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AMERICAN SOCIETY FOR TESTING AND MATERIALS
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# Standard Test Method for Dynamic Tear Testing of Cast Irons to Establish Transition Temperature[1]

This standard is issued under the fixed designation A 993; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method covers dynamic tear testing and is applicable to graphitic cast irons and establishes the transition temperature from examination of fracture appearance. Details of apparatus, specimens, and procedures are included.

1.2 The values stated in SI units are to be regarded as the standard. The inch-pound units given in parentheses are for information only.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

2.1 *ASTM Standards:*

A 644 Terminology Related to Iron Castings[2]

E 208 Test Method for Conducting Drop-Weight Test to Determine Nil-Ductility Transition Temperature of Ferritic Steels[3]

E 604 Test Method for Dynamic Tear Testing of Metallic Materials[3]

## 3. Summary of Test Method

3.1 The Dynamic Tear (DT) test involves a single-edge notched beam that is impact loaded in three-point bending.

3.2 The DT specimens are fractured with a drop-weight machine at a variety of temperatures.

3.3 The fracture surface of each specimen is examined to determine the ratio of ductile to brittle fracture and these values are then plotted against temperature to determine the transition temperature; the temperature at which the fracture surface shows 50 % ductile and 50 % brittle fracture, is the transition temperature.

3.4 If this test method is to be used solely to establish that the transition temperature is at or below a customer specified temperature, the specimens are tested at the specified temperature. Using the ratio of ductile to brittle fracture, the area is measured for each sample and the results of all samples tested at each temperature are averaged. The area of brittle (cleavage) fracture must be no more than 50 % of the fracture surface.

## 4. Test Specimen

4.1 Dynamic Tear (DT) specimens, with dimensions as specified in Fig. 1, are to be cast in green sand or dried, baked, or chemically bonded molds made with siliceous sand and appropriate binders. When placing more than one sample in a given mold, each sample shall be separated sufficiently to assure a cooling rate essentially independent of the adjacent samples. Each DT sample shall be cooled until totally black prior to shakeout.

4.2 Machining will be required on at least two faces of the test piece. One side is to be notched and the other impacted. A notch is milled or sawn into each specimen as shown in Fig. 1.

## 5. Apparatus

5.1 A typical fracture test drop tower is shown in Fig. 2.

5.2 A drop weight with a non-instrumented tup is used. The standard combined weight for these two items is 22.7 kg (50 lb). Tup design is to be as defined in Test Method E 604.

5.3 The weight is allowed to fall via guide rails to cause DT specimen fracture. Frictional effects that slow the velocity of the falling weight, prior to specimen fracture, are to be kept to a minimum.

5.4 At the time of weight release, the standard distance between the bottom of the tup and the top (impact) surface of the specimen is 760, ± 7.6 mm (30 ± 0.30 in.), as illustrated in Fig. 2.

5.5 The fixture on which the specimen rests at the time of impact is shown in Fig. 1. Each anvil is to have a radius of 12.7 ± 0.25 ± mm (0.500 ± 0.01 in.). The distance between anvil centers is to be 165.0 ± 1.65 mm (6.500 ± 0.403 in.).

5.6 The force used must be sufficient to break the specimen in a single blow. If use of the standard height and weight do not produce this result for the iron being evaluated, the weight or drop distance must be increased. The weight and drop distance used must be reported. A weight increase is preferable.

## 6. Procedure

6.1 Test temperatures are typically in the range between -73°C (-100° F) and room temperature 22°C (72°F). To establish transition temperature, samples must be tested at a minimum of two temperatures. The transition temperature

[1] This test method is under the jurisdiction of ASTM Committee A-4 on Iron Castings and is the direct responsibility of Subcommittee A04.21 on Testing.
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[2] *Annual Book of ASTM Standards*, Vol 01.02.

[3] *Annual Book of ASTM Standards*, Vol 03.01.

