Interim Report into
Cement Train Derailment at the Suir River Viaduct
On 07/10/03

1.0 Summary:

1.1 The cement train derailment that occurred at Cahir at approximately 06.00 hours on 07/10/03 resulted in significant damage to infrastructure and rolling stock but no injury. Had the circumstances of the derailment or its time of occurrence been different it is possible the driver of the train and/or members of the public may have been injured.

1.2 Present indications are that the accident was not caused by over-speeding of the train or by a malicious act. Similarly, evidence suggests that major structural failure of the Suir viaduct was unlikely and that it was the damage caused by the progressive derailment of the train that caused the structural collapse of the viaduct.

1.3 It is not clear at this time whether derailment was train initiated or was the result of failure of the track-work on the viaduct. The extent of damage caused by the accident means that it may not be possible to be definitive in this regard. Neither is it clear whether the behaviour of the viaduct under load in any way contributed to the accident. Detailed analysis should give some guidance in this regard.

1.4 Staff of the Interim Railway Safety Commission (IRSC) visited the site on the day of the accident and again on 09/10/03. Having initially instructed Iarnród Éireann (IE) to retain those wagons that remained on the track-bed following the accident the IRSC has since released them following further inspection. To facilitate its investigation the IRSC has asked IE to keep it advised regarding recovery of bridge material from the river and river bank. The IRSC has also asked IE to carry out an immediate inspection of all similar bridge structures throughout its railway system.

1.5 The magnitude of the accident in terms of material damage and potential for injury suggests that further investigation/reporting by the IRSC is required. Under present legislation the IRSC may, at the direction of the Minister, carry out a formal public 'investigation' or a less formal 'inquiry' as was the case with the Kiltoom accident.

1.6 IE has initiated its own investigation of the circumstances of the accident and advised that this will be led by an independent industry chairperson from Great Britain supported by independent experts.

1.7 The most appropriate course of action appears to be, under the provisions of the Railway Regulation Act, 1871, for the IRSC to conduct an independent Inquiry at the direction of the Minister. The provisions of this Act would allow the IRSC to utilise the findings of the independent experts engaged by IE enabling it to conduct the Inquiry broadly within the limits of the IRSC's current resources.

2.0 Introduction:

2.1 At approximately 08.00 hours on 07/10/03 John Mullen, on behalf of IE Safety Department, contacted the IRSC advising that the Limerick to Waterford bulk cement train had derailed at the viaduct that carries the railway over the Suir river on the approach to Cahir station. The time of the derailment was not specified but it was indicated that a number of wagons were involved and that some had ended up on the bank of the river. It was also stated that no parties had been injured as a result of the accident. From telephone calls to IE over the following hour the full extent of the accident became evident including the extensive damage to the viaduct itself.

2.2 IRSC inspectors Donal Casey and John Welsby arrived at the accident site at approximately 13.15 hours. This preliminary report is based on their observations and on information gained from various IE staff on that occasion and during a subsequent visit to the site on 09/10/03.

3.0 The site:

3.1 The Viaduct is situated at 38.15 miles on the Limerick to Rosslare railway and approximately 200m from Cahir station.

3.2 Approaching the viaduct from Limerick (*in the direction of travel of the train*) the railway is on a left hand horizontal curve that terminates at the viaduct. Across the viaduct the alignment is straight while beyond it there is a right hand curve through the station. On both sides of the viaduct the railway is constructed on an embankment.

3.3 The track approaching, across, and for approximately 100m beyond the viaduct, comprises 50kg/m flat-bottomed rail on timber sleepers. This rail is understood to have been manufactured in the 1970's, originally laid on one of the more heavily trafficked lines on the IE system and 'cascaded' to the Limerick – Rosslare line in 1999. Beyond this and through the station the track comprises older bullhead rail, again on timber sleepers. Both tracks are laid in panels with standard fish-plate joints though on the 50kg/m rail section some joints are welded effectively creating long panels. Generally all components of both track types appear to be in reasonable condition.

3.4 The maximum permitted line speed on this route between Limerick Junction and Waterford is 40 mph (*65km/hr*) subject to any local speed restrictions. While IE 201 class locomotives are only permitted on this route in emergencies and are restricted to 20 mph (*30km/h*) over the viaduct the train involved in the accident was permitted to travel up to full line speed. No temporary speed restrictions were in force at the site at the time of the accident.

