



3rd June 2020

Passenger restraints/control systems: safety advice

TARGET AUDIENCE:

This safety advice is aimed at controllers of high-speed fairground rides where failure of a restraint to be properly locked could result in ejection of passengers, and at those responsible for the operation, maintenance and inspection of these devices.

INTRODUCTION:

The advice follows HSE investigation of a number of accidents over an 18-month period, all involving ejection of passengers from high speed, rotating 'orbiter' type rides.

HSE has identified that although the rides were made by different manufacturers, all had similar design failings with the interlocking mechanisms of the passenger restraint systems. It is also likely that there was a failure to ensure that passengers were correctly restrained before the start of the ride cycle.

BACKGROUND:

This note applies to rides where passenger containment is achieved with either 'over the shoulder' or 'lap bar' restraints (referred to as 'restraints' in this document).

Restraints may be automatically opened and closed or manually operated. There will be a locking mechanism to mechanically lock the restraints down and prevent them from opening during operation.

The issues raised in this advice note apply on rides where electrical switches (called limit switches or proximity sensors) are used to detect that the restraints are down and locked in place. This can either be as an indication to the operator, or as part of a "safety interlock" which will only allow the ride to start when all restraints are down and locked. In either case the limit switches/proximity sensors are an important safety feature of the ride.

HSE findings

HSE investigations into the four incidents, and subsequent follow up sample inspections of similar rides found the following issues on the devices seen:

- Limit switches had failed in such a way that they always indicated that the restraints were down and locked even when they were not.
- Faults with limit switches were not detected by the control system.
- Faults with limit switches had not been identified during maintenance.
- Limit switches had been modified to enable the ride to run regardless of the restraint position.
- Faults with switches were being reset by ride operators even though switches were known to be faulty.
- Switches were incorrectly adjusted to indicate that restraints were fully down when there was an excessive gap between the seat and restraint that was potentially dangerous.

Sample inspections of similar rides by HSE found failed interlock switches and prohibition notices were served to prevent the rides from being used until all faults were put right.

Limitations of control systems for seat restraint monitoring

Control systems used for monitoring seat restraints should be manufactured and installed to meet the relevant standards and be subject to the relevant pre-use inspections before the amusement device is put into use.

However, even when a control system has met the relevant standards, there are limitations to their effectiveness to monitor that the passenger restraints are correctly adjusted, and passengers are secured.

The not exhaustive list below gives several examples where even a correctly designed and installed control system may not be able to effectively determine that it is safe to initiate the ride cycle,

A control system may not detect;

- that the passenger is of the correct height can brace themselves sufficiently and the seat restraint is fitted correctly adjusted so that the passenger can be effectively contained by the restraint system;
- that the restraint is confirmed to be securely locked;
- that the passenger is in a fit condition to ride the device;
- that unmonitored restraint devices such as crotch straps have been fastened and adjusted as necessary and that seat pommels and other features of the seat design form part of the containment system remain effective;
- that the passenger is not unwittingly sitting on top of a lowered lap bar.

ACTIONS REQUIRED: Ride Controllers

Physical checking of restraint systems at each cycle

Failure of limit switches fitted to restraints can cause the ride control system to indicate that the restraints are down and locked even if they are not. This may allow a ride to run when it is not safe for it to do so.

Ride control systems cannot always be relied upon to identify failures with the limit switches and therefore require frequent and thorough checks and maintenance on the restraint system switches, following manufacturer's instructions to ensure that switches are opening and closing properly.

Therefore, it is imperative that at each cycle, and before running a ride, operators **must** carry out physical checks to ensure all the restraints are positioned correctly and passengers are secured.

The physical check should be such that the attendant/operator is satisfied that locking mechanism has engaged properly, such as "pulling" on the restraint to confirm it has locked. The requirements of any such physical check should be appropriate for the design of the locking mechanism, and if there is any doubt, advice from a competent person should be sought

Although automatic restraint monitoring may give the impression that all restraints are down and locked, poorly designed systems, equipment failures or limitations of the system can lead to false signals.

It should be noted that the requirement to carry out physical checks to ensure that the restraint is correctly fitted and adjusted, is set out in HSG175, which states in paragraph 322 that "*physical checks are essential because of the limitations in automatic systems.*"

Ongoing maintenance, functional testing and annual inspection

In addition, the controllers of all rides with restraint monitoring limit switches should:

1. Arrange for a competent person to test each limit switch individually to ensure that none have failed and arrange for any that have failed to be replaced or repaired before the ride is put into use.
2. Undertake a functional check of the restraint interlock system each day before putting a ride into use, following the guidance below:
 - Close all but one of the restraints.
 - Check whether the restraint "closed and locked" signal is present (try to run the ride, operating any reset function to try and clear the fault). Do this for every restraint in turn.

- If at any point it is possible to start the ride with a restraint raised, the ride should immediately be taken out of use and the fault investigated and repaired by a competent person.
3. At the next in-service annual inspection ask the appointed inspection body for advice regarding your ride's automatic restraint monitoring system. Not all inspection bodies are competent to make a full assessment of the restraint limit switches and associated control systems, however they should be familiar with this safety alert and be able to advise whether the ride requires further assessment.

If the examiner identifies that the interlock system is susceptible to the type of failures identified in this alert, then the ride automatic restraint monitoring system should be subject to a 'partial design review' by an independent person, competent in control system design, and familiar with the issues described in this safety alert to ensure that the design is suitable and the ride is safe.

Until such time that any necessary modifications to the control system have taken place, or the design review gives the automatic restraint monitoring system the 'all clear', rides needs to be subject to frequent, thorough manual checks, including a functional check. Each day before putting the ride into use, a functional check (as described in point 2) of the interlock system must be undertaken. It is recommended that the results of this check are recorded. This functional check should be supplemented by testing of the restraint monitoring limit switches by a competent person at suitable intervals.

Note: periodic functional checks and maintenance will always be necessary and should be carried out in accordance with manufacturer's instructions.

4. A safety control system, designed to fail safe and with cross monitoring diagnostics, will detect most failures of restraint interlock switches and stop the ride from running unless the restraints are down and locked.

Ride controllers should seek advice from the ride manufacturer as to whether any changes would be necessary to modify the design of the ride to ensure that the ride is as safe as possible. The benefits are that they would provide a more reliable control system, reduce the need to perform rigorous maintenance in between annual inspections and would provide a robust long-term solution to the issues described in this safety alert and ensure the safety of passengers.

5. Finally, it should be noted that whilst it is important to ensure that the control system for monitoring seat restraints meets the relevant standards and it is correctly installed and maintained, it cannot be relied upon in isolation to confirm that the passengers will be safely contained by the seat restraints.

Therefore, it is imperative that at each cycle, and before running a ride, operators must carry out physical checks to ensure that the restraints are positioned correctly and passengers are secured.

These physical checks should be effectively integrated into the operational procedures for the amusement device, with effective training, information, instruction and supervision to ensure that they are completed at each ride cycle.