



Guidance Note PM 68 from the Health and Safety Executive

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These Guidance Notes are published under five subject headings: Environmental Hygiene, Chemical Safety, Plant and Machinery and General and Medical.

INTRODUCTION

1 The Code of Safe Practice at Fairs was published by the Health and Safety Executive (HSE) in April 1984. It is the result of a joint initiative of HSE and the associations* representing the amusement industry designed to improve safety standards at fairgrounds. The Code describes general principles and procedures required to safeguard operators, employees and members of the general public against injury from fairground amusement devices.

2 This Guidance Note describes various factors that can contribute to accidents on track-guided gravity rides and the precautions that should be taken to avoid them. It is intended for controllers, operators, ride attendants and anyone else concerned with the safe operation of these rides.

3 The guidance is based on HSE reports of incidents, visits to fairgrounds by inspectors, and the considerable experience of fairground operators. The advice is not exhaustive and should be read in conjunction with the Code. However, compliance with this Guidance Note or the adoption of other equally effective measures will reduce the risk of accidents on these rides.

SCOPE

4 This Guidance Note deals with the safe operation of roller coasters. These are track-guided rides in which the passenger-carrying cars or trains are released from a high point on a track, and are then propelled by forces generated by gravity.

5 The guidance deals both with rides supported on steel structures, including those rides with suspended cars or cars which are designed to carry passengers in the standing position, and with rides supported on timber structures. It does not deal with rides which have cars or trains that have integral drive units which are used throughout the circuit.

*British Association of Leisure Parks, Piers and Attractions
The Showmen's Guild of Great Britain
British Amusement Catering Trades Association

Safe operation of passenger carrying amusement devices - Roller Coasters

6 Most roller coasters in the United Kingdom are installed at fixed sites in amusement and leisure parks, and operate in the open air, but some are inside buildings or other types of enclosure, and operated in the dark. Although many of the medium size and smaller rides were designed so that they could be easily dismantled and moved from site to site, very few of them are used in this way. This guidance, however, is applicable to fixed site and mobile rides.



DESCRIPTION OF RIDE

7 Passengers ride in cars which travel on or are suspended from a track. The cars may operate individually, or be linked to form trains. After passengers have boarded the cars at the ride station, the cars are sent along the track to the start of an incline, which normally rises to the highest point on the ride. The cars are then hauled or driven up the incline to a point where the track peaks, and at this point they are released. They then follow the track which falls away from this point and are propelled along the track to the end of the circuit by gravity. The tracks normally incorporate several troughs and peaks, and the speed and acceleration of the cars vary as they negotiate these features. Some of the more sophisticated rides incorporate track formations, such as loops or 'corkscrew' sections, where the cars are rotated through 360 degrees or more as they pass through them. Many of these rides are designed so that more than one car or train can be free on the same track at the same time. Where it is necessary to prevent collisions between consecutive units, there should be brake units at various points throughout the length of the track, except where there is a brakeman on each train.

RISKS

- 8 The safe design and safe operation of roller coasters should guard against:
- (a) passengers falling or being thrown from cars;
 - (b) collisions between cars;
 - (c) injury to passengers by rapid deceleration of cars during emergency braking, or as the result of mechanical failure;
 - (d) failure of rollback arresters;
 - (e) unsafe working practices by employees during operation, inspection and maintenance of the ride;
 - (f) reckless behaviour by passengers, so far as is reasonably practicable.

SAFE ACCOMMODATION OF PASSENGERS

(paragraphs 31-40 of the Code)

9 Passenger accommodation should be constructed so that each passenger is safely carried in the car during the course of the ride, protected by containment, restraint or a combination of both to the extent necessary to minimise the risk of injury. In determining what standards of containment and restraint are necessary, the assessment made should take account of forces generated by rapid deceleration both during emergency braking and resulting from mechanical failures in the cars or track, as well as those forces generated during the normal course of the ride.

10 The advice contained in paragraph 36 must be followed if any modification is planned which may affect the integrity of the passenger containment or restraint arrangements.

11 Where passenger restraint arrangements are required, devices used to lock them in position should be placed or constructed so that they cannot be operated inadvertently by passengers in the cars; they should be constructed so that the restraint arrangements are locked in place positively.

12 Areas alongside or above the track that may be reached by properly accommodated passengers should be clear of features which, because of their position or nature, could cause reasonably foreseeable injury to anyone who leans out, or who puts an arm or leg outside the car.

