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Transport Infrastructure Ireland

# TII Publications

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## Transition Assessment Procedure

DN-REQ-03081  
April 2017

## About TII

Transport Infrastructure Ireland (TII) is responsible for managing and improving the country's national road and light rail networks.

## About TII Publications

TII maintains an online suite of technical publications, which is managed through the TII Publications website. The contents of TII Publications is clearly split into 'Standards' and 'Technical' documentation. All documentation for implementation on TII schemes is collectively referred to as TII Publications (Standards), and all other documentation within the system is collectively referred to as TII Publications (Technical).

## Document Attributes

Each document within TII Publications has a range of attributes associated with it, which allows for efficient access and retrieval of the document from the website. These attributes are also contained on the inside cover of each current document, for reference.

<b>TII Publication Title</b>	<i>Transition Assessment Procedure</i>
<b>TII Publication Number</b>	<i>DN-REQ-03081</i>

<b>Activity</b>	<i>Design (DN)</i>		<b>Document Set</b>	<i>Standards</i>
<b>Stream</b>	<i>Road Equipment (REQ)</i>		<b>Publication Date</b>	<i>April 2017</i>
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## TII Publications Website

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## TII Publications



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<b>Activity:</b>	Design (DN)
<b>Stream:</b>	Road Equipment (REQ)
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# 1. Introduction

## 1.1 General

Transitions are an essential part of Vehicle Restraint System (VRS) installations where two systems of differing cross section or lateral stiffness are connected together. Collision records have shown that barrier connections without a proper transition pose potential risks such as vehicle pocketing, failure of connections, vehicle impalement, high impact severity or failure to contain the impacting vehicle; all of which have the potential to cause serious or fatal injuries to vehicle occupants. It is therefore essential to provide suitable transitions which are designed to eliminate these risks.

Standardised full-scale impact testing is a robust way of assessing the level of safety provided by VRS, including transitions. There are many possible combinations of connections between different types of barriers and parapets; most of which would require a unique transition arrangement. The length of installation for a transition is often much less than the standard installation length of a barrier. This can make it impractical for VRS manufacturers to undertake full scale impact testing for every possible transition. With the improvement of computing technologies and the experience gained over time, computational mechanics has shown to be a valuable, cost and time efficient alternative to full scale impact testing. Where virtual testing is used to simulate full scale crash testing, it is imperative that the virtual test is as close a representation as practical of the physical impact test.

There is currently no harmonised European Standard for the testing and approval of transitions and therefore transitions are not CE marked products. To ensure that a standardised approach is applied to the evaluation of transitions proposed for use on the Irish national road network, TII has established the Transition Assessment Procedure outlined in this Standard with the ultimate objective of ensuring an improved level of safety in this area. This procedure will ensure that an in depth quality assessment is undertaken of every physical or virtual impact test carried out on a transition using the standardised assessment criteria outlined in this Standard.

Transitions deemed suitable for use on Irish national roads following assessment under this Standard will be added to the Compliant Transitions list accessible through the Downloads section of the TII Publications website <http://tiipublications.ie/downloads/>.

## 1.2 Scope

The scope of this Standard covers all transitions proposed for use on the Irish national road network.

The safety performance and testing requirements for transitions are based upon the principles contained in EN 1317-1:2010, EN 1317-2:2010 and ENV 1317-4:2002 and are outlined in DN-REQ-03034. Further guidance and clarification is contained in this Standard.

The assessments are not intended to provide an “approval” or “refusal” of the system. They are carried out to check compliance against requirements within DN-REQ-03034.

The assessment shall consist of an independent professional review of the physical and/or virtual test documentation provided by the supplier as per the requirements contained within this document. The supplier shall ensure all documents provided are accurate and genuine.

Compliance with the requirements of this Standard shall not indemnify the supplier against any claims in law. TII reserves the right to withdraw the system from the Compliant Transition List if there is evidence that the system performs in a different way from that shown in the Initial Type Test or for any other reason for which it sees fit.

