



Guidance Note PM 48 from the Health and Safety Executive

Safe operation of passenger carrying amusement devices - the Octopus

Plant and Machinery 48 (January 1985)

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 the Health and Safety Executive (HSE) in April 1984. It is the result of a joint initiative of 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 note describes various factors that can contribute to accidents on the Octopus 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 risk of accidents on these rides.

SCOPE

4 This Guidance Note relates to the safe operation of the passenger carrying amusement devices known as the Octopus, and of such design variations as the Disco Octopus, Monster Octopus, Spider, Monster and the smaller devices specifically for younger children such as the Junior Octopus and the Mini-Octopus. Throughout this Guidance Note, the term Octopus will include all design variations unless specified otherwise.

DESCRIPTION OF OCTOPUS

5 There are a number of designs of Octopus, each different in detail but with a common basic motion and construction.

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

6 The basic Octopus is illustrated in Fig 1. Six or eight arms (sweeps) radiate from a cage on a central frame which is rotated by a drive unit. A passenger car for two people is attached to the outer end of each arm on a vertical axle that allows the car to rotate freely. An offset crank-pin carrying a spindle hub projects vertically above the central drive unit and rotates in the opposite direction to the arms. Support rods connect the spindle hub to the outer end of each arm. This eccentric connection makes the arms undulate as they rotate and makes the cars spin.

7 The Spider and Monster are basically similar except that the arms are arched rather than straight. The Spider has two cars which are free to rotate at the ends of a 'Y' extension to each arm. The Monster has four cars which are free to rotate on their own axles at the ends of each arm.

8 The drive assembly usually consists of a central pillar to which the arms are mounted. A motor, usually electric, rotates the pillar and arms via a combination of belt drives, chain drives and gearing. The motor also drives the offset crank by means of a shaft that runs inside the central pillar. The crank is driven in the opposite direction to the central pillar and arms.

9 The drive is transmitted through separate clutches so that the arms can be rotated with the crank stationary (for loading/unloading of passengers) and the ride can stop while the motor is still running.

10 The Mini-Octopus and other designs for younger children may differ in that the crank is fixed in position and only the central pillar and arms are rotated.

11 Brakes are also provided to stop the radial arms and/or the crank. The designs of brakes and clutches vary but it is common to have a combined brake and clutch with one control; releasing the clutch simultaneously applies the brake.

12 Passengers on an Octopus are loaded into one or two cars at a time by operating the ride so that each arm in turn arrives at its lowest position at the loading platform.

RISKS

13 The safe design and safe operation of the Octopus should guard against:

- (a) passengers being thrown from the car;
- (b) a car breaking away from its arm;

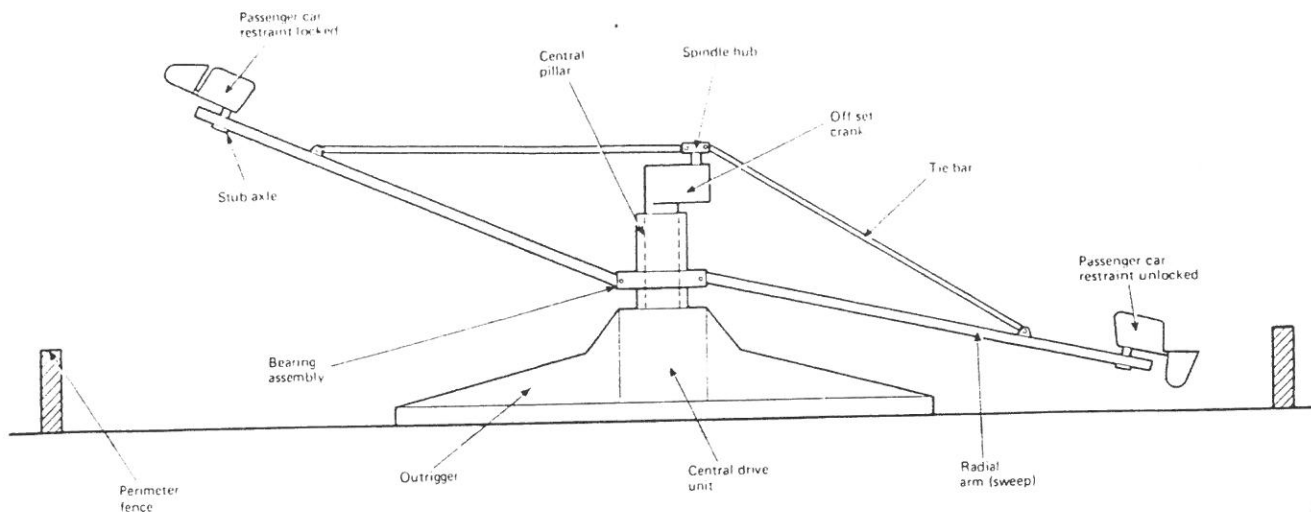


Fig 1 General view of Octopus

- (c) failure of a radial arm;
- (d) failure of the central drive unit, cage or offset crank;
- (e) failure of the tie bar universal joint assemblies;
- (f) injury to passengers during mounting/dismounting from the cars;
- (g) injury to operators, spectators and other persons in the vicinity of the ride whilst the ride is in operation.