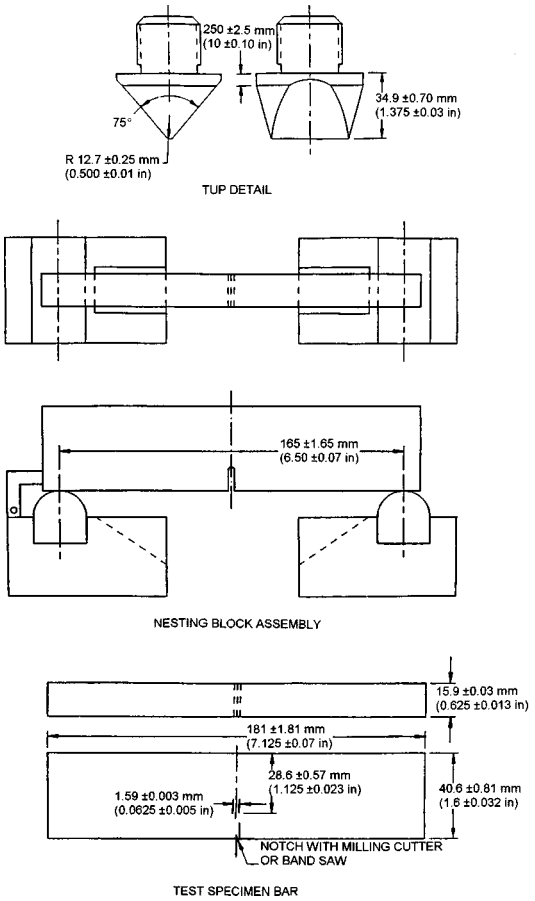


**FIG. 1 Assembly Details of Transformation Temperature Test Machine**

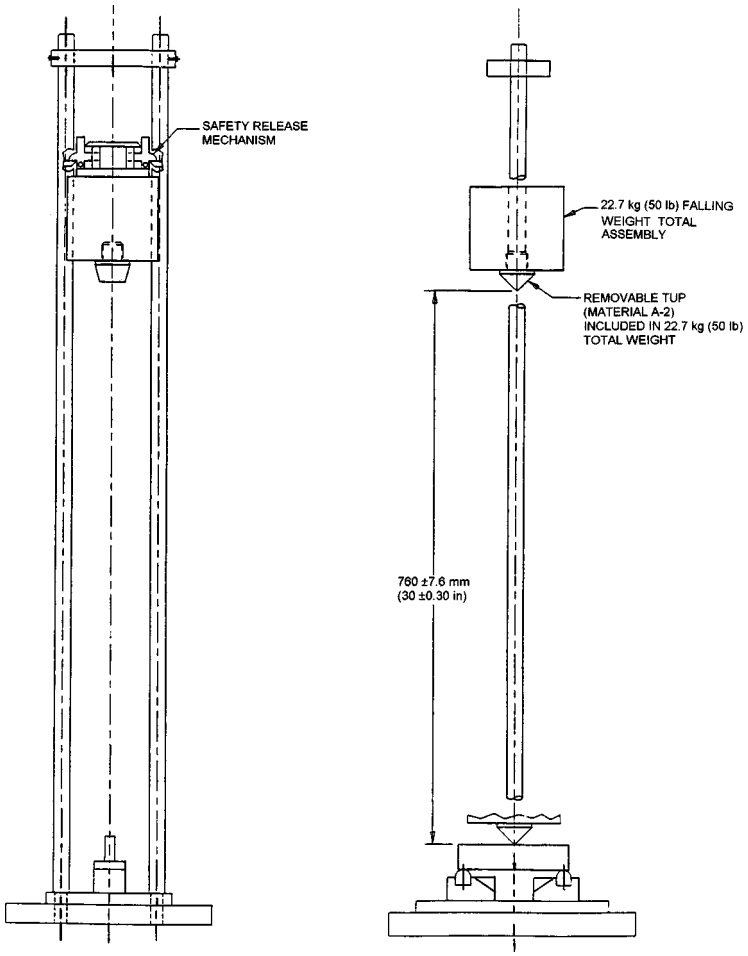


**FIG. 2 Assembly Views**

must lie between the two test temperatures. The two test temperatures must be bracketing the transition temperature and be no more than 14, ± 1° C, (25, ± 2°F) apart. To establish that the transition temperature is no higher than a specified temperature, all samples are tested at the specified temperature.

6.2 A minimum of three specimens are to be tested at each temperature. A minimum of six specimens are required if statistics are to be applied to the data.

6.3 Prior to testing, the DT specimens are to be heated or cooled to the desired test temperature and, in accordance with Test Method E 208, held at the test temperature for a minimum of 45 min before removal from the heating or cooling medium for testing.

6.4 To ensure that all specimens are at the desired temperature prior to testing, a thermocouple is to be kept adjacent to the test specimens in the heating or cooling medium.

6.5 For each test, handle the DT specimens carefully and rapidly with tongs designed to minimize specimen temperature changes.

6.6 For each test, place a DT specimen of known temperature on the anvil, with the notch side down, and release the drop weight within 15 s from the time of specimen removal from the heating or cooling medium.

6.7 Rate the percent ductile fracture (dark) and percent brittle fracture (cleavage, bright) on the fractured surface of each specimen. This can be done by visual estimation, or preferably by a quantitative method such as photographing the fracture surface and using a correctly sized transparent film grid to point count the number of intersections on each type fracture.

6.8 For the transition temperature determination, plot the percent of ductile to brittle fracture area for each specimen versus test temperature and then put a best fit curve through the data points. The temperature corresponding to a 50 % of brittle fracture area is the transition temperature. The report shall include the number of samples tested at each temperature and the transition temperature determined.

6.9 For confirmation that the transition temperature is no greater than a specified temperature, calculated the mean value of the percent brittle (cleavage) fracture for all samples tested at the specified temperature. The mean value calculated must be less than, or equal to, 50 % for conformance. The report shall include the number of samples tested, the test temperature, and the mean value.

## 7. Report

7.1 The report shall include material identification, cast date, sample identification, and the transition temperature results.

7.2 If non-standard drop heights, drop weights, or sample thicknesses are used, these must be reported along with the results in the test report.