3.5 The railway is single track with provision for trains to pass each other at a number of double track 'loops' at intermediate locations or 'block posts'. Train control is under the Electric Token Block System (ETS). A train can only enter a single line section it the driver is in possession of a token which can only be issued if the section is clear of other trains and the signal permitting entry from the other end of the section is indicating a 'stop' aspect. The site of the accident is approximately mid way in the Tipperary/Clonmel block section.

4.0 The Viaduct:

4.1 The viaduct has three spans, two minor approach spans on either side of the river and the main span of approximately 67m over the river itself. The height of the railway above the river is approximately 15m. The viaduct was constructed to accommodate two railway tracks but now carries only one which is offset from the longitudinal centre-line of the deck.

4.2 There are three discrete structural systems in the viaduct, the masonry piers and abutments, the main steel spans and the timbers that directly support the rails and secure them to the main steelwork.

4.2.1 The piers and abutments are constructed of cut limestone and initial inspection suggests that they are in good condition. While the accident resulted in some damage to the tops of two piers and to their common base their structural integrity has not been compromised.

4.2.2 There are two main elements to the steel deck, the two main support beams that span between the piers, and between the piers and abutments, and smaller cross beams that span between the main beams. These effectively form a trough through which the railway passes. All beams are of 'plate girder' type being fabricated from steel plates and angle sections riveted together. Though some rusting is evident this is minor in nature and overall the metalwork appears to be in good condition and to have been recently (*within last 10 years*) re-painted.

4.2.3 The main timber elements are the 'way-beams' that are connected to the steel cross beams and to which the rails are directly attached. There run longitudinally across the bridge i.e. are continuous under the rails except where joined. Outside the way-beams there are timber 'guard-beams' that rise approximately to the height of the top of the rails. The purpose of these beams is to help contain a derailment should one occur. Track gauge is maintained by timbers that are placed between the way-beams keeping them at the required spacing and metal tie bars that pass through both the guard and way beams, are secured at their ends with metal plates and nuts and designed to stop the track gauge spreading. On the un-damaged section of the bridge some sections of both the guard and way beams displayed various degrees of rotting and the plates on the ends of some tie bars were either not fully secured or had dug into the face of the guard beams. A programme of replacement of both way-beams and guard-beams had commenced prior to the accident and it is understood that on the Sunday before the accident three new way-beams were installed.

4.3 There is a pathway along the river bank that passes beneath the side span at the Waterford side of the viaduct.

5.0 The train:

5.1 The train was hauled by two General Motors locomotives; a 121 class leading that has been in service since c. 1960, followed by a 181 class that has been in service since c. 1966. Both locomotives have two twin axle bogies and their respective axle loadings are c. 16 and 17 tonnes. There were 22 purpose built bulk cement wagons each with a net weight of c. 11 tonnes and a 20 tonne load capacity. The wagons are of rigid frame construction with two fixed axles giving a laden axle load of c. 16 tonnes.

5.2 The train was scheduled to pass through Cahir station at 04.52 hours (*detailed in current IE Working Timetable*). It is understood that it was delayed due to its having to wait at Tipperary to 'cross' (*pass*) a beet train. This delay is unlikely to be material to the accident.

5.3 Both 121 and 181 locomotives are equipped with a 'Hazler' recorder. This is an analogue device, somewhat similar to a road vehicle tachograph, that records speed over the last c. ¾ mile (*1.2 km*) travelled. Train braking can also be inferred from the recording. Following the accident IE removed the discs from both recorders for analysis. The IRSC has not yet had sight of the discs but IE advise that they indicate that at the time of the accident the train was travelling within its permitted speed of 40 mph (*65 kph*).

6.0 The Accident:

6.1 Following the accident both locomotives and the leading wagon remained fully on the rails. The rear axle of the second wagon was derailed as were the remaining 20 wagons. During the course of the accident the train divided. The locomotives and the first 10 wagons, all of which remained upright and on the track bed, came to a stand with the front of the leading locomotive c. 10m from the platform of the station and the rear of the 10th wagon c. 100m from the viaduct. The track was progressively destroyed from beneath the 3rd wagon as far as the viaduct. The rear 12 wagons fell though the deck of the bridge, 7 falling onto the river bank between the piers and abutment on the Waterford side of the river and the remaining 5 either onto the bank or in the river beneath the main span of the viaduct.

