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NEMA STANDARDS PUBLICATION

NEMA MW 700

TEST PROCEDURES FOR MAGNET WIRE PLASTIC SPOOLS/REELS

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Test Procedures for Magnet Wire Plastic Spools/Reels

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Foreword

Test Procedures for Magnet Wire Plastic Spools/Reels, MW 700-1997, was prepared by the NEMA Magnet Wire Packaging Committee.

NEMA Magnet Wire publications are periodically reviewed by the NEMA Magnet Wire Section for revisions considered necessary to keep them current with technology changes. Proposed revisions should be submitted to:

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This Standards Publication was developed by the Magnet Wire Section of the National Electrical Manufacturers Association. At the time it was approved, the Magnet Wire Section had the following members:

Alcatel Magnet Wire, Inc.—La Grange, KY
American Wire Corporation—Sandy Hook, CT
Bridgeport Insulated Wire Company—Bridgeport, CT
Elektrisola, Inc.—Boscawen, NH
Essex Group, Inc., Magnet Wire Products Division, Fort Wayne, IN
Magnetek, Inc.—Gallman, MS
Optec D D USA, Inc.—St. Louis, MO
Phelps Dodge Magnet Wire Company—Fort Wayne, IN
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Southwire Specialty Products—Osceola, AR

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Section 1
STRENGTH TEST

Safety Statement: *Mechanical Hazard*—Some tests utilizing mechanical equipment may expose the operator to mechanical hazards. Care must be exercised to protect eyes, fingers, hands, and other body parts from injury.

1.1 SCOPE

This test method applies only to spools/reels for magnet wire products. It provides guidelines for the testing of 10/11x12 or smaller straight or tapered flange spools and reels, and is to be used in conjunction with all other testing procedures for magnet wire spools and reels.

1.2 PREPARATION OF TEST SPECIMENS

Flange and barrel strengths shall be determined by using a tensile test machine having a minimum capacity of 10,000 lbs. and the capability of measuring jaw travel in inches or seconds. The spool shall be held in a set of pulling jaws as shown in Figure 1-1. The test fixture or jaws shall have a rate of jaw travel of 1 inch ±0.25 inch per minute.

Tests shall be made at room temperature (22-26ºC). Spools or reels for test shall be held at the test temperature for at least 24 hours prior to testing. Spools and reels that are solvent bonded shall not be tested prior to 7 days after assembly.

1.3 STRAIGHT FLANGE SPOOLS/REELS

1.3.1 Methods

1.3.1.1 Method A—Flange Test

The load "L" is applied to the flanges by a circular ring at a diameter "D" equal to the spool or reel barrel diameter plus 1.5 times the flange overhang, less 1/4 inch. The jaws should be designed to allow the flange to slide during testing, and should not contact the flange inside the specified diameter.

1.3.1.2 Method B—Barrel Test

The load "L" is applied to the flanges by a circular ring at a diameter "D" equal to the spool or reel barrel diameter plus 1/8". The jaws should be designed to allow the flange to slide during the test.

1.3.2 Evaluation

Minimum or range of performance values shall be determined by mutual agreement between the supplier and the wire producer.

1.4 TAPERED FLANGE SPOOLS/REELS

1.4.1 Method

For testing of tapered top tapered barrel spools and reels, a fixture similar to the one used for straight flange and barrel reels is used. The load is applied to the flanges at a diameter equal to the spool or reel barrel diameter plus 1/8" on the radius. For example, if the diameter at the barrel is 5 inches, the opening in the fixture shall be 5-1/4 inches. With a tapered barrel the fixture openings at the top and bottom will be

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of different diameters. The opening at the top shall be cut at a 45 degree angle or an angle to match the angle of the top flange. Where spools or reels have double taper of both flanges, the bottom of the fixture shall be designed in the same manner as the plate or ring holding the top flange.

The load shall be applied by a circular ring. The jaws should be designed to allow the flange to slide during the test and should not contact the flange inside the above specified diameter.

1.4.2 Evaluation

The values from the testing and the minimum or range for spool/reel performance shall be determined by mutual agreement between the supplier and the wire producer.

