INTERNATIONAL

**Designation: D 5591 – ~~98a~~02**

# Standard Test Method for Thermal Shrinkage Force of Yarn and Cord With ~~the Testrite~~ a Thermal Shrinkage Force Tester[1]

This standard is issued under the fixed designation D 5591; 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 preparation and procedures ~~for use of the Testrite Shrinkage-Force Tester~~ to measure the thermal shrinkage force of yarns and cords in air.

1.2 This test method is applicable to measurement of the thermal shrinkage force of yarns and cords whose shrinkage force at ~~177±~~ 180 ± 2°C (355 ± 4°F) in air does not exceed 20 N (4 lbf). This test method is applicable to nylon, polyester, and aramid yarns and cords within the applicable range of thermal shrinkage force, as well as to comparable yarns and cords from other polymers.

~~1.2.1 Yarns or cords for testing~~

1.2.1 Test specimens may be taken from yarn or cord packages, or retrieved from fabrics.

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.4 *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.* Specific hazards statements are given in Section 8.

## 2. Referenced Documents

2.1 *ASTM Standards:*

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[1] This test method is under the jurisdiction of ASTM Committee D-13 on Textiles and is the direct responsibility of Subcommittee D13.19 on Tire Cord and Fabrics . Current edition approved April 10, ~~1998.~~ 2002. Published ~~July 1998.~~ June 2002. Originally published as D 5591 – 95. Last previous edition D 5591 – 9~~5~~8a.

D 123 Terminology Relating to Textiles[2]

D 885 Methods for ~~Testing~~ Tire Cords, Tire Cord Fabrics, and Industrial Filament Yarns Made from Manufactured Organic-Base Fibers[2]

D 2258 Practice for Sampling Yarn for Testing[2]

D ~~2906 Practice for Statements on Precision~~ 6477 Terminology Relating to Tire Cord and ~~Bias for Textiles[2]~~ Fabrics[3]

## 3. Terminology

3.1 *Definitions:*~~—~~

3.1.1 For definitions of ~~textile~~ terms ~~used in this test method, refer~~ relating to ~~Terminology D 123.~~

~~3.2 *Definitions of Terms Specific to This Standard:*~~

~~3.2.1 *adhesive-treated*~~ *tire cord*~~, *n*—a tire cord whose adhesion to rubber or other elastomer has been improved by the application of a dip followed by rapid drying~~ and ~~(normally) additional heat treatment.~~

~~3.2.2 *atmosphere for testing textiles, n—for tire cords and industrial yarns,* air maintained at a relative humidity of 55 ± 2 % and at a temperature of 24 ± 1°C (75 ± 2°F).~~

~~3.2.3 *cord, n*—a twisted or formed structure composed of one or more single or plied filaments, strands, or yarns of organic polymer or inorganic materials.~~

~~3.2.3.1 *Discussion—for the manufacture of pneumatic tires or other industrial fabrics*, the direction of twist used~~ fabrics, refer to ~~combine single or plied yarn elements into a cord construction is in a direction opposite to that used in the yarns. Tire and other reinforcing cords frequently consist~~ Terminology D 6477.

3.2 For definitions of ~~a single yarn strand having little or no twist. These cords, as well as single monofilaments, are~~ textile terms used ~~synonymously with twisted and plied cords~~ in this test ~~method.~~

~~3.2.4 *greige tire cord, n*—a tire cord that has not been dip treated or heat treated before use (see *tire cord*).~~

~~3.2.5 *pneumatic tire, n*—a hollow tire that becomes load-bearing upon inflation with air, or other gas,~~ method, refer to ~~a pressure above atmosphere.~~

~~3.2.6 *retraction, n—in yarns and cords*, the reduction in length when previous restraint is removed and relaxation is allowed, thus causing a directionally proportional increase in linear density.~~

~~3.2.7 *thermal shrinkage force, n*—that force induced when a restrained material is restricted from shrinking upon exposure to heat.~~

~~3.2.8 *thermal shrinkage force tester, n*— an apparatus that measures the force achieved when a yarn or similar specimen, held at constant (fixed) length, is subjected to a temperature above that at which the specimen was mounted in the apparatus.~~

~~3.2.9 *tire, n*—a load-bearing, ground-contacting circumferential attachment to a vehicle wheel.~~

~~3.2.10 *yarn, n*—a generic term for a continuous strand of textile fibers, filaments, or material in a form suitable for knitting, weaving, or otherwise intertwining to form a textile fabric.~~ Terminology D 123.