6.2 As a result of the accident the rails, timbers and cross beams were destroyed over approximately 60% or the viaduct. In some cases the riveted connections between the cross and main beams were sheared off but in some the connections were torn out causing damage to the main beam. Both main beams remained in place following the accident with no obvious signs of deformation.

6.3 There was no damage to, or marking of, the track on the approach to the viaduct indicative of derailment. Indications are that initial derailment occurred on the main centre span.

6.4 At least one of the wagons that landed on the bank was ruptured and had discharged cement onto the bank. There was a covering of cement dust over the ground and bushes immediately in the vicinity of the wagons that may have occurred as the wagons fell or as a result of subsequent wind-blow. The vessels of the wagons in the river appeared to be intact with no discharge of cement.

7.0 Subsequent action:

7.1 The accident response by all parties appears to have been prompt and effective. Independent of IE's actions An Garda Siochana initially secured the site, interviewed the driver of the train and subsequently spoke with IE's Chief Mechanical and Chief Civil Engineers.

7.2 The Local Authority, The Environmental Protection Agency and The Fisheries Board were involved in assessing any environmental impact, and in particular the risk of pollution to the Suir river.

7.3 Civil Defence personnel were in attendance to initially take action to minimise the risk of further pollution from the discharged cement on the bank and then coordinate clean-up operations.

8.0 Preliminary Analysis:

8.1 Independent of the risk to the driver of the train there was risk to members of the public walking on the path beneath the viaduct. It is fortunate that the accident occurred at a time of day when the likelihood of such use was low. Given that at this time the exact cause of the accident has not been identified it is not possible to say whether the condition of the viaduct prior to the accident in any way compromised the safety of passengers on trains using the line.

8.2 Given that the derailment appears to have occurred on the straight section of track over the viaduct and that the train was being driven within operational speed limits, speed does not appear to be the primary cause of the derailment. The possibility must however be considered that at the time of the accident, in the context of the condition of the viaduct and/or the train, this speed was inappropriate. A view on this can only be taken when further investigation and analysis of data have taken place.

8.3 Derailment could be caused by an obstruction on the track, whether placed there maliciously or otherwise. This does not appear to be a likely cause of the derailment as it is understood that the driver of the train did not report having seen any such obstruction on the track, a beet train had passed over the viaduct without incident approximately 1 hour prior to the accident and the time of day makes an act of vandalism unlikely.

8.4 The apparent good condition of the masonry and steel bridge systems suggests that they were fully serviceable at the time of the accident and that it is unlikely that general structural failure of the viaduct occurred. It is possible however that the static and/or dynamic behaviour of the viaduct under load had some impact on the accident. Again, detailed structural analysis/modelling will be necessary in order to understand the potential for such impact.

8.5 Independent of any fracture that occurred as a result of the accident, in so far as can be seen, the condition of the rails was good, they were fully serviceable prior to the accident and it is unlikely that a rail-break was the primary cause of the derailment.

8.6 Many of the timber way and guard beams where the derailment occurred were either destroyed or are in the river. The condition of those that remain within, or in advance of, the derailment area varies. Some have only recently been replaced, others show some but not significant signs of rotting and/or distress but some are in poor condition and were, it is understood, scheduled for replacement. Outward movement of the rails or 'spreading' of the gauge is a possible cause of derailment. Given the extent of damage in the area of the derailment it will be difficult to ascertain if this occurred though examination of timbers recovered from in, or on the bank of, the river may give some indication in this regard.

8.7 Replacement of timber guard-beams and way-beams should not of itself cause a derailment. If anything, where all such timbers are properly prepared, installed and the rails correctly attached and gauged, the track in the area of new timbers should be more secure than on older timbers where fixings/fastenings are more likely to become loose under train loading. The extent to which recently replaced timbers were damaged in the accident is not known but when recovered they may give some guidance as to robustness of the replacement process.

8.8 Derailment may occur where a wagon 'climbs' the rail. Factors that contribute to the potential for this are speed, lateral train movement or 'hunting', 'twist' which is a form of vertical track irregularity, differential wheel loading and vehicle rigidity.

