Guidance Note PM49
from the
Health and Safety
Executive

Safe operation of passenger carrying amusement devices — the Cyclone Twist

Plant and Machinery 49 (September 1985)

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

INTRODUCTION

1 The Code of Safe Practice at Fairs was published by HSE in April 1984. It is the result of a joint initiative between HSE and the Associations* representing the fairground 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 devices.

2 This Guidance Note describes various factors that can contribute to accidents on the Cyclone Twist and the precautions that should be taken to avoid them. It is intended for operators, ride attendants and anyone else concerned with the safe operation of this ride.

3 The guidance is based on HSE reports on 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 risks of accidents on these rides.

THE SCOPE OF THE GUIDANCE NOTE

4 This Guidance Note relates to the passenger carrying amusement device known as the Cyclone Twist, and to design variations such as the Scrambler, Merrymixer, Zig-Zag, Sidewinder, Disco Twist, and Sizzler. Some of these names may be used for other rides of a different type. Conversely, other names may be used for this type of ride.

GENERAL DESCRIPTION OF THE CYCLONE TWIST

5 The ride consists of a central vertical column, rotating under power, from which project three equally spaced radial arms. Each arm is made up of both lower and upper horizontal members attached to the central column (figs 1a and 1b).

6 At the outer end of each radial arm is a further pivot on which is mounted a rotating vertical shaft between bearings. This vertical shaft (known as a capstan shaft) carries a carousel assembly which consists of four equally spaced radial arms in the form of a cross, on the outer ends of which are mounted passenger carrying cars. Each car is rigidly attached to the end of the subsidiary arm.

7 Normally each carousel assembly carries four cars, and there is one carousel assembly attached to each of the three main arms. Thus twelve cars in total are provided to take passengers on each ride.

8 The vertical shaft carrying the carousel assembly is also driven; this drive may be interdependent or independent of the main drive to the central vertical column. The central column of the device is normally designed to rotate clockwise, while the secondary drive to the carousel assembly is designed to rotate this assembly in the opposite direction.

9 The power to the ride may be supplied electrically, hydraulically or by internal combustion engine.

10 When the drive to the carousel assembly depends on motion supplied from the main central column, the motion may be transmitted through a bevel gear drive via a propshaft. A pre-set slip clutch, which is adjustable, may be located at the carousel end. Alternatively, the motion may be imparted frictionally by a tyred wheel.

11 Where the carousels are independently driven, the drive is imparted to each carousel assembly by electric motors via a gearbox and vee belt drive, or by hydraulic motors.

RISKS

12 The safe design and safe operation of the Cyclone Twist should guard against:

(a) injury to passengers within the car;

(b) passengers being thrown from the car;

(c) injury to passengers, spectators, ride operators and attendants who might be struck by cars or arms, either when mounting or dismounting from the cars, or when moving into the path of the moving parts during the ride;