## 4. Summary of Test Method

4.1 A specified length of yarn or cord is ~~relaxed, conditioned, and pretensioned~~ conditioned in a relaxed state, mounted with a ~~specific mass to induce a specified~~ pretension ~~force in the yarn or cord.~~

~~4.2 A conditioned specimen is exposed for 120 ±~~ of 5 ± 1 mN/tex (0.05 ± 0.01 gf/den), then exposed to dry heat at a temperature of ~~177~~ 180 ± 2°C (355 ± 4°F) for 120 ± 5 s.

4.~~3~~2 The shrinkage force induced in the specimen is read from the tester.

## 5. Significance and Use

5.1 This test method may be used for the acceptance testing of commercial shipments of yarns and ~~cords, but caution is advised since information on between-laboratory precision is incomplete.~~

~~5.1.1 In case of a dispute arising from~~ cords.

5.1.1 If there are differences of practical significance between reported test results ~~when using this test method~~ for ~~acceptance testing of commercial shipments, the purchaser and the supplier should conduct~~ two laboratories (or more), comparative tests should be performed to determine ~~whether~~ if there is a statistical bias between ~~their laboratories. Competent~~ them, using competent statistical ~~assistance is recommended for the investigation of bias.~~ assistance. As a minimum, ~~the two parties should take a group of~~ test ~~specimens~~ samples should be used that are as homogeneous as ~~possible and~~ possible, that are drawn from ~~a lot of~~ the material ~~of~~ from which the ~~type in question. The~~ disparate test ~~specimens should then be assigned~~ results were obtained, and that are randomly assigned in equal numbers to each laboratory for testing. Other materials with established test values may be used for this purpose. The ~~average~~ test results from the two laboratories should be compared using ~~the Student's *t*-test~~ a statistical test

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[2] *Annual Book of ASTM Standards*, Vol 07.01.

~~[3] Besides the apparatus specified in Section 7, there is a Mark IV and Mark V with software version 5.01 that do not fit the requirements~~

[3] *Annual Book* ~~*of this test method. These models eliminate the pretension force via electronic circuitry. Thermal shrinkage force readings that include pretension differ from readings that do not include pretension.*~~ *ASTM Standards*, Vol 07.02.

for unpaired data and an acceptable data, at a probability level chosen by prior to the two parties before the testing is begun. series. If a bias is found, either its cause must be found and corrected, or the purchaser and the supplier must agree to interpret future test results for that material must be adjusted in view consideration of the known bias.

5.1.2 YaExperience shows that yarnds or cord ms on would packages, usually being under tension, exhibit a contraction in length (and a resulting increase in linear density) when removed from the package and allowed to relax over a period of time due to at room temperature r. Consequentrly, it they acre tested without bein. Tg allowed to relax, they will register higher thermal shrinkage force values are reduced proportionately by as the amount of room temperature retraction.

5.1.3 Experience shows that retractive forces are present in most wound packages. This may relaxation shrinkage will be observed directly incorrectly included as a shortening of length (or indirectly as an increase in linear density) in unrestrained yarn or cord that is not relaxed fully. After retraction, such relaxed yarns exhibit lower the thermal shrinkage force values.

5.1.4 Retractive force.

5.2.1 Retractive forces vary widely by polymer type, being almost nil within aramids and significant within most nylons. For example, the exposure of untensioned skeins of nylon yarn or cord to 95 to 100 % relative humidity at room temperature for two days and reconditioning under standard laboratory conditions will cause most of the length change that is possible at room temperature to occur within a sample. This reduction in length is accompanied by some lowering of thermal shrinkage force.

5.23 The thermal shrinkage force of nylon, polyester, and aramid fiber is related to the polymer of origin and its manipulation in processing. Thermal shrinkage force measurement can be used to control product uniformity.

5.34 The level of thermal shrinkage force is critical in the user's subsequent operations, such as the drum-set (original length of cord) required to build a tire of a particular size.

5.45 The thermal shrinkage force is critical to the final shape and size of fiber-reinforced articles. For example, thermal shrinkage force affects the final size of V-belts and their ability to maintain tension during their operation.

5.56 This test method is in agreement with the nominal procedures of Methods D 885 for the determination of thermal shrinkage force in yarns and cords.

5.56.1 Shrinkage force is measured while the specimen is within an oven at a specified temperature and after a specified length of time.