## 1.3 Definitions

For the purpose of this Standard, the following terms defined in IS EN 1317-1 apply:

- a) Vehicle restraint system
- b) Safety barrier

The following terms defined in DN-REQ-03034 also apply:

- a) Hazard
- b) Dynamic Deflection

Particular terms used in this Standard are defined as follows:

- a) **Critical Impact Point:** An impact point identified to reasonably represent the worst case for testing.
- b) **Pocketing:** The effect where an errant vehicle pockets or snags at the connection point between VRS of different cross section or lateral stiffness due to the difference in dynamic deflection or stiffness between the two elements.
- c) **TII Compliant Transitions:** A transition assessed as having undergone appropriate physical and/or virtual testing using the procedure outlined in this Standard which is approved for use on Irish national roads.
- d) **Transition:** A connection of two VRS of different designs and/or performances.

## 2. Application Procedure for Physical Impact Tests

### 2.1 General

Applications for assessment shall be submitted to TII through the Departures from Standards website which can be accessed through the TII Publications website home page.

The following documents and media shall be submitted as a minimum for each of the connected barriers:

- Certificate of constancy of performance; and
- Technical drawings.

The following documents and media shall be submitted as a minimum for each impact test carried out with the transition:

- Full test report in accordance with EN 1317 Parts 1, 2 and ENV 1317 Part 4;
- High speed and real time videos of test coverage as specified in relevant part of EN 1317;
- Still photographs of complete installation before and after impact;
- Still photographs of vehicle before and after impact;
- Technical drawings of test item; and
- Confirmation letter from test house which states that the test complies with the relevant requirements of EN 1317.

The applicant shall also complete and submit the Transition Assessment Application Checklist for physical impact tests provided in Appendix A to this document which is available for download through the Downloads section of the TII Publications website <http://tiipublications.ie/downloads/>.

No assessment will be carried out until all documentation listed in the Transition Assessment Application Checklist is submitted to TII.

### 2.2 Application Procedure for Virtual Impact Tests

The following documents and media shall be submitted as a minimum for each of the connected barriers:

- Certificate of constancy of performance;
- Technical drawings;
- Full test reports in accordance with EN 1317 Parts 1 and 2;
- High speed and real time videos of all physical impact test coverage connected barriers as specified in relevant part of EN 1317;
- Still photographs of complete installation before and after impact for each test; and
- Still photographs of vehicle before and after impact for each test.

For each of the connected barriers a simulation of the higher containment full scale impact test shall be carried out. These simulations shall provide accurate representations of the full scale impact tests and the resulting measurements shall be comparable. With particular reference to the simulations carried out, a formal technical report shall be submitted. This report shall include:

- Details of the model construction, barrier joint condition details at fixings;
- Close up views of the mesh density plus size details in the heavily loaded areas;
- Videos showing global performance and local deformation characteristics;
- Recorded bolt forces and comparison to installation data;
- Failure mechanism or localised buckling review and comparison;
- Energy balance showing Total, Kinetic, Sliding Interface, Internal and Hourglass Energies;
- Barrier material model data source and model implementation;
- Element types and integration points;
- Statement on the validation of the vehicles used for impact;
- Comparison measurements at key deformation points;
- Acceleration Severity Index (ASI), Theoretical Head Impact Velocity (THIV) and Exit box overlay and proof of validity; and
- Statement of rigid and deformable elements within the barrier and vehicle.

The following documents and media shall be submitted as a minimum for each virtual impact test carried out with the transition:

- Formal technical report detailing the model construction, transition joint condition details at fixings;
- Close up views of the mesh details around the impacted point;
- Videos showing global performance and local deformation characteristics;
- Recorded bolt forces and comparison to installation data;
- Energy balance showing Total, Kinetic, Sliding Interface, Internal and Hourglass Energies;
- Transition material model data source and model implementation;
- Element types and integration points; and
- Statement of rigid and deformable elements within the barrier and vehicle.

The applicant shall also complete and submit the Transition Assessment Checklist and Barrier Correlation Assessment Checklist for Virtual Impact Tests provided in Appendix B to this document which are available for download through the Downloads section of the TII Publications website <http://tiipublications.ie/downloads/>.

Assessments shall not be carried out until all documentation listed in the assessment application checklists contained in Appendix B has been submitted to TII.