14 The Health and Safety Executive has recorded incidents involving the Octopus, many of which have involved component failure. Most of these failures were caused by fatigue, initiated by defects introduced during welding. In many cases, the welding had been done to make a modification after manufacture and had introduced the stress concentration that led to fatigue failure.

DESIGN AND MANUFACTURE (Paragraphs 73-106 of the Code)

New devices

15 Each Octopus should have a log book into which have been inserted relevant details, guidance/instructions on assembly and dismantling, maintenance, examination, test and inspection procedures. For assembly purposes, suitable drawings should be available to clearly indicate the packing points and ground loadings. If there are special requirements for certain components, they should be specified. For example, torque settings should be given for the retaining nuts to the trunnion bearing assemblies and stub axles securing the cars to the radial arms. Where the manufacturer has stipulated a torque setting, this should be applied.

16 Experience has shown which components are likely to suffer fatigue failure. The manufacturer should design to minimise this risk which may involve the periodic replacement of components liable to fatigue failure: the manufacturer should specify the period of time involved. The manufacturer should also consider the need for non-

destructive testing (NDT) to identify any faults before failure can occur. If NDT is necessary, the manufacturer should indicate the components involved, the recommended interval between such testing and the technique to be used.

17 Any single pin connections that are not fitted with a safety device should have a factor of safety of at least 10, based on ultimate tensile strength. This may apply to the radial arm trunnion bearing assemblies; the tie bar mountings to the hub spindles and to the radial arms; and the stub axle mountings of the cars onto the ends of the arms.

All devices

18 Safety chains or other devices should be provided between the inner end of the radial arms and the central hub assembly, to avert collapse if the bearing assembly fails.

19 Safety chains, wire ropes or other devices should be provided at either end of each tie bar to connect the tie bar to the central hub and the radial arm, to avert collapse if the tie bar fails.

20 The safety chains/wire ropes and mounting points should be able to withstand the dynamic loadings that could occur in the event of a failure.

21 Trunnion bearing assemblies with detachable caps should have a 'butterfly' type bracket that fits over the outer shells. The bracket should hold the trunnion covers in place if a retaining stud fails, and should withstand any static or dynamic loadings imparted during the operation of the Octopus.

22 The arrangements for containing the passengers in the cars are given in paragraphs 39-41.

23 The operating control should be sited so that the operator has a clear view of the loading area. The maximum operational speed should be clearly marked on the controls.

24 The ride should have a perimeter fence. The fence should be at least one metre high and should be able to

withstand people leaning on it or being pushed against it. It should be designed so that it can be positioned with sufficient clearance to prevent anyone being struck by the Octopus. There should be two openings for entry and exit located in the fence in close proximity to the control box to allow passengers to enter and leave the enclosure. These points should be provided with suitable means for controlling people in and out of the enclosure e.g. gate, turnstile, or offset barrier and raised platform (Fig 2).

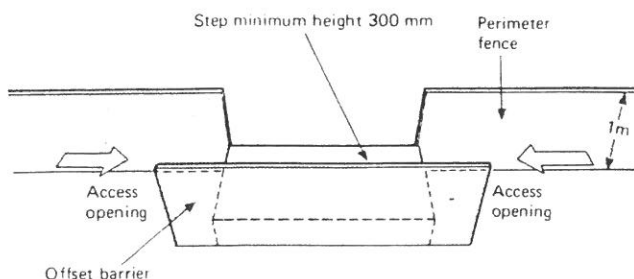


Fig 2 Supervised opening, showing two requirements for access:

- (a) necessary change of direction;
 - (b) step up onto access platform placed radially to ride.
- At ground based rides the edge of the platform nearest the ride may be tapered to form a ramp.

25 Suitable lighting should be provided to illuminate adequately the loading area and the route from the loading area to the access point.

MODIFICATIONS

(Paragraphs 107-109 of the Code)

26 Some failures have been caused by unsatisfactory modifications. No modification which may affect the integrity of the Octopus should be made unless it has been verified with the manufacturer. If it is not possible to verify the modification with the manufacturer, the design and calculations must be submitted to an independent consulting engineer beforehand, to make sure that they are sound. A modification should incorporate only compatible materials, and a further thorough examination should be completed before the Octopus is used again.