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

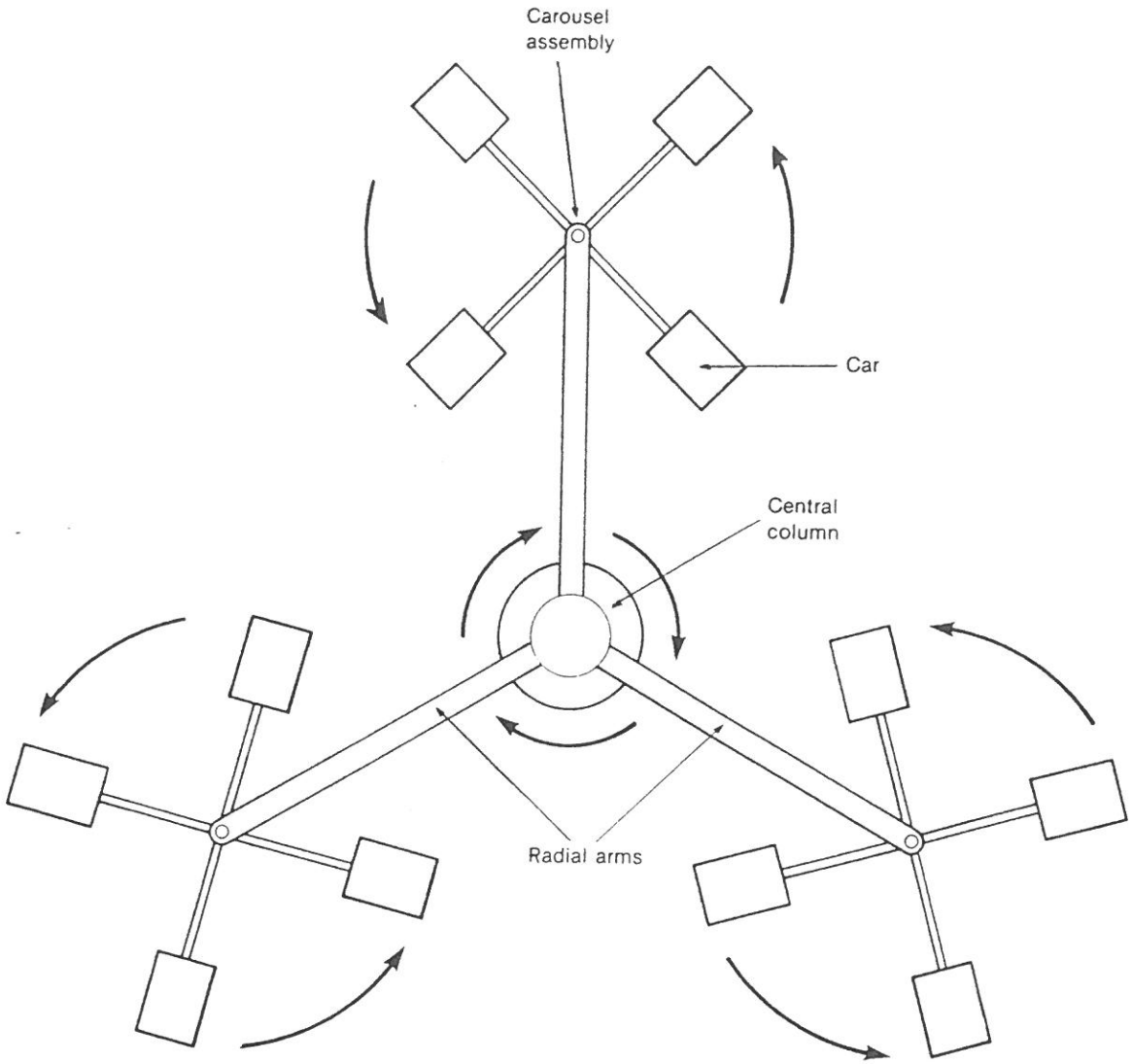

Fig. 1a Plan view of Cyclone Twist showing direction of movement

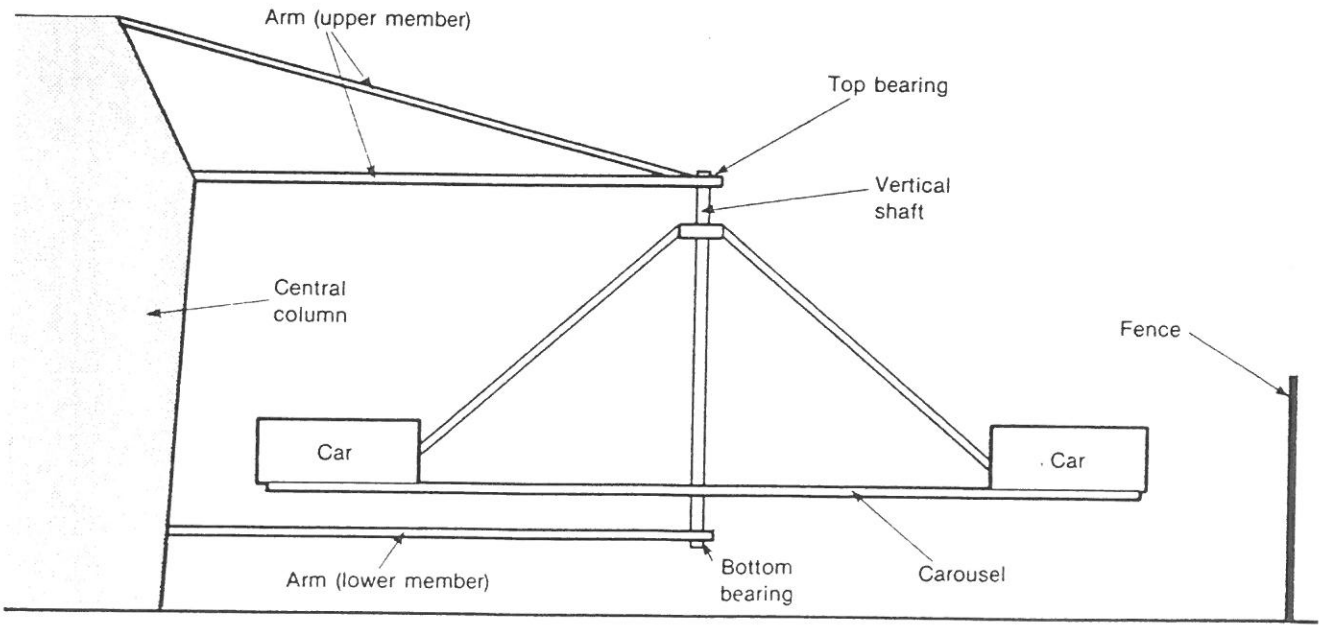

Fig. 1b Section through central column and carousel assembly

(d) fatigue failure of the vertical carousel shaft or central column;

(e) failure at the pins securing the cars to the radial arm.

DESIGN, MANUFACTURE AND MODIFICATIONS
(Paragraphs 73 - 109 of the Code)

13 To prevent injury to passengers in the car, the drive arrangements to all devices should either be incapable of exceeding the maximum operating speed, or be fitted with cut-out arrangements or governors so that this speed cannot be exceeded. Overspeeding can also be prevented by incorporating an effective physical stop into the control mechanism, eg into the rheostat, to prevent the ride from revolving at more than a safe speed. The maximum operating speed should be clearly marked at the controls of the device.

14 Twists that incorporate friction drives impose considerable loads on the vertical capstan shafts supporting the carousels. This may well lead to early fatigue fracture, unless they have been constructed or modified with a full determination of likely stress levels and fatigue life expectation.

15 Where additional strengthening, such as gusset plates, is fitted to provide further bracing between the capstan shaft and car support arms, particular care should be taken to ensure that welding is carefully and properly carried out, and regularly examined to detect cracks.