## **2.3 Application Costs**

There is no application charge to a supplier proposing a transition for an initial assessment under this procedure. Any subsequent applications for re-assessment of a transition due to the system initially being deemed to not having undergone appropriate testing shall be subject to a cost at a rate to be set by TII.

## **2.4 Application Enquiries**

Any enquiries regarding an application submitted under the TII Transition Assessment Procedure with regard to a specific product shall be submitted to [barriers@tii.ie](mailto:barriers@tii.ie).

## **3. Assessment Procedure**

### **3.1 General**

The assessment procedure shall commence once all required documents and media have been received by TII.

An independent professional review shall be undertaken of the documents submitted for each test completed on a transition to assess the transitions conformity with the safety performance and testing requirements set out in DN-REQ-03034.

The Individual Transition Physical Test Assessment Form, as shown in Appendix C, shall be used as a standard template of review and a checklist for the minimum requirements of each individual physical impact test. The virtual tests will be assessed according to the minimum requirements identified in Section 2 of this Standard and a Virtual Test Assessment Report will be prepared to summarise the findings of the assessment. Additional checks may be completed if it is felt necessary. TII may request further information from the applicant to support any further checks deemed necessary to complete the assessment.

### **3.2 Assessment Results**

The findings of the independent review for each impact test shall be summarised in the Transition Assessment Summary, as shown in Appendix D to this document.

The decision to include or not to include a proposed transition on the Compliant Transitions list shall be taken by TII based upon the findings of the independent review as outlined in the Transition Assessment Summary and Individual Transition Physical Test Assessment Forms or the Virtual Test Assessment Report. The supplier of the transition being assessed shall be informed of the assessment findings through a letter issued by TII.

Suppliers of transition systems that are deemed to have not undergone appropriate testing based on the assessment of the test results and hence are not acceptable for use on the Irish national road network shall be informed of this with reasoning through a letter issued by TII. Any appeals made to TII on the findings of an assessment shall be treated as a new application for assessment and shall be priced and charged as such. This excludes minor changes and minor reviews where additional clarification material is provided by the applicant.

## 4. Testing & Performance Requirements for Transitions

The testing and performance requirements for transitions shall be as described in DN-REQ-03034, with reference to EN1317-1:2010, EN 1317-2:2010 and ENV 1317-4:2002, with additional clarifications provided in this section.

### 4.1 Impact Point

The Selection of the impact point should generally be carried out in accordance with the guidance provided in ENV 1317-4. Further clarification is presented below to ensure the impact points are selected so as to achieve the objectives of the required tests.

The impact point shall be taken as the point of intersection of a straight line parallel to the vehicle centreline, at the maximum width of the vehicle, with the traffic side of the transition, or the safety barrier, as shown in Figure 4.1. It shall not be taken as a projection of the centreline of the vehicle.

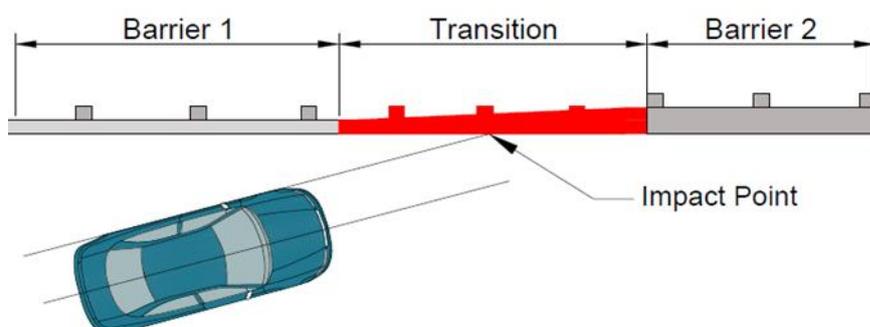


Figure 4.1 – Impact Point

#### 4.1.1 Light Vehicle Test (TB11)

- i) The aim of this test is to evaluate the impact severity of the transition. It is important that the impact point chosen shall provide an acceptable representation of the highest possible severity which can occur during an impact.
- ii) This is generally located at or close to the connection with the stiffer barrier for most transitions. Based on this, the impact point should generally be at a distance of not less than  $\frac{3}{4}$  of the length of the transition ( $\frac{3}{4} L$ ) downstream of the start point of the transition and no more than 2m upstream from the end of the transition.
- iii) In the case of longer transitions, the  $\frac{3}{4} L$  impact point may be too far away from the stiffest point of the transition, as demonstrated in Figure 4.2. In such circumstances, the main objective of the impact test is not fulfilled and it may not be deemed acceptable when assessed under the procedure outlined in this Standard.