27 Modifications that involve welding, particularly on the radial arms, may affect the integrity of the Octopus. *It is imperative* that any modification involving welding is carefully devised and is verified by the manufacturer, or independent consulting engineer.

EXAMINATION, INSPECTION AND MAINTENANCE

(Paragraphs 1-30 of the Code)

Examination (Paragraphs 8-19 of the Code)

28 Each Octopus should be thoroughly examined at least once every 14 months by an appointed person as required by the Code. The Octopus should be examined before the beginning of each season, where practicable, but in any case within three months of this date.

29 The examination should include the following:

- (a) the packing and stability of the central hub;
- (b) the condition of the central frame, shafts and offset crank;
- (c) the condition of the radial arms;
- (d) any safety chains, wires or rods and safety clamps and their attachments to the structure of the Octopus;
- (e) the perimeter fence and paybox;
- (f) the running gear and drive mechanism;
- (g) the trunnion bearings and retaining studs on all arms for excess play, wear or damage;
- (h) the car pivots and bushes;
- (j) the restraining and locking devices on each car;
- (k) the general condition of each car frame;
- (l) the security of the car seats.

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

31 The examiner should also consider the use of NDT methods on certain components to test for cracks that could indicate the onset of failure due to fatigue or other causes. In particular, he should consider the use of NDT on:

- (a) the radial arm pins;
- (b) the trunnion bearings and retaining studs;
- (c) any reinforcing bands on the radial arms;
- (d) the radial arms to test for corrosion and thickness of material;
- (e) any lugs connecting the tie bars to the radial arms and spindle hubs;
- (f) the axle/bearing assembly securing the car to the radial arm.

32 The examiner should pay particular attention to the trunnion bearing retaining studs and any structure welded onto the radial arms.

33 Paint on the structure of the Octopus may cover cracks and defects. It is important that the examiner bears this in mind when conducting visual examinations. Paint should be removed from areas that may be subject to high stress or, in the opinion of the examiner, may be susceptible to cracks or other faults.

Inspection (Paragraphs 20-30 of the Code)

34 The daily inspection before use should take into account any details and information provided by the manufacturer. The inspection should include visual checks of:

- (a) the packing and stability of the central hub;
- (b) the bearing assemblies connecting the radial arms to the central hub;

- (c) the tie bars and hub spindles;
- (d) the condition of the cars and restraint arrangements;
- (e) the mountings of the cars onto the radial arms;
- (f) the perimeter fence, paybox and controls;
- (g) pins and retaining clips.

35 Once the daily inspection has been completed, the Octopus should be given a trial run before it is used to carry passengers.

36 The device 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.

Maintenance (Paragraphs 24-30 of the Code)

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

Records

38 Records of all examinations and inspections should be kept by the operator, as required in paragraph 3 of the Code.

SAFE ACCOMMODATION OF PASSENGERS (Paragraphs 31-40 of the Code)

39 Each car should be designed so that passengers cannot be thrown or fall from the car. A restraint should be provided with a primary robust locking device that is inaccessible to the passengers and can only be released by the operator or attendant. The locking device should be designed so that it positively locks the restraining device in position and cannot be released by inadvertent actions or by the movement of the Octopus.

40 The Junior Octopus and similar rides designed for young children generally operate at lower speeds and are smaller with shorter radial arms. Consequently, the risk of children being thrown or falling from a car is reduced. However the behaviour of children is less predictable and restraining devices which can be fastened should be provided.

41 If for any reason the restraining device on any car becomes inoperative or defective, that car should not be used until suitable repairs have been completed.

SAFE OPERATION AND TRAINING OF OPERATORS/ATTENDANTS (Paragraphs 41-72 of the Code)

Safe operation (Paragraphs 46-70 of the Code)

42 The systems of work used in operating the Octopus are

crucial in ensuring the safety of the public and of the attendants employed at the device.

43 The operator should determine the minimum number of attendants needed to operate the device safely and should ensure that they are on duty when the ride is in operation. In deciding on the number, he should ensure that there are sufficient attendants to load/unload the cars, control entry of the public into and out of the enclosure and to man the controls throughout the times when the Octopus is used by the public. The devices should be immobilised when the minimum number of attendants cannot be achieved, and when the Octopus is closed to the public.

44 The operator should institute a suitable system of work to ensure that the public are admitted into the enclosure only when cars are ready at the loading area. The loading area should be in front of the access point in the perimeter fence and within clear view of the person at the controls. The attendants should not attempt to load/unload cars until the arms are at the loading area and the cars are stationary. The attendants should release the restraining device, and remain present during the loading/unloading operations. They should close the restraining device and ensure that the device is satisfactorily locked in position. The Octopus should not be moved until the person at the controls is satisfied that the passengers are secure in the cars.