16 A retaining or catch plate should be fitted beneath the vertical capstan shaft to prevent the lower member of the radial arm dropping to the ground or platform in the event of the failure of the shaft. On certain models, following early failures of the vertical capstan shaft, U-shaped skid plates have been fitted beneath the bottom bearings of the vertical carousel shaft, to prevent the shaft and lower bearing assembly becoming embedded in the ground or platform beneath the ride on failure of the shaft. These measures also reduce the risk of a carousel unit being struck by the following unit before it is brought to a halt. The advice in paragraphs 107 to 109 of the Code should be followed in relation to such modifications.

17 Particular care is necessary to ensure that the connecting pins manufactured to join the structural members together are of proper design and construction.

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

18 The ride should be provided with a perimeter fence. The fence should be at least one metre high and should be capable of restraining people leaning on it or being pushed against it. This fencing should be designed and positioned with sufficient clearance to prevent anyone outside the fence being within reach of any moving part of the Twist.

19 The number of passenger openings for access and egress should be limited to the number necessary for safe loading and unloading. No more than four such openings at even spacing should be allowed.

20 At a ground based ride, a platform based ride with a platform 300 mm high or less, or a ramp access ride, physical means, eg turnstiles, swing gates or offset barrier and step arrangements (see fig 2), should be provided at the necessary openings to prevent people from entering the danger area. In addition, there should be effective supervision to prevent access to the danger area.