13 People whose physical characteristics are such that they are not able to ride the device in safety should be excluded from the ride. Suitable signs should be erected which draw the public's attention to the restrictions that apply on particular rides and the operating staff should be given clear instruction on the need to exclude passengers who would not be able to ride in safety.

SAFE OPERATION OF RIDE (Paragraphs 41 - 70 of the Code)

14 Systems of work and standards of supervision play an important part in the safe running of any passenger-carrying ride. The ride controller should ensure that the systems of work employed are safe and that employees operating a ride are adequately supervised.

15 The ride controller should decide how many attendants are needed to operate the ride safely and should ensure that the correct number are on duty and properly supervised when the ride is in operation.

16 The ride operator and attendants should ensure that cars are brought to a halt or held stationary relative to the platform before passengers are allowed to get in or out.

17 No car or train should be sent from the loading station until all the passengers are properly accommodated, and have been given clear verbal instructions about how they should behave during the ride. These instructions should also be displayed in notices on the ride.

18 Where a system of visual signalling is used by ride attendants to tell the operator that cars are ready to go, the signalling system should be clearly defined and properly understood by all operational and maintenance staff.

19 It may be necessary to communicate with the passengers in a car or train on the track away from the station during the course of a ride or in an emergency. Suitable means should be provided to do this. On the larger gravity rides a public address system or loud hailer may be necessary to aid communication.

20 Where a car or train comes to a halt on the track, for example because of mechanical failure or if the unit is arrested on a rollback arrester, the ride operator should reassure passengers and instruct them to remain seated in the cars (see paragraph 19).

21 The ride controller should make arrangements for the safe evacuation of passengers from cars that become stranded away from the ride station (see paragraphs 41 and 49 dealing with safe access to the ride). Priority should be given to returning passengers to the station in the car: they should not be asked to disembark unless it would be unsafe or impracticable for them to be returned to the station in the car.

22 Gravity rides which have manually operated braking systems and which operate with more than one car free on the track beyond the hoist should be supervised by a minimum of two people, one of whom should be able to operate the emergency braking system at any time while the ride is in use. The person in charge of this braking system must be able to monitor the progress of the cars on the track from the operating position and should be able to activate the

emergency braking system and switch off the car hoist. Where reasonably practicable, a single control device should be provided for this purpose.

23 The intervals at which cars are released from the hoist should be controlled so that the length of track separating consecutive cars at any point in the circuit has at least one emergency brake unit.

24 Roller coasters incorporating features that prevent the operator from monitoring the progress of the cars (including those rides that operate in the dark inside buildings) should have a fail safe block system that automatically maintains safe intervals between consecutive cars and prevents car to car collisions.

25 All dangerous parts of machinery should be securely fenced when in motion or use in accordance with the British Standard Code of Practice *Safeguarding of machinery* BS 5304:1975.

PASSENGER ACCESS TO THE RIDE (Paragraphs 57/58 of the Code)

26 Low level sections of the track and any parts of the track support structure that young children might be able to climb should be fenced off. The fencing should be at least one metre high and should be constructed and positioned in such a way that people cannot reach over, through, or under it into areas where they may be struck by parts of the moving cars.

27 There should be some arrangement for preventing uncontrolled access to the loading platform. This may include either effective supervision or some physical means, eg offset barriers, turnstiles or steps.

EXAMINATION AND INSPECTION OF RIDES (Paragraphs 1-23 of the Code)

28 Each ride should be thoroughly examined at least once in every 14 months by an appointed person as required by the Code. This examination should, where practicable, be carried out before the season starts, but in any case within 3 months of its starting. The examination should be based on a check list prepared by the appointed person on the basis of their experience, discussions with the ride controller and advice from the ride manufacturer (where available). The examination should, where applicable, include the following:

- (a) the track support structure, its foundations and any packing materials used;
- (b) the condition and securing of ballast weights;
- (c) the track, track joints and the fixings between track sections, or between the track and the support structure;
- (d) the pull-ups, their hoists, chains or ropes, and the dogs or grips which engage with them;
- (e) rollback arresters and arrester dogs;
- (f) brake assemblies and their fixings;

- (g) car couplings and safety cables (where appropriate);
- (h) car support and guide wheels and their tyres;
- (i) wheel mountings or housings and support bearings;
- (j) the brake fin and/or other brake components mounted on the car;
- (k) the car structure;
- (l) passenger seating and restraint arrangements;
- (m) the location and condition of all car position and brake condition sensors;
- (n) assessment of the functioning of the ride control system during test running of the ride.