45 The operator should ensure that either every car is fully loaded, or passenger loading is evenly distributed and balanced around the device. When the operator is ready to start the Octopus, he should first check to ensure that the enclosure is clear of all members of the public and attendants. Attendants should not remain in the enclosure and should not indulge in reckless behaviour on the ride, e.g. spinning the cars whilst the Octopus is moving.

46 When the Octopus is started, speed should always be allowed to build up gradually. The maximum operational speed as specified by the manufacturer should not be exceeded.

47 The area within the enclosure should be clearly indicated as a danger area whilst the ride is in motion.

Training (Paragraphs 71-72 of the Code)

48 Each operator should have received suitable and sufficient training in the working of the Octopus. This should include adequate knowledge of:

- (a) the method of operating the Octopus;
- (b) the safe loading of the Octopus;
- (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 method of assembling/dismantling the Octopus;
- (h) the methods for daily inspection of the Octopus.

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

50 Each attendant should receive suitable training for his type of work. The training should include:

- (a) arrangements for controlling the public to and from the enclosure;
- (b) arrangements for ensuring the safe loading/unloading of passengers;
- (c) the risks and precautions associated with his work;
- (d) the procedures for reporting defects or breakdowns;
- (e) the measures he is required to take in the event of an emergency.

SITING AND LOCATION

(Paragraphs 110-113 of the Code)

51 Before the Octopus is erected, the site should be checked to ensure that it is not crossed by overhead electricity lines. The cars of an Octopus can be raised to heights of 7.5 metres or more, which may be higher than some overhead power lines. The device should never be sited anywhere near overhead power lines which may put at risk passengers in the cars or anyone involved in erecting/dismantling the Octopus. The danger includes arcing as well as direct contact. Advice from the Electricity Board should be obtained in all cases where overhead lines are present. The owner of the land and/or the Electricity Board should also be consulted as to the presence of underground electrical cables, where equipment has to be staked into the ground.

ASSEMBLY AND DISMANTLING

(Paragraphs 134-155 Of the Code)

52 All assembly and dismantling operations should be directly supervised by a person trained/experienced in such work. A safe system of work should be followed.

53 The central hub of the Octopus should be positioned on ground that is firm and even. All the outriggers should be used. Packing used to support the hub should be carefully assembled and should be positioned exactly in accordance with the manufacturer's instructions. Packing should be made from solid timber or other suitable materials. It should be capable of withstanding the compression loads involved and should have a base area which gives adequate load spreading support for the ground conditions on any particular site. Wooden pallets, bottle crates and water tanks should not be used. No further assembly should start until the supervisor is satisfied the central assembly is level, stable and secure.

54 The central drive unit and offset crank should be

examined for excessive wear or damage. Particular attention should be paid to the crank arm and the spindle hub assemblies.

55 Each arm should be examined for damage and checked to ensure that it is not bent or distorted. The bearing assembly that connects the arm to the central hub should be closely examined for excessive wear or other damage.

56 Particular attention should be paid to the condition of the retaining studs of the bearing block and the radial arm pins. If any surface cracks are evident or there is other visual damage or wear, the component(s) should be replaced before the ride is assembled. The replacement component(s) should be to the manufacturer's requirements and temporary repairs should not be undertaken. On assembly, shake-proof washers should be provided on the retaining studs and a torque spanner should be used to avoid overtightening the nuts where torque settings have been specified.

57 The connections at either end of the tie bar should be visually examined for wear and damage before assembly.

58 Each car should be examined for excessive wear or damage. There should be no signs of such wear or play in the pivot pin assembly connecting the car to the radial arm. If these faults are detected, the assembly should be stripped down and the worn/damaged component should be replaced. The structure of the car should be checked and any damaged parts or sharp edges should be repaired. Particular attention should be paid to the restraining device. The hinges, sliding safety bars and locking mechanism should be checked to ensure that they operate satisfactorily. Any faults should be rectified before the car is used.

59 Safety chains or wire ropes should be checked to ensure that they are in sound condition and that they have been properly connected to the mounting points on the radial arms and on the central hub assembly.

60 The perimeter fence should be erected around the device with sufficient clearance from the outer part of the ride. The controls for the ride should be positioned so that the operator has a clear view of the loading area. The entry and exit openings in the perimeter fence should be next to the loading area.

61 When the Octopus is complete the supervisor should check the device to make sure that it has been properly and safely assembled. He should then run the ride with the cars empty and check the safe operation, including the controls and brakes. After running the Octopus, the supervisor should check the assembly again, paying particular attention to the stability of the control hub and packing to ensure that there has been no movement or settlement.

62 The Octopus should not be used to take passengers until the supervisor is satisfied that the ride has been safely assembled.

FURTHER INFORMATION

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

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