8.8.1 As previously indicated it is understood that the train was travelling within permitted speed at the time of the derailment.

8.8.2 Adverse ‘twist’ is typically associated with ballasted track and is caused by settlement under train loading. Such track is constantly monitored and ‘tamped’ to remove these irregularities before they become critical. It is unlikely, although not impossible, that adverse twist would develop on this type of track where rails are rigidly attached to the main structure of the viaduct.

8.8.3 Hunting can occur when rail vehicles are subject to some form of lateral force. This may occur, for example, where there are irregularities in horizontal track alignment and its effects are generally magnified as speed increases. Wagons such as those involved in the accident are more prone to ‘hunting’ because they are relatively short, their construction is relatively basic with no mechanisms to dampen such movement when it occurs and they are ‘loose coupled’ allowing a high degree of relative movement between wagons. Where hunting becomes excessive wheels may ‘climb’ the rail leading to possible derailment. Not withstanding the relative susceptibility of the wagons other factors such as travel within permissible speed limits and straight track alignment on the viaduct suggest a low potential for hunting.

8.8.4 The cement wagons involved in this accident have a longer wheel base than the ‘bogies’ on which passenger carriages and larger freight wagons are mounted. This makes them more sensitive to ‘twist’ and the potential for wheel climb. However such sensitivity of itself should not initiate derailment.

8.8.5 Differential wheel loading may arise from poor distribution of the product on the wagon. In this instance the wagons are specifically designed to carry bulk cement and as such give more or less equal loading over all wheels. Failure of an element of the wagon such as a suspension component could also cause differential wheel loading. While preliminary examination of the 10 wagons that remained on the track-bed indicates that, to varying degrees, they sustained damage as a result of the derailment, there was no apparent damage to the suspension of the 2nd and 3rd wagons that appear to have been the first to derail.

9.0 Conclusion

9.1 The cement train derailment that occurred at Cahir at approximately 06.00 hours on 07/10/03 resulted in significant damage to infrastructure and rolling stock but no injury. Had the circumstances of the derailment or its time of occurrence been different it is possible the driver of the train and/or members of the public may have been injured.

9.2 Present indications are that the accident was not caused by over-speeding of the train or by a malicious act. Similarly, evidence suggests that major structural failure of the Suir viaduct was unlikely and that it was the damage caused by the progressive derailment of the train that caused the structural collapse of the viaduct.

9.3 It is not clear at this time whether derailment was train initiated or was the result of failure of the track-work on the viaduct. The extent of damage caused by the accident means that it may not be possible to be definitive in this regard. Neither is it clear if the behaviour of the viaduct under loading in any way contributed to the accident.

10.0 Further Actions

10.1 Staff of the Interim Railway Safety Commission (IRSC) visited the site on the day of the accident and again on 09/10/03. The IRSC has asked IE to carry out an immediate inspection of all similar bridge structures throughout its railway system. The IRSC has also advised IE that those wagons that remained on the track-bed following the accident, and which had been retained at the site at its request, can now be moved. IE has also been asked to keep the IRSC advised of progress on recovery of bridge materials from the river and river bank in order that it may inspect these.

10.2 The magnitude of the accident in terms of material damage and potential for injury suggests that further investigation/reporting by the IRSC is required. Under present legislation the IRSC may, at the direction of the Minister, carry out a formal public 'investigation' or a less formal 'inquiry' as was the case with the Kiltoom accident. 'Formal investigations' are typically initiated where an accident has resulted in multiple fatalities. In this instance, where there was only material damage and no fatality or injury, an 'inquiry' is considered more appropriate.

10.3 IE has initiated its own investigation of the circumstances of the accident and advised that this will be led by an independent industry chairperson from Great Britain supported by independent experts.

10.4 In the circumstances the most appropriate process for further investigation by the IRSC appears to be the establishment of a statutory inquiry under the provisions of the Railway Regulation Act 1871. Under associated provisions IE would be required to provide all information requested by the appointed Inspector which may include details on any testing and technical analysis carried out by or on IE's behalf by any third party. This would effectively permit the IRSC to share IE's independent expert support. The Inspector may also request IE to carry out specific tests or analyses. While the IRSC may need to engage its own consultants the 'sharing' of IE's expertise would keep such arrangements to a minimum.

John Welsby

Chief Railway Inspecting Officer