This list is not intended to be exhaustive, nor should it inhibit the exercise of judgement on the part of the appointed person.

29 Where the appointed person directs, or where recommended by the manufacturer, parts of the ride should be subjected to suitable non-destructive tests. Such testing should be carried out by people competent to select and apply appropriate techniques and interpret the results.

30 The ride should be inspected and tested each day before it is brought into use. These operations should take account of information supplied by the manufacturer (where this is available) and should be based on a suitable check list which is signed off by the person performing the inspection.

31 Such inspections should be carried out by properly trained staff and should, where appropriate, include checks of:

- (a) car couplings and safety cables and their attachments;
- (b) the dogs or clamps that engage with the hoist chain or rope of the pull-ups;
- (c) roll back arrester devices and their dogs;
- (d) the condition of the car wheels and their tyres;
- (e) track joints and the condition of the track surface;
- (f) the operation and fixing of braking mechanisms and brake parts fixed to the cars;
- (g) passenger seating;
- (h) passenger restraint systems and their locking devices;
- (i) the car transfer station and the transfer track positioning prior to test run;
- (j) the condition of the hoist ropes or chains at the pull-ups;
- (k) the condition and thickness of the brake linings.

The above list is not exhaustive and other features may need to be included in the daily inspection.

32 Following this inspection, the ride should be test run. This test should involve all the cars or trains to be

used that day. The test run should be used to check the cars, the operation of the brake units in normal use and the proper functioning of the control system.

33 Only where it is operationally essential should anyone ride in a car or train on a test run and no one should ride in the first car or train despatched. Anyone who rides during a test should travel in the normal riding position and use any restraint provided, where reasonably practicable. The ride operator or other person conducting the test run should ensure that the track is clear and that no one is in a dangerous position before the test is started (see paragraph 41).

34 The ride should not be made available to the public until any adjustments or repairs judged to be necessary as a result of the daily inspection have been satisfactorily completed.

35 Records of all examinations and inspections should be kept by the operator and/or the ride controller in the form required by the Code.

MAINTENANCE OF THE RIDE (Paragraphs 24-30 of the Code)

36 This guidance draws a distinction between routine maintenance operations and those operations involving modification or repair of the ride likely to affect the integrity of the device. This is an important distinction; ride controllers should follow the advice contained in the Code of Safe Practice at Fairs relating to modification and repair (paragraphs 9 and 107 to 109 of the Code).

37 The ride should be maintained in accordance with the manufacturer's instructions. If such instructions are not available, the ride controller should prepare suitable instructions which should incorporate advice from the ride supplier, the independent appointed person and other sources of relevant expertise.

38 Replacement parts should be of suitable design and specification. If the replacement parts used are of a different design or specification from those specified by the manufacturer, their use may affect the integrity of the ride. In such circumstances the guidance in paragraph 39 and 40 may need to be followed.

MODIFICATION AND REPAIR

39 Where it is intended to carry out modifications or repairs that may adversely affect the integrity of a ride, the modification should be devised in accordance either with the manufacturer's and designer's instructions, or with a plan and specification drawn up by a person competent to prepare such instructions. Once these instructions have been drawn up they should be submitted to an independent consulting engineer to establish that the design concept is sound and that the calculations are correct, before any changes are made.

40 Ride controllers should take care to ensure that their employees and others who may be involved with

the maintenance, modification and repair of the ride make a distinction between routine maintenance work and work involving modification and repair, and should issue clear instructions regarding this distinction.

ACCESS TO THE RIDE FOR MAINTENANCE, REPAIR AND IN EMERGENCY

41 Ride controllers should make suitable arrangements for allowing access to the ride for the purposes of inspection, examination, testing, maintenance, repair and in emergency. In this context ride controllers should consider using suitable permit-to-work schemes and the provision of power isolators that can be locked in the off position by maintenance staff, contractors or anyone else who may need access to the ride.

42 When ride attendants, maintenance personnel or other employees ride in the cars to test or examine the ride, they should ride in the normal riding position and use any restraint provided, where reasonably practicable.

43 Some serious and fatal injuries have occurred as a result of falls from one level to another during maintenance or repair. It is important therefore that work of this kind on roller coasters is properly planned and controlled.