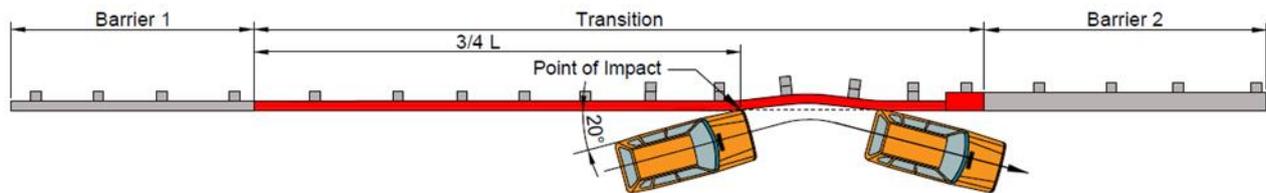


Figure 4.2 – Example of a TB11 test on a longer transition, where  $3/4L$  Impact point is too far away from the stiffer barrier to show highest severity

- iv) In some cases a transition may be required between barriers of similar stiffness, due to difference in cross-section. This transition may be in the form of a short connection between two barriers. In such a scenario, the TB11 impact point should be on the connection piece, as demonstrated in Figure 4.3.

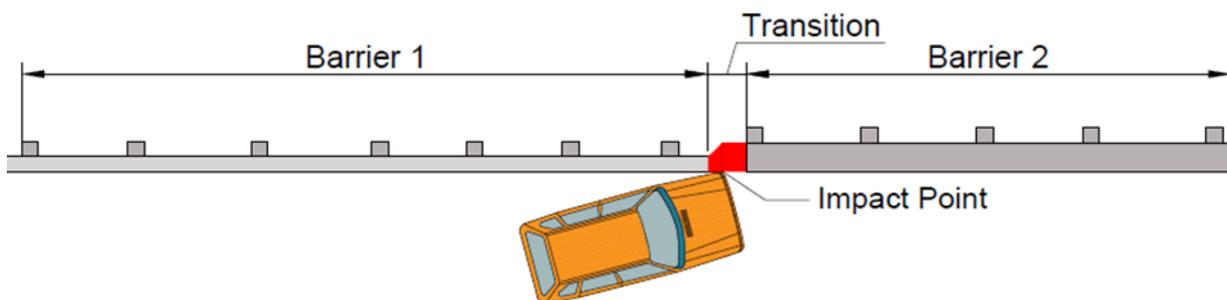


Figure 4.3 – Example of a TB11 test on a short transition

#### 4.1.2 Containment Test (TB32 or higher)

- i) The aim of the test is to provide the highest impact momentum among tests specified and therefore evaluate the containment level of the transition and to identify any potential for pocketing. It is important to choose an impact point which gives the highest potential for pocketing.
- ii) Generally, an impact point of  $1/2 L$  of the length of transition ( $1/2 L$ ) is recommended. However, as the transition gets longer, the mid-point gets further away from the end. In the case of a very long transition, a vehicle impacting the  $1/2 L$  point may be redirected before interacting with the area of highest concern in terms of pocketing. This is demonstrated in Figure 4.4. In such circumstances, the main objective of the impact test is not fulfilled and it may not be deemed acceptable when assessed under the procedure outlined in this Standard. In such cases the impact point should be positioned closer to the end of the transition. An acceptable impact point is generally 2 to 5 metres upstream from the end of transition for semi-rigid systems dependant on the VRS specific details.