## 6. Interferences

6.1 Because

6.1 If the chamber in which the specimen is heated is open on three sides, air drafts can effectively shorten the length of specimen experiencing the prescribed temperature environment. The results obtained without a shield are generally lower than those obtained with a shield.

6.2 The accurate control of temperature at any prescribed setting is one of utmost importance. Differences between the manufacturer's strongest claims. Nevertheless, for a number of reasons, it is possible for a difference to exist from tester to tester in set point temperature and the actual temperature developed in experienced by the specimen. An intralaboratory comparison is the preferred method to determine whether specimen are a bias exists between major cause of the results from one tester to another. If a bias is found, its cause of test results. The temperature that the specimen experiences may be r checked by attaching a small calibrated thermocouple to any number a piece of factors. To ensure that either the temperature induced cord and suspending it in the specimen position such that the same between instruments, or tip of the temperature on thermocouple is in the specimen matches center of the oven cavity. The thermocouple must not touch the oven walls. Eit-her correct any set point/sample temperature of a given instrument, bias or both, use determine the procedures given in proper set point to give the specified specimen temperature. An intralaboratory comparison is thex preferred method to calibrate Mark III Testrite ovens. determine whether a bias exists.

6.3 The differences in the amount of pre-relaxation of yarns can cause differences in thermal shrinkage force, as noted in 5.1.2. 5.2.1.

6.4 Shrinkage force as measured by the Testrite Shrinkage Force Tester is a combination of pretension force and the force that is developed in the specimen as a result of the specimen being heated.

6.5 Shrinkage force can be affected by the pretension, the length of specimen exposure, improper location of the specimen within the oven, and oven-surface contact of any part of the specimen. Specimens that are spun, textured, or crimped (such as those removed from a fabric) may allow filaments to come into contact with interior surfaces of the thermal shrinkage force oven. Such physical contact will cause inaccurate readings of the thermal shrinkage force.

## 7. Apparatus

7.1 *Testrite ThermalThermal Shrinkage Force Tester Mark III Oven*, consisting of a specimen heating cavity capable of heating up to 250°C (480°F), a means of accurately controlling the temperature of the cavity ± 2°C (4°F), and Mark V,[4] software version 5.12 a means for measuring and later (Fig. 1).[3] displaying the shrinkage force up to 0.1 N (0.02 lbf).

7.2 *Stopwatch or Time*, capable of reading to ± 1.0 s.[4] s.

7.3 *Clip-On Tensioning Masses.*

7.4 *Draft Shield for Testrite Shrinkage Oven,* as shown in Figs. 2 and 3 (dimensions in SI and inch-pound units, respectively)

~~or equivalent. Testrite Ltd. stated in 1992 that subsequent Testrite ovens would~~ if the oven does not have ~~draft shields as an integral part.~~ one provided.

## 8. Hazards

8.1 Do not touch the oven while it is in operation because it can reach temperatures up to 200°C (390°F).

8.2 Do not leave the oven unattended if a specimen is installed.

## 9. Sampling

9.1 *Lot Sample*—As a lot sample for acceptance testing, ~~take at random~~ randomly select the number of ~~primary sampling units~~ shipping containers directed in an applicable material specification or other agreement between the purchaser and the supplier. In the absence of such an agreement or material specification, proceed as directed in Practice D 2258. Consider shipping containers of yarn, cord and rolls of fabric to be the ~~primary~~ lot sampling units.

NOTE ~~1—A realistic~~ 1—An adequate specification or other agreement between the purchaser and the supplier requires taking into account the variability between ~~and within primary~~ shipping containers, between laboratory sampling units within a shipping container, and between test specimens within a laboratory sampling unit to ~~provide~~ produce a sampling plan with a meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

9.2 *Laboratory Sample*—As a laboratory sample for acceptance testing, proceed as follows:

9.2.1 For yarn or cord, take at random the number of packages per shipping container in the lot sample as directed in an applicable material specification or other agreement between the purchaser and the supplier. In the absence of such an agreement or material specification, proceed as directed in Practice D 2258.

9.2.2 For fabric, take a full-width swatch at least 1-m (1-yd) long from the outside of each roll of fabric in the lot sample, after first discarding all fabric from the outside of the rolls that contains creases, fold marks, disturbed weave, or contamination by foreign material.

