



Multi-Axial Impact Testing Procedure

1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. This standard provides a procedure for instrumented multiaxial impact testing for both ISO and ASTM methods. The purpose of this specification is to provide additional information regarding the testing and interpretation of results for instrumented multiaxial impact testing for both ISO 6603 and ASTM D3763 test methods, as they pertain to requirements within GM material specifications.

1.2 Applicability. This standard applied to all plastic materials where instrumented impact testing is required.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

ASTM D3763 ISO 6603-1 ISO 6603-2

2.2 GM Standards/Specifications.

None

3 Resources

3.1 Facilities.

3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.2 Equipment. The equipment should be an instrumented impact machine capable of, but not limited to, speeds of 2.2 m/s (exterior parts-ASTM), 6.7 m/s (interior parts-ASTM); 4.4 m/s (either exterior or interior parts-ISO).

3.2.1 The equipment should also be a self-lubricating system if using the ISO method or apply a lubricant to each specimen prior to impact – see 4.3.3.1. (Tests at a high standard test speed of 4.4 m/s using lubricants in the viscosity range of 0,01 Pa s < η < 10 Pa s have shown that the type of lubricant is not relevant—the MTL uses Vaseline). An example of an acceptable impact machine is the Instron-CEAST 9350 model.

3.3 Test Vehicle/Test Piece. The test pieces (specimens) should be flat and the same size and approximately the same thickness for every sample grouping. Note that ISO and ASTM specimens are different in size. As a general rule, ASTM specimens should be 102 mm square or round or 102 × 152 mm. The preferred ISO specimen is 60 mm ± 2 mm. (see ASTM3763 or ISO 6602 for all sizes). The specimens can be die cut (preferred method) or if it is an actual part, a band saw can be utilized.

3.4 Test Time. Based on a 20 specimen request:

Calendar time: 1 day

Test time: 1 h

Coordination time: 1 h

3.5 Test Required Information. The test request should provide the following (if known):

3.5.1 GMW Material Specification.

3.5.2 Part Category & Part Name.

3.5.3 Part Number.

3.5.4 Material Type and Grade.

3.5.5 Sample History.

3.5.6 Detailed Test Instructions including the method and speed of testing.

3.6 Personnel/Skills. The testing personnel should be listed as C (competent) or E (expert) on the laboratory training matrix.

4 Procedure

4.1 Preparation. The specimens should be prepared to the proper size as listed by ISO or ASTM and according to WI (work instruction) and/or TIS (task instruction sheet).

4.2 Conditions.

4.2.1 Environmental Conditions. The environmental conditions should be listed either in the GMW Materials specification or in the Test Request.

4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

4.3 Instructions.

4.3.1 If the specimens are not delivered as plaques to the proper size (per ISO/ASTM), cut to size and then measure the thickness in the center of each specimen.

4.3.2 Condition the cold samples in a calibrated environmental chamber (minimum of four hours for cold). Heated specimens may be conditioned in the Instron-Ceast chamber until the chamber/sample set reaches temperature – generally about 30 minutes.

4.3.2.1 If cold/hot temperature is a requirement, the specimen should be within $\pm 2^\circ\text{C}$ when the striker makes contact with the specimen.

4.3.3 Run the test according to the appropriate in-house test method.

4.3.3.1 If ISO testing is being performed, it is important to lubricate the tup/striker prior to each impact (lubrication is not required for ASTM testing).

4.3.4 A minimum of five specimens should be tested per each sample set.

4.3.5 If the proper specimen size cannot be attained, it should be noted in the report and the specimens must be large enough to be adequately gripped in the clamping mechanism. Generally, the minimum lateral dimension should be at least 13 mm greater than the diameter of the hole in the clamp.

5 Data

5.1 Calculations. Calculations are done via CeastVIEW 6.13 or equivalent software.

5.2 Interpretation of Results.

5.2.1 See 7.3 for failure mode interpretation. Note that the GM Materials Engineer has the final decision for failure mode if it is ambiguous.

5.3 Test Documentation. The documentation/report should include the following:

5.3.1 Identification of the material tested.

5.3.2 Specimen size and thickness.

5.3.3 Geometry of the clamp and tup (striker).

5.3.4 Type of equipment.

5.3.5 Speed of testing.

5.3.6 The graphs from testing, as well as the numerical data that is requested in the GMW specification (generally, Energy to Maximum Load (J)).

5.3.7 Temperature of testing.

5.3.8 Photographs of impacted specimens.

5.3.9 Any anomalies that occurred during testing (e.g., specimen slippage, temperature variation greater than ± 2 °C from the designated temperature).

6 Safety

This Engineering Standard may involve safety requirements for hazardous materials, the method of operations and equipment. This standard does not propose to address all the safety issues associated with its use. It is the responsibility of the user of this standard to ensure compliance with all appropriate safety and health practices. This would include any specific training that may be required. The safety and health standards include site specific rules and procedures, company rules and procedures, and Government Standards. Contact shall be made with the appropriate site Safety and Health personnel for further direction and guidance in these matters.

7 Notes

7.1 Glossary.

7.1.1 Failure Modes (Refer to ASTM D3763 and ISO 6603-2). Figures A1 through A7 in Appendix A depict the failure modes and examples of graphs for each. It also exhibits how ASTM and ISO failure modes compare to one another.

7.1.1.1 Definitions of Failure Modes (reference ASTM D3763)

- ASTM – Definition of Ductile Failure: The specimen deforms plastically before fracture, and is without cracks radiating more than 10 mm beyond the center of the impact point (see Appendix A, Figure A2).
- ASTM – Definition of Brittle Failure: The specimen test area is broken into two or more pieces, with sharp edges and shows no plastic flow (see Appendix A, Figure A3).

7.1.1.2 Definitions of Failure Modes with ISO 6603 Multiaxial Impact (reference ISO 6603):

- YD: Yielding followed by deep drawing - comparable to ASTM Ductile Failure. (See Appendix A, Figure A4.)
- YS: Yielding followed by stable cracking - comparable to ASTM Ductile Failure. (See Appendix A, Figure A5.)
- YU: Yielding followed by unstable cracking - comparable to ASTM Brittle Failure. (See Appendix A, Figure A6.)
- NY: No Yielding - comparable to ASTM Brittle Failure. (See Appendix A, Figure A7.)

Note: The failure mode interpretation can be somewhat subjective in nature. The GM Materials Engineer has final interpretation of failure mode.

7.2 Acronyms, Abbreviations, and Symbols. Not applicable.

8 Coding System

This standard shall be referenced in other documents, drawings, etc., as follows:

Test to GMW17895

9 Release and Revisions

This standard was originated in August 2017. It was first approved by Materials – Plastics Global Subsystem Leadership Team (GSSLT) in September 2017. It was first published in September 2017.

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1	SEP 2017	Initial publication.