighting. Code of practice for the emergency lighting of premises.
- BS EN 60529:1992, Specification for degrees of protection provided by enclosures (IP code).
- BS EN 60309-2:1999, IEC 60309-2:1999, Plugs, socket outlets and couplers for industrial purposes.
- ISO/TR 9721:1992, Nickel and nickel alloys – Rules for material description based on chemical symbols.
- BS EN 60529:1992, Degrees of protection provided by enclosures (IP code).
- BS EN 982:1996, Safety of machinery. Safety requirements for fluid power systems and their components. Hydraulics.
- ISO 4021:1992, Hydraulic fluid power – Particulate contamination analysis – Extraction of fluid samples from lines of an operating system.
- Pressure Systems Safety Regulations:2000 – Written Schemes of Examination.

- BS EN 14960:2006, Inflatable Play Equipment. Safety requirements and test methods.
- BS EN 1338:2003, Concrete paving blocks. Requirements and test methods.
- BS EN 1176:1998, Playground equipment.
- BS EN 1177:1998, Impact absorbing playground surfacing. Safety requirements and test methods.
- BS EN 473:2008, Non-destructive testing. Qualification and certification of NDT personnel. General principles.