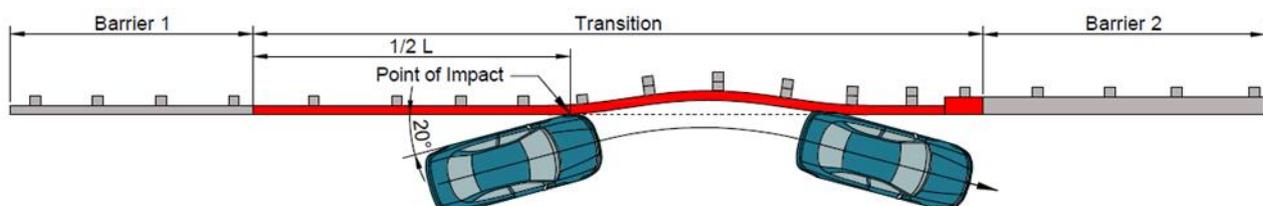
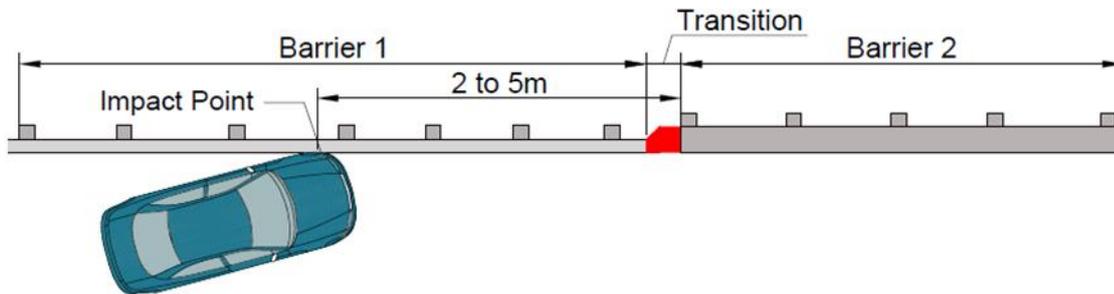


Figure 4.4 – Example of a TB32 test on a long transition, where half way impact point is too far away from the stiffer barrier to show potential pocketing

- iii) In some cases a transition may be required between barriers of similar stiffness, due to difference in cross-section. This transition may be in the form of a short connection between two barriers. This connection is likely to present the stiffest point in the system. In such a scenario, the containment test impact point should be positioned upstream of the connection as demonstrated in Figure 4.5. The objective of this impact position is to evaluate the potential for pocketing around the stiffer connection piece, as well as to evaluate the strength of the connection. An acceptable impact point is generally between 2 to 5 metres from the end of transition for semi-rigid systems dependent on the VRS specific details.



**Figure 4.5 – Example of a TB32 test on a short transition**

## **Appendix A:**

Transition Assessment Application  
Checklist for Physical Impact  
Tests



TII Transition Assessment Procedure

TRANSITION ASSESSMENT CHECKLIST (FOR FULL SCALE IMPACT TESTED SYSTEMS)			
Submission Date:			Contact Details:
Manufacturer:			
Product Name:			
Transition Between	Barrier 1:		
	Barrier 2:		

Documents and Multimedia to be Provided for Each Test*			
#	Item	Comment	Item Submitted (Y/N)
1	Full test report	In accordance with EN1317 Parts 1, 2 & 4	
2	High speed & real time videos	Of test coverage as specified in relevant part of EN1317	
3	Still photographs	Of complete installation before and after impact	
4	Still photographs	Of Vehicle before and after impact	
5	Technical drawings	Of test item and connected barriers	
6	Confirmation from test house	That the test complies with the relevant requirements of EN1317	
7	Certificate of constancy of performance for connected barriers	Showing performance parameters such as containment level, dynamic deflection, working width, impact severity level	

Tests Submitted				
#	Test Type	Test House	Test No	Comments
1				
2				
3				

Submitted By:

Signature:

\*All documents which are not English will have to be translated.