9.3 *Test Specimens*:

9.3.1 For yarns and cords, strip at least ~~15~~ 50 m ~~(16~~ (55 yd) from the outside of each package in the laboratory sample. Inspect the outside of the package after stripping off the yarn. If there is visible damage, continue to strip off units of ~~15~~ 50 m (55 yd) and reinspect until there is no visible damage. Take ~~on~~ at least three specimens, 600-mm (24-in.) long, from each package in the laboratory sample. Discard and replace specimen lengths that are visibly damaged.

9.3.2 For tire cord fabrics, remove a minimum of ~~three~~ five lengths of warp yarn or cord 600-mm (24-in.) long from each swatch in the laboratory sample, with the specimens being taken at least 75 mm (3 in.) from the selvage of the swatch. For fabrics other than tire cord fabric, such as square-woven fabrics, also take from each swatch in the laboratory sample a minimum of ~~three~~ five lengths of filling yarn or cord 600-mm (24-in.) long after discarding those portions within 75 mm (3 in.) of the selvage of the ~~swatch. Take warp specimens that are free of filling material and filling specimens that are free of warp material in all cases.~~ swatch.

9.3.2.1 The instructions on number of test specimens given in 9.3.2 assume that ~~a single valid~~ the mean value of three thermal shrinkage force results will characterize adequately the thermal shrinkage force of the laboratory sample from which the specimens were taken. The extra two specimens from fabric are taken to ensure that a specimen free of handling damage is available after ~~conditioning (see Section 11).~~ conditioning. If the applicable material specification or other agreement between the purchaser and the supplier specifies testing more than ~~on~~ three specimens per laboratory sample, an additional two specimens above the number ~~to be tested~~ specified should be taken from the laboratory sample and conditioned.

9.4 Exercise caution that the specimens do not change twist in handling.

## 10. Preparation of Apparatus

10.1 Preheat the oven 45 min prior to testing with the draft shield covering the three open sides of the heating chamber.

10.2 Test in the standard atmosphere for testing industrial yarns (see ~~3.2.2).~~ 3.1).

10.3 Adjust the oven temperature controller set point to ~~177°C.~~

~~10.4 Consider use of the procedure described in the Annex if the calibration of the oven temperature is suspected to be in error.~~ 180°C (355°F).

## 11. Conditioning

11.1 Condition unrestrained specimens or segments of untensioned fabric in the atmosphere for testing industrial yarns (see ~~3.2.2).~~ 3.1). Ensure that no change in twist occurs while conducting this procedure.

11.1.1 Condition and relax the yarn and greige cord specimens 12 to 28 h.

11.1.2 Condition and relax the adhesive-treated cord samples 16 to 28 h, unless immediate testing (5 to 20 min after processing) is agreed upon between the ~~buyer~~ purchaser and the ~~seller.~~ supplier. Immediate testing must be reported as an exception to this test method (see Section 13).

## 12. Procedure

~~12.1 Raise the draft shield.~~

12.1 For yarns or cords, use a pretension load of 5 ± 1 mN/tex (0.05 ± 0.01 gf/den).

12.2 Pull the specimen transport carriage assembly forward against the front stops.

12.3 Lower the draft shield.

12.4 Insert

12.3 Insert one end of the specimen through the open right hand clamp and guide the end through to the opposite clamp atop the load cell post.

12.4 Zero the load cell.

12.5 Close the right hand clamp, firmly securing the right hand end of the specimen.

12.6 Apply the prescribed pretensioning mass to the free end of the specimen (see Table 1) outside the left hand post.

12.7 Close the left hand clamp, securing the specimen atop the load cell post.

NOTE 2—Take care that during the closing of the clamp on top of the load cell, the reading stays on zero.

12.8 Remove the pretensioning mass.

12.9 Raise

12.9 Push the draft shield.

12.10 Push the carriage assembly to the rear of the tester against the back stops. into the oven. Ensure that the specimen is centered in the oven and that no part of it is in contact with oven surfaces or will be in contact with surfaces.

12.10 Start the draft shield after it is lowered.

12.11 Lower the draft shield.

12.12 Start the timer at the moment that the draft shield carriage assembly is lowered in the oven, if the apparatus does not have an automatic start feature.

12.131 At the end of 120 ± 5 s, read the maximum shrinkage force on the instrument scale to the nearest 0.1 N.

12.14 Raise N (0.02 lbf).

12.12 Pull the draft shield, pull the carriage to the front, lower the draft shield, front and discard the specimen.

## 13. Report

13.1 State that the specimens were tested as directed in this test method. D 5591. Describe the material(s) or product(s) tested and the method of sampling used. Report the following information:

13.1.1 Individual thermal shrinkage force results as read from the indicator dial to the nearest tenth of a unit. Exercise caution that the final shrinkage force is reported. Some computerized data printout options available may show the average force for a defined time interval.