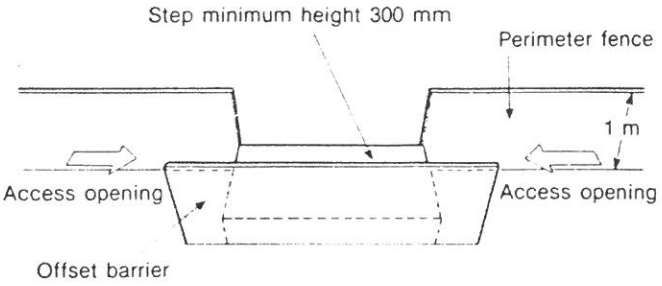

Fig. 2 Supervised opening, showing two requirements for access
(a) necessary change of direction
(b) step up onto access platform placed radially to ride

21 A platform based ride where the platform is more than 300 mm high should be safeguarded either (a) as outlined in paragraph 20 or (b) by at least one step at least 150 mm high with at least 1.1 m between the outside edge of the bottom step and the nearest part of the path of the moving parts of the device, together with effective supervision of each opening to ensure that there is no access to the platform or steps while the ride is in motion.

ASSEMBLY AND DISMANTLING OPERATIONS
(Paragraphs 134 - 155 of the Code)

22 All assembly pins or bolts should be kept in position by appropriate securing devices, ie retaining pins (R-clips), klik pins or similar pins. Where these pins are used, it is essential to ensure that they are securely fixed in place. If the clip is a loose fit or has lost its tension, it should be discarded. Only the correct size of clip should be used. The clips should be inserted by hand only, and not forced into place. It is important that they are fitted correctly.

23 Where the manufacturer supplies a particular type of securing device, no clip other than a suitable retaining pin, klik pin or similar pin of the original manufacturer's design or its equivalent specification should be used.

24 Retaining pins and klik pins, provided to help the speed of assembly, should not be used where a higher standard of securing device is required. Where necessary, the assembly pin should be replaced by threaded bolts and retaining nuts.

25 During assembly, particular attention should be paid to the fitting and securing of ties between the four bottom arms of the carousel support frame and between the three main radial arms which project from the central column, where these are necessary (see fig 1). These ties prevent excessive wear at the main pin joints on the radial arms, and should therefore be in position, properly secured and fitted, at all times when the ride is in use.

26 The stability of the central column of the ride is particularly important during erection. Where outriggers are provided, suitable packing, eg wooden blocks, should be provided to ensure a hard and solid base.

27 On sloping ground, the ride should be erected so that the central column is as near vertical as is reasonably practicable, or in such a way that it conforms to the tolerances recommended by the manufacturer.

28 On occasion, Twist rides fitted with slip clutches have caused passenger discomfort. The slip clutches should be kept properly adjusted and clean, otherwise they will not function properly, and passengers may be moved to the inner side and forward during the ride. During normal operation, passengers are eased to the outer side of the seat, and one indication that something is wrong is that passengers may involuntarily be sliding from one side of the seat to the other.

SAFE ACCOMMODATION OF PASSENGERS
(Paragraphs 31 - 70 of the Code)

29 Since the ride generates varying centrifugal forces, it is particularly important that every individual passenger should be secured into the car to ensure that he cannot fall or be ejected from it during the ride. The usual restraint arrangement is a fixed, hinged gate which pivots out of the way to allow access to the seat. Once a passenger has entered the car the gate is closed and secured in position. The gate should extend from one side of the car to the other.

30 Each gate should be provided with adequate locking devices, eg positive catch arrangements, which are fully closed by the ride attendants before the ride is set in motion. The locks should be constructed or positioned so that they cannot be readily opened by passengers in the car, eg they should have double feature catches, suitably shrouded catches, or catches so positioned that only the ride attendant or operator can open them. All locking devices should be regularly inspected to ensure that they do not fail in operation. They should also be designed to fail safe, eg there should be no possibility of the gate opening on the failure of a spring.

31 One ride manufacturer has provided a solenoid operated centrally controlled switch system to ensure that the restraint arrangement is not opened while the ride is in motion. The ride operator operates the switch in the control cabin. To minimise the risk of ejection from a car where the restraint arrangement is not properly closed, manufacturers and ride operators should consider fitting similar arrangements where practicable. This system also protects passengers who may try to dismount from the car before it is fully stopped. The system should also ensure that the ride cannot be set in motion until all restraint arrangements are closed.

32 The ride should be brought to a complete halt before the operator or ride attendants move forward into the fenced enclosure to release passengers, except in a rare emergency situation where the risk of a more serious injury is foreseeable, and there is no movement by the operator or attendant into the path of a moving car. The ride should not be set in motion until the enclosure within the perimeter fence is clear of anyone except passengers properly seated and restrained in cars.