Assessment ID:

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Form V.1.0

## **Appendix B:**

### Transition Assessment Application Checklists for Virtual Impact Tests



TII Transition Assessment Procedure

TRANSITION ASSESSMENT CHECKLIST (FOR SIMULATION ASSESSED SYSTEMS)			
Submission Date:			Contact Details:
Manufacturer:			
Product Name:			
Transition Between	Barrier 1:		
	Barrier 2:		

Documents and Multimedia to be Provided for Each Simulation*			
#	Item	Comment	Item Submitted (Y/N)
1	Formal technical report	Including model construction details, vehicle positioning and close-up views of the mesh details	
2	Videos showing global performance and local deformation characteristics	Various view angles such as Front, Side, Rear, Top and Iso	
3	Recorded bolt forces and comparison to installation data	Time history files and effective stress calculation	
4	Energy balance	Total, Kinetic, Sliding Interface, Internal and Hourglass Energies	
5	Transition material model data source and model implementation	Curves of stress-vs-strain and conversion to model input	
6	Element types and integration points	With reference to the software version	
7	Statement of rigid and deformable elements within the barrier and vehicle	Visual layout	

Simulations Submitted				
#	Simulation Date	Supplier (if not Manufacturer)	Unique ID	Comments
1				
2				
3				

Submitted By:

Signature:

\*All documents which are not English will have to be translated.

Assessment ID:

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Form V.1.0



TII Transition Assessment Scheme

BARRIER CORRELATION ASSESSMENT CHECKLIST (FOR SIMULATION ASSESSED SYSTEMS)			
Submission Date:		Contact Details:	
Manufacturer:			
Product Name:			
	Barrier 1:		
	Barrier 2:		

Documents and Multimedia to be Provided for Each Simulation*			
#	Item	Comment	Item Submitted for Both Barriers (Y/N)
1	Formal technical report	Including model construction details, vehicle positioning and close-up views of the mesh details	
2	Videos showing global performance and local deformation characteristics	Various view angles such as Front, Side, Rear, Top and Iso	
3	Recorded bolt forces and comparison to installation data	Time history files and effective stress calculation	
4	Failure mechanism or localised buckling review and comparison	Photos from Test and Still Images from Simulation	
5	Energy balance	Total, Kinetic, Sliding Interface, Internal and Hourglass Energies	
6	Barrier material model data source and model implementation	Curves of stress-vs-strain and conversion to model input	
7	Element types and integration points	With reference to the software version	
8	Statement on the validation of the vehicles used for simulation	Data showing correlation achieved to vehicle only test, other barrier test or assumptions made on performance.	
9	Comparison measurements at key deformation points	Matching points on Test and Simulation using the same measurement method.	
10	ASI, THIV and Exit box overlay and proof of validity	Still Image comparison.	
11	Statement of rigid and deformable elements within the barrier and vehicle	Visual layout	

Simulations Submitted				
#	Simulation Date	Supplier (if not Manufacturer)	Unique ID	Comments
1				
2				
3				

Submitted By:

Signature:

\*All documents which are not English will have to be translated.

Assessment ID:

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Form V.1.0

## **Appendix C:**

### Individual Transition Physical Test Assessment Form



TII Transition Assessment Scheme

**Individual Transition Full Scale Impact Test Assessment Form  
 Submitted for Compliance with EN1317-1, 2 & 4**

1) General Information	
Assessment Date:	Contact Details:
Manufacturer:	
Product Name:	
Between Barrier 1 and Barrier 2	
Impact Test Type:	
Test Standard:	
Test House:	
Test Date:	Test No:



2) Properties of Barrier 1	
Manufacturer:	
Product Name:	
Containment Level:	
Normalised Working Width:	
Normalised Dynamic Deflection:	
Impact Severity Level:	
Vehicle Intrusion:	

3) Properties of Barrier 2	
Manufacturer:	
Product Name:	
Containment Level:	
Normalised Working Width:	
Normalised Dynamic Deflection:	
Impact Severity Level:	
Vehicle Intrusion:	

Assessment ID:

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Form V.1.0



TII Transition Assessment Scheme

4) Installation	
Transition installed with sufficient length of barrier to demonstrate performance? (Y/N)	
Does installation match technical drawings provided? (Y/N)	

5) Test Site	
Is test lab accredited for EN1317? (Y/N)	
Is test area flat with gradient not exceeding 2.5%? (Y/N)	
Is test area clear of standing water, ice or snow? (Y/N)	
Enough space provided for demonstration of exit box characteristics? (Y/N)	

6) Impact Direction (ID)	
Impact Direction: from Barrier #:	to Barrier #:
Is ID as described in standard; i.e. from softer to stiffer barrier? (Y/N)	
Is justification provided if other ID is chosen? (Y/N/NA)	
Is ID representative of worst case scenario ? (Y/N)	