TABLE 1 Tensioning Masses[A,B]

| Single Strand Yarns | | |
|---|---|---|
| dtex | Denier | Tensioning Mass, g |
| Dtex | Denier | Tensioning Mass, g |
| 235 | 210 | 12 |
| 940 | 840 | 48 |
| 1100 | 1000 | 56 |
| 1170 | 1050 | 60 |
| 1400 | 1260 | 71 |
| 1440 | 1300 | 73 |
| 1880 | 1680 | 96 |
| 2100 | 1890 | 107 |
| 2100 | 1890 | 105 |
| Multiple Strands or Cords of Multiple Strands | | |
| Construction | | Tensioning Mass, g |
| Construction, Dtex | Construction, Denier | Tensioning Mass, g |
| 940 × 2 | 840 × 2 | 96 |
| 1100 × 2 | 1000 × 2 | 112 |
| 1100 × 2 | 1000 × 2 | 110 |
| 1400 × 2 | 1260 × 2 | 143 |
| 1400 × 2 | 1260 × 2 | 140 |
| 1440 × 2 | 1300 × 2 | 147 |
| 1440 × 2 | 1300 × 2 | 144 |
| 1880 × 2 | 1680 × 2 | 192 |
| 1880 × 2 | 1680 × 2 | 188 |
| 2100 × 2 | 1890 × 2 | 214 |
| 2100 × 2 | 1890 × 2 | 210 |

[A] For yarns or cords not shown in Table 1, calculate clip-on tensioning mass (g) required by multiplying the total dtex of the specimen by 0.05 or total denier by 0.055 g.

[B] Specified tensioning masses are for the nominal dtex specified. The D denier column is for information only.

13.1.2 Pretension force used.

13.1.3 Measurements as "immediate testing" if not conditioned for the standard period (see 11.1.1 and 11.1.2).

13.1.4 Measurements as "package testing" if the specimens taken from packages are not removed from the package and relaxed prior to testing.

## 14. Precision and Bias

14.1 *Summary*—The following precision and bias statements have been prepared in accordance with Practice D 2906. In comparing two single observations (single operator precision) for the materials tested, the difference should not exceed the values shown in Table 2 in 95 out of 100 cases when both observations are taken by the same well trained operator using the same piece of test equipment and specimens randomly drawn from the same sample of material. Larger differences are likely to occur under all other circumstances. The true value of thermal shrinkage force can be defined only in terms of a specific test method. Within this limitation, this test method has no known bias. Paragraphs 14.2-14.4 explain the basis for this summary and for evaluations made under other conditions.

14.2 *Interlaboratory Test Data*—An interlaboratory test was run in 1995 in which randomly drawn samples of three materials, 1260/2 denier nylon cord, 1000/1 denier polyester yarn, and 1500/2 denier polyester cord, were tested in each of five laboratories. Two operators in each laboratory tested three specimens of each material on each of two days. For each material, the components of variance for testrite thermal shrinkage force expressed as variances were calculated and are listed in Table 3 2.

14.32 *Critical Differences*—For each material and for the components of variance listed in Table 3, two averages should be considered significantly different at the 95 % probability level if the difference equals or exceeds the critical differences listed in Table 2 3.

14.43 *Bias*—The procedure in this test method for measuring thermal shrinkage force has no bias because the value of this property can be defined only in terms of a test method.

## 15. Keywords

15.1 thermal shrinkage force; tire cords; yarn

**TABLE 3 2 Components of Variance (Variances)**

| Material | Single Operator | Within Laboratory | Between Laboratory |
|---|---|---|---|
| 1260/2 Denier Nylon Cord | 0.0133 | ... | 1.3547 |
| 1000/1 Denier Polyester Yarn | 0.0018 | 0.0004 | 0.0415 |
| 1500/2 Denier Polyester Cord | 0.0047 | 0.0057 | 0.0264 |