33 Passengers should remain correctly seated throughout the ride. This rule should be reinforced by verbal warnings, eg from an amplified loud speaker, and by legible notices. Loose items should not be taken onto the ride.

34 The restraint arrangements should prevent passengers sliding about in the car in such a way that they may be injured or slip out of the car from the normal seated position during the ride. The arrangements should include:

(a) a footwell with an upstand section against which the feet can be braced. The gaps at the outside edges of the footwell should be protected to prevent feet projecting out of the car;

(b) a restraint arrangement which spans the width of the car to enable the person sitting in it to hold the top bar comfortably. This arrangement should include a second lower bar to prevent people sliding forwards off the seat;

(c) a seat with a surface material of a high frictional resistance to prevent people from slipping about.

35 On some designs it has been found necessary to put a canopy above the seat to prevent passengers standing up during the ride. The design of the restraint arrangement and its locked position in relation to the seat should also prevent this.

36 The design of the passenger carrying car and fixings should be such as to ensure that single component failure does not lead to further failure of the seat, sides, restraint arrangements or footwell on the car.

37 Experience indicates that the ride is not suitable for carrying passengers who cannot brace their feet against the upper edge of the footwell singly in a car. Where such passengers are taken onto the ride, they should be loaded inboard in the same car as a responsible adult who can brace his feet against the upper edge of the footwell. In any event children under a specified height should not be carried on the ride, whether accompanied or not, if the dimensions of the seating make it dangerous to do so. The minimum specified height of passengers should be clearly indicated at the ride. As far as practicable, the largest passenger in any car should be positioned on the outer side of it.

THOROUGH EXAMINATION, MAINTENANCE AND INSPECTION
(Paragraphs 1 - 30 of the Code)

38 The thorough examination should ensure that the ride and its load bearing parts are in good condition. The examination should establish that:

(a) there are no unacceptable cracks in the sweep arms;

(b) there are no unacceptable cracks in the central column or vertical shaft to the carousel assembly;

(c) cars are adequately secured to the carousel, and the carousel to the sweep arms;

(d) all pins and clips are properly maintained;

(e) driving parts, eg gearing, vee belt drives and hydraulic transmission systems, are in good condition;

(f) all bearings including the central column and top and bottom bearings of the carousel assembly are in good condition;

(g) the condition of tyres used on friction drive units, where applicable, is good, and the pressures are correct;

(h) there is no elongation of the assembly pin mounting holes outside acceptable tolerances;

(i) the fixings for the passenger carrying car are in a good condition such as will ensure no failure of the seat, sides, restraint arrangement and footwell of the car.

The above list is not exhaustive and the examination should include all parts that may affect the safe operation of the Twist.

39 The appointed person should consider key parts of the ride for non-destructive testing, particularly the pins, main welded joints, and car support arrangements.

40 Non-destructive testing during the thorough examination will normally detect fatigue cracks so that resultant structural failure can be prevented. There is, however, no substitute for adequate design and sound construction. The appointed person should be aware of any fatigue life appraisal carried out by the maker in his design calculations.

41 At least one manufacturer recommends that the main bearings above and below the carousel assembly should be replaced at four-yearly intervals. Where the manufacturer advises a replacement life, this should be met.

42 Daily inspections should ensure that the car restraint arrangements are functioning properly without defect, that the cars are in good condition, and that all assembly pins and their securing devices are properly in place. The perimeter fence and any other physical means to prevent access should also be checked to establish that no damage has occurred.

43 Once the daily inspection has been completed, the device should be given a trial run before it is used to carry passengers. It should not be made available to the public until any adjustments or repairs judged to be necessary as a result of this inspection have been satisfactorily carried out.

44 Full maintenance should be conducted in accordance with the manufacturer's guidance and schedules. If such guidance and schedules are not available, the owner should specify the procedures, in the light of experience and advice from the supplier, appointed ride examiner, HSE or the associations representing the fairground industry.