7) Impact Point (IP)	
Impact Point Location:	
Is IP as described in standard? (Y/N)	
Is justification provided if other IP is chosen? (Y/N/NA)	
Is IP representative of worst case scenario (based on TII requirements)? (Y/N)	
Is IP identified in the report match the actual achieved in the test? (Y/N)	

8) Test Vehicle				
Is the test vehicle representative of current traffic in Europe? (Y/N)				
Are tyres inflated to manufacturers Specification? (Y/N)				
Is the test vehicle road worthy? (Y/N)				
	Target Value	Tolerance	Actual	Compliant? (Y/N)
Total Mass (kg):				
Test Inertial Mass (kg):				
Maximum Ballast (kg):				
ATD Mass (kg):				
Wheel Track (kg):				
CGX (m):				
CGY (m):				
CGZ _ Vehicle Mass (m):				

9) Impact Conditions				
	Target Value	Tolerance	Actual	Compliant? (Y/N)
Impact Speed (km/h):				
Impact Angle (*):				
Is combined tolerances within envelope? (Y/N)				
Does test footage match values shown in the report? (Y/N)				

10) Impact Severity		
ASI:	THIV:	Class:



TII Transition Assessment Scheme

11) Deflection Characteristics				
Normalised Dynamic Deflection (m)	Normalised Working Width (m)	Normalised Working Width Class	Normalised Vehicle Intrusion (m)	Normalised Vehicle Intrusion Class
Does test footage match values shown in the report? (Y/N)				

12) Exit Box	
Exit Box Width (A+16% of veh. Length)	Exit Box Length (B)
Did test vehicle stayed within vehicle exit box ? (Y/N)	

13) Vehicle & Transition Impact Behaviour	
Any parts of transition or connected barriers penetrated passenger compartment? (Y/N)	
Deflection of / intrusion into passenger compartment? (Y/N)	
Did any principal longitudinal element of transition or connected barriers break? (Y/N)	
No more than one of the wheels of vehicle completely passed over or under the transition ? (Y/N)	
Did test vehicle rolled over? (Y/N)	
Did test vehicle have excessive roll, yaw or pitch? (Y/N)	
If tested with an HGV or Bus, no more than 5% of the mass of ballast became detached or split during the test up to the time when the wheel tracks of the vehicle left the exit box ? (Y/N/NA)	

14) Verdict	
Is the test compliant with TII requirements? (Y/N)	
With following Notes to Consider:	

Assessed by:

Signature:

Assessment ID:

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Form V.1.0

## **Appendix D:** Transition Assessment Summary



TII Transition Assessment Scheme

TRANSITION ASSESSMENT SUMMARY	
Date:	Contact Details:
Manufacturer:	
Product Name:	
Transition Between	Barrier 1:
	Barrier 2:

Properties of Barrier 1	
Manufacturer:	
Product Name:	
Containment Level:	
Normalised Working Width:	
Normalised Dynamic Deflection:	
Impact Severity Level:	
Vehicle Intrusion:	
Is permission received from manufacturer of Barrier 1 ? (Y/N/NA)	

Properties of Barrier 2	
Manufacturer:	
Product Name:	
Containment Level:	
Normalised Working Width:	
Normalised Dynamic Deflection:	
Impact Severity Level:	
Vehicle Intrusion:	
Is permission received from manufacturer of Barrier 2 ? (Y/N/NA)	

Testing Programme				
#	Test Code	Test Report Reviewed (Y/N)	Test Compliant (Y/N)	Comments
1				
2				
3				

Containment Level	
Containment Level:	
Is Containment Level of transition is higher than or equal to lower Containment Level of connected barriers? (Y/N)	

Permitted Use in TII Network	
Speed of Road (km/h):	

Impact Severity Level				
#	Test Code	ASI	THIV	Impact Severity Class for Test
1				
2				
3				
Impact Severity Class of Transition:				

Assessment ID:

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Form V.1.0







Ionad Ghnó Gheata na Páirce,  
Stráid Gheata na Páirce,  
Baile Átha Cliath 8, D08 DK10, Éire



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