## ANNEX

**(Mandatory Information)**

## A1. CALIBRATION OF OVEN TEMPERATURE ON TESTRITE TESTER

**TABLE 2 3 Critical Differences for Two Averages, 95 % Probability Level, Newtons**

| Number of Test Results in Each Average | Single Operator Precision | Within Laboratory Precision | Between Laboratory Precision |
|---|---|---|---|
| 1260/Denier Nylon Cord | | | |
| 1 | 0.32 | 0.32 | 3.24 |
| 2 | 0.23 | 0.23 | 3.23 |
| 3 | 0.18 | 0.18 | 3.23 |
| 4 | 0.16 | 0.16 | 3.23 |
| 5 | 0.14 | 0.14 | 3.23 |
| 1000/1 Denier Polyester Yarn | | | |
| 1 | 0.12 | 0.13 | 0.58 |
| 2 | 0.08 | 0.10 | 0.57 |
| 3 | 0.07 | 0.09 | 0.57 |
| 4 | 0.06 | 0.08 | 0.57 |
| 5 | 0.05 | 0.08 | 0.57 |
| 1500/2 Denier Polyester Yarn | | | |
| 1 | 0.19 | 0.28 | 0.53 |
| 2 | 0.13 | 0.25 | 0.51 |
| 3 | 0.11 | 0.24 | 0.51 |
| 4 | 0.09 | 0.23 | 0.51 |
| 5 | 0.08 | 0.22 | 0.50 |

**A1.1 Objective**

A1.1.1 The objective is to operate at a true temperature level, as measured by a thin wire thermocouple tied to a threadline of 177°C at the center of the oven.

**A1.2 Apparatus**

A1.2.1 *Type "J" Certified Wire Thermocouple and Certified Indicator Device*, 12-in. long, 1⁄16-in. diameter.
A1.2.2 *Hook Mass*, approximately 10 N.
A1.2.3 *Strand of Yarn or Cord*, 65 to 75-cm long.

**A1.3 Procedure**

A1.3.1 Tie the wire thermocouple (probe) to a yarn or cord specimen to be inserted into the oven. Tie the probe near the tip and at one or two other locations to prevent the thermocouple from touching the oven.

A1.3.2 Attach one end of the yarn strand and the thermocouple wire in the Testrite specimen clamp so that the yarn and probe are held firmly. Adjust the yarn and probe assembly so that the tip of the probe will be in the center of the oven.

A1.3.3 Bring the other end of the yarn or cord specimen through the other (open) clamp and attach approximately 10 N mass to the end of the strand to hold the specimen/probe assembly taut in the oven.

A1.3.4 Raise the oven cover and push the carriage assembly toward the oven so that the specimen/probe assembly comes to rest at the normal testing position.

A1.3.5 Check to ensure that the threadline and wire thermocouple probe are positioned correctly in the normal threadline testing path. The thermocouple probe should be collinear with the thread path used during testing. The probe should also be centered between the oven platens. The probe must not touch either platen. Close the cover during this process.

A1.3.6 Allow the above system to reach thermal equilibrium (approximately 5 min).

A1.3.7 Record and compare the temperature indicated on the Testrite digital readout and temperature measured by the certified wire thermocouple device. These temperatures must agree within 2.0°C.

A1.3.8 If necessary, the controller may be calibrated so that the Testrite controller indication agrees with the certified wire calibration check probe. This procedure is described in A1.4.

**A1.4 Procedure for Re-Calibration of Controller for Mark III and Earlier Testrite Models (Use a Qualified Electrician)**

A1.4.1 If the Testrite controller is found to be miscalibrated as determined by the procedure described above, proceed as follows. Switch the machine off (tag, lock, and so forth), and then pull the flap open on the bottom front of the controller.

A1.4.2 Release the controller from the Testrite unit by turning the screw fastener on the right side of the controller. The controller slides out of the Testrite as a complete unit from front of the tester.

A1.4.3 On the bottom side of the controller are three holes. Located through the two holes closest to the front of the controller are potentiometers; the SPAN (closest to the front of the tester) and the ZERO (middle opening). The SPAN should be used to adjust temperatures above 150°C. By turning the SPAN pot clockwise or counterclockwise, the temperature in the oven will fall or rise accordingly for a given setpoint. Only the slightest movement is necessary.

A1.4.4 Replace the controller. Switch the instrument on. Leave for 10 to 15 min until the set temperature is indicated by the controller. Recheck the calibration by the threadline method and readjust as necessary until the controller indication agrees with the certified device.

**A1.5 Procedure for Re-Calibration of Controller for Mark IV and Later Testrite Models**

A1.5.1 The procedure for re-calibration of the Mark IV and V Testrite can be supplied upon request from Testrite Ltd, Halifax, England, HX36TF, according to a letter to D13.19 Subcommittee in 1992. The user should contact Testrite Ltd. directly for this information as needed.