THE TRAINING OF OPERATORS AND ATTENDANTS
(Paragraphs 71 and 72)

45 Each operator should have sufficient and suitable training in the working of the Twist ride. This should include adequate knowledge of:

(a) the method of operating the Twist;

(b) the safe loading of the Twist;

(c) the maximum operational speed;

(d) the systems of work necessary to ensure the safety of his attendants;

(e) the systems of work necessary to ensure the safety of passengers and members of the public;

(f) the training needs of his attendants;

(g) the safe methods of assembling and dismantling the Twist (when applicable);

(h) the method for daily inspection and its recording.

Where available, advice from manufacturers should be incorporated into this instruction.

46 Operators should be aware of the Code requirements relating to the intervals at which thorough examination and testing should be carried out, and the reasoning behind such procedures.

47 Each attendant should receive suitable training for his type of work, including:

(a) the arrangements for controlling the public into and out of the enclosure;

(b) the arrangements for securing the safe loading and unloading of passengers;

(c) the risks and precautions associated with the work;

(d) the procedures for reporting defects or breakdowns;

(e) the measures which he is required to take in the event of an emergency.

48 Ride attendants must not:

(a) ride on parts of the Twist in motion, except where properly seated;

(b) move through the enclosure while the ride is in motion, except in the emergency situation described in paragraph 32.

Particular care is needed to ensure that these rules are followed when fares are collected.

FURTHER INFORMATION

This guidance work is produced by the Health and Safety Executive. Further advice on this or any other publication produced by the Executive is obtainable from St Hugh's House, Stanley Precinct, Bootle, Merseyside, L20 3QY, or from Area Offices of HSE.

GUIDANCE NOTES

General Series

GS 1 Fumigation using methyl bromide
GS 2 Metrication of construction safety regulations
GS 3 Fire in the storage and industrial use of cellular plastics
GS 4 Safety in pressure testing
GS 5 Entry into confined spaces
GS 6 Avoidance of danger from overhead electrical lines
GS 7 Accidents to children on construction sites
GS 8 Articles and substances for use at work - guidance for designers, manufacturers, importers, suppliers, erectors and installers
GS 9 Road transport in factories
GS10 Roofwork: prevention of falls
GS11 Whisky cask racking
GS12 Effluent storage on farms
GS14 Provision of sanitary conveniences and washing facilities in agriculture
GS15 General access scaffolds
GS16 Gaseous fire extinguishing systems: precautions for toxic and asphyxiating hazards
GS17 Safe custody and handling of stock bulls on farms and at artificial insemination centres
GS18 Commercial ultra-violet tanning equipment
GS19 General precautions aboard ships being fitted out or under repair
GS20 Fire precautions in pressurised workings
GS21 Assessment of radio frequency ignition hazards
GS23 Electrical safety in schools
GS24 Electricity on construction sites
GS25 Prevention of falls to window cleaners
GS26 Access to road tankers
GS27 Protection against electrical shock
GS29/1 Health and safety in demolition work. Part 1: preparation and planning
GS29/2 Health and safety in demolition work. Part 2: Legislation
GS30 Health and safety hazards associated with pig husbandry
GS31 Safe use of ladders, step ladders and trestles
GS32 Health and safety in shoe repair premises
GS33 Avoiding danger from buried electricity cables
GS35 Safe custody and handling of bulls on farms and similar premises
GS36 Safe custody of and handling of bulls at agricultural shows, markets and similar premises off the farm

Chemical Safety Series

CS 1 Industrial use of flammable gas detectors
CS 2 The storage of highly flammable liquids
CS 3 Storage and use of sodium chlorate
CS 4 The keeping of LPG in cylinders and similar containers
CS 5 The storage of LPG at fixed installations
CS 6 The storage and use of LPG on construction sites
CS 7 Oderisation of bulk oxygen in shipyards
CS 8 Small scale storage and display of L.P.G. at retail premises
CS 9 Bulk storage of liquid carbon dioxide