44 Operations involving the construction, structural alteration, demolition or repair of the structure of a ride may well be subject to the Construction Regulations made under the Factories Act 1961.*

45 Where it is necessary to gain frequent access to raised parts of the ride, for example brake units, or the ride support structure, for inspection or maintenance purposes, safe means of access should be provided and used, for example suitable fixed ladders, stairs, walkways or mobile access equipment.

46 Ladders should be constructed to the standard specified in BS 4211: 1967 *Steel ladders for permanent access*, and should be fitted with safety loops. Where ladders rise more than 9.14 m (30 ft) suitable landing places should if practicable be provided adjacent to the ladder at intervals of not more than 9.14 m. These rest platforms should be big enough for a person to rest in safety clear of the ladder and should have guard rails and toe boards. The top guard rail should be 0.92 m to 1.14 m (3 ft to 3 ft 9 in) above platform level, and if the gap between the rail and the top of the toe board is more than 0.76 m (2 ft 6 in), an intermediate guard rail should be provided.

47 Where working platforms are provided and a person could fall more than 1.98 m (6 ft 6 in) from any side of them, the platforms should be provided with suitable guard rails and toe boards, as specified previously (see paragraph 46), or some other suitable

*The Construction (General Provisions) Regulations 1961
The Construction (Lifting Operations) Regulations 1961
The Construction (Working Places) Regulations 1966 and
The Construction (Health and Welfare) Regulations 1966

means of preventing people or materials falling from the edge of the platform.

48 Walkways and inclined ramps adjacent to haul-ups and in other locations should have a surface that provides a secure foothold. Where any person is liable to fall a distance of more than 1.98 m from the edge of a ramp, guard rails and toe boards, as specified above, should be provided at that edge. The upper rail of the edge protection should be designed so that it can be used as a hand rail and easily gripped by the hand.

49 Where it is necessary for people to gain access to parts of the ride or its supporting structure in positions where there is no permanent equipment provided for safe access and safe working, suitable temporary arrangements should be made for safe access and precautions against falls.

TRAINING OF OPERATORS AND RIDE ATTENDANTS (Paragraphs 71/72 of the Code)

50 Each operator should receive suitable and sufficient training in the safe operation of the ride. Training should include adequate instruction on:

- (a) the method of operating the ride;
- (b) the maximum passenger loading of the ride;
- (c) the systems of work that should be followed to ensure the safety of ride attendants;
- (d) the systems of work that should be followed to ensure the safety of passengers and other members of the public;
- (e) the duties of ride attendants;
- (f) the safe method of assembling and dismantling the ride where applicable;
- (g) how to carry out the daily inspection of the ride where undertaken by them.

51 It is desirable that operators are aware of the Code requirements relating to daily inspections, the intervals at which thorough examination and testing should be carried out and the reasoning behind such procedures.

52 Attendants should receive suitable and sufficient training for the type of work they are expected to do. Training should include adequate instruction on:

- (a) control of passengers on the station platform and the loading and unloading areas;
- (b) the safe systems of work they should adopt and the risks they should avoid;
- (c) the procedure for reporting defects or breakdowns;
- (d) procedures that should be followed in an emergency.

RIDE CONTROL SYSTEMS

53 The systems used for the control of certain roller coasters may be computer-based; the controller itself may be a programmable controller (PC) or a programmable logic controller (PLC). Such systems are referred to generically as programmable electronic systems (PESs).

54 Where such systems incorporate safety functions, such as car braking, car sequencing, position sensing and operation of pull-ups, it is important to ensure that the level of safety integrity achieved is not less than that which would have been achieved by non-programmable systems based on, for example, conventional electro-mechanical devices.

55 These systems should be engineered by competent and experienced people who understand the safety engineering principles involved. Guidance on such systems is given in *Guidance on the use of programmable electronic systems in safety related applications* which is shortly to be published by HSE.

56 If the system used for the control of an existing ride is computer-based, and incorporates ride safety functions, the design should be assessed to determine its safety integrity. This assessment and any design improvements needed to achieve an adequate level of safety integrity should be based on the guidance in paragraph 55 and on the publication referred to in that paragraph.

57 These systems should be maintained by people competent to carry out such work.

58 No modification should be made to the hardware or software of any programmable electronic system which controls safety functions unless the guidance in paragraphs 54 and 55 has been followed.