Plant and Machinery Series

PM 1 Guarding of portable pipe-threading machines
PM 2 Guards for planing machines
PM 3 Erection and dismantling of tower cranes
PM 4 Safety at high temperature dyeing machines
PM 5 Automatically controlled steam and hot water boilers
PM 6 Dough dividers
PM 7 Lifts
PM 8 Passenger carrying paternosters
PM 9 Access to tower cranes
PM10 Tripping devices for radial and heavy vertical drilling machines
PM13 Zinc embrittlement of austenitic stainless steel
PM14 Safety in the use of cartridge operated tools
PM15 Safety in the use of timber pallets
PM16 Eyebolts
PM17 Pneumatic nailing and stapling tools
PM18 Locomotive boilers
PM19 Use of lasers for display purposes
PM20 Cable-laid slings and grommets
PM21 Safety in the use of woodworking machines
PM22 Mounting of abrasive wheels
PM23 Photo-electric safety systems
PM24 Safety at rack and pinion hoists
PM25 Vehicle finishing units: fire and explosion hazards
PM26 Safety at lift landings
PM27 Construction hoists
PM28 Working platforms on fork lift trucks
PM29 Electrical hazards from steam/water pressure cleaners etc
PM30 Suspended access equipment
PM31 Chain saws
PM32 The safe use of portable electrical apparatus
PM33 Safety of bandsaws in the food industry
PM34 Safety in the use of escalators
PM35 Dough brakes
PM36 Weld defect acceptance levels
PM37 Electrical installations in motor vehicle repair premises
PM38 Electric handlamps
PM39 Hydrogen embrittlement of grade T chain
PM40 Protection of workers at welded steel tube mills
PM41 The application of photo-electric safety systems to machinery
PM42 Excavators used as cranes
PM43 Scotch derrik cranes
PM44 Escalators - periodic thorough examination
PM46 Wedges and socket anchorages
PM47 Safe operation of passenger carrying devices - waltzer
PM48 Safe operation of passenger carrying devices - octopus

Medical Series

MS 3 Skin tests in dermatitis and occupational chest disease
MS 4 Organic dust surveys
MS 5 Lung funtion
MS 6 Chest x-rays in dust disease
MS 7 Colour vision
MS 8 Isocyanates - medical surveillance
MS 9 Byssinosis
MS10 Beat conditions and tenosynovitis
MS12 Mercury - medical surveillance
MS13 Asbestos
MS15 Welding
MS16 Training of offshore sick-bay attendants ('rig-medics')
MS17 Biological monitoring of workers exposed to organophosphorous pesticides
MS18 Health surveillance by routine procedures
MS20 Pre-employment health screening
MS21 Precautions for the safe handling of cytotoxic drugs
MS22 The medical monitoring of workers exposed to plutonium salts

Environmental Hygiene Series

EH 2 Chromium - health and safety precautions
EH 4 Aniline - health and safety precautions
EH 5 Trichloroethylene - health and safety precautions
EH 6 Chromic acid concentrations in air
EH 7 Petroleum based adhesives in building operations
EH 8 Arsenic - health and safety precautions
EH 9 Spraying of highly flammable liquids
Asbestos - Control Limits measurement of airbourne dust concentrations and assessment of control measures.
EH11 Arsine - health and safety precautions
EH12 Stibine - health and safety precautions
EH13 Beryllium - health and safety precautions
EH14 Level of training for technicianc making noise surveys
EH16 Isocyanates: toxic hazards and precautions
EH17 Mercury - health and safety precautions
EH18 Toxic substances; a precautionary policy

EH19 Antimony - health and safety precautions
EH20 Phosphine - health and safety precautions
EH21 Carbon dust - health and safety precautions
EH22 Ventilation of buildings: fresh air requirements
EH23 Anthrax - health hazards
EH24 Dust accidents in malthouses
EH25 Cotton dust sampling
EH26 Occupational skin diseases: health and safety precautions
EH27 Acrylonitrile: personal protective equipment
EH28 Control of lead: air sampling techniques and strategies
EH29 Control of lead: outside workers
EH30 Control of lead: pottery and related industries
EH31 Control of exposure to polyvinyl chloride dust
EH32 Control of exposure to talc dust
EH33 Atmospheric pollution in car parks
EH34 Benzidine based dyes
EH35 Probable asbestos dust concentrations on construction premises
EH36 Work with asbestos cement
EH37 Work with asbestos insulating board
EH38 Ozone: health hazards and precautionary measures
EH40 Occupational exposure limits 1984
EH43 Carbon monoxide
EH44 Dust
EH45 Carbon disulphide: control of exposure in the viscose industry

HMSO AB
ISBN 0 11 883525 4

First published 1985

Printed in the UK for HMSO
C100 9/85