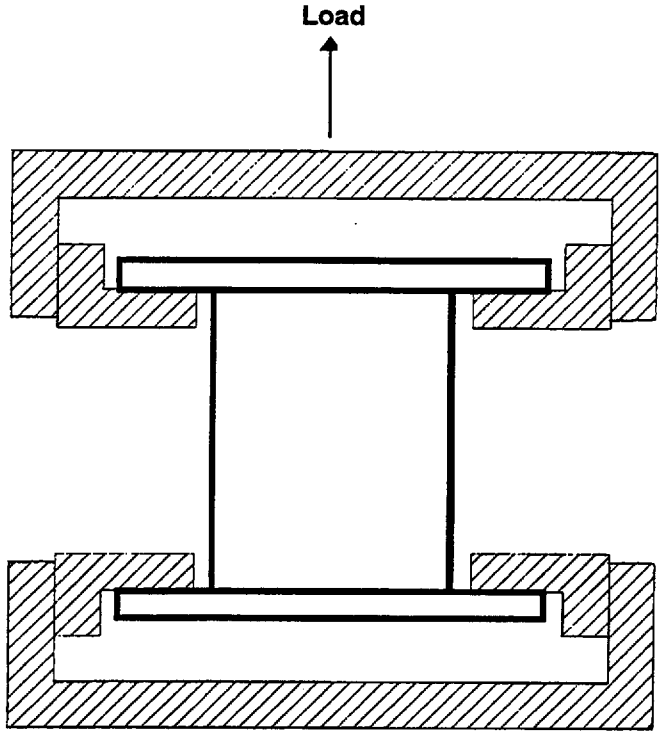


Figure 1-1
PREPARATION OF SAMPLE—STRENGTH TEST

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Section 2
CHEMICAL COMPATIBILITY TEST

As magnet wire is wound on plastic spools or reels, the plastic spool or reel comes in contact with chemicals used to treat the wire such as lubricants, cleaners, coatings, etc. Some of these chemicals may not be compatible with the plastic used in the construction of the reel and may adversely affect the performance of the plastic reel. Cracks may develop in the reel, which can trap or break the wire during the dereeling process, or the reel may break.

Chemical incompatibility or attack is referred to as an environmental stress cracking (ESC). The degree of ESC present in actual application on spools and reels is directly influenced by the type of plastic resin, the amount of chemical added to the wire, evaporation rates of the chemical, wire temperature at the point of application of the chemical, winding speed, distance from the point of application to the spool or reel, winding tension, and the amount of time a wound spool or reel is stored before use.

2.1 SAFETY STATEMENTS

It is not the intent of this document to address all of the safety issues associated with its use. It is the responsibility of the user to train personnel, to establish proper health and safety procedures, and to be aware of local, state, and national regulatory restrictions that may apply.

WARNING: *Chemical Hazard*—This test shall be performed under controlled conditions which allow for safety and protection of personnel. The chemicals being evaluated may be hazardous. Information and instructions contained in Material Safety Data Sheets (MSDS) for handling, working with, and disposal of hazardous chemicals shall be followed. Furthermore, discharges of these chemicals to the environment must be performed in compliance with current Federal, state, and local regulations.

WARNING: *Mechanical Hazard*—When test specimens are placed in the test fixture under tension, they can break at any time. The sudden release of energy could propel parts of the specimen, the chemical being evaluated, or the fixture itself in a hazardous way or into hazardous circumstances. The hydraulic test apparatus to be used may also expose the operator to mechanical hazards. Care must be exercised to protect eyes, fingers, hands, and other body parts from injury.

2.2 SUMMARY OF TEST METHOD

2.2.1 Preparation of Test Specimens

Test specimens, referred to as a "dog bone" because of their shape (Figure 2-1), are molded from the same thermoplastic resin used in molding the spool or reel to be evaluated. The dog bone measures 1 inch wide X 5 inches long X 0.110 inch thick overall and necks down to 1-3/4 inches long and 3/8 inch wide X 0.110 inch thick, with 0.055 inch radius edges in the test section (0.0373 in.^{2} cross-sectional area), with a 3/8 inch diameter mounting hole, and bosses 0.150 inch high on both sides of the dog bone.

For each chemical tested, four dog bone specimens are required. Two specimens shall be tested at a tensile load of 2030 p.s.i., and two tested at 3030 p.s.i. All four dog bones will be measured, covered with paper toweling (Figure 2-2), and saturated with the chemical being tested. Two of these will also be wrapped in polyethylene film to slow the evaporation rate—see Table 2-1.

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Table 2-1
PREPARATION OF DOG BONE TEST SPECIMENS

Specimen No.	Tensile Load, p.s.i.	Paper Toweling Only	Paper Toweling and Polyethylene Film
1	2030	X	
2	2030		X
3	3030	X	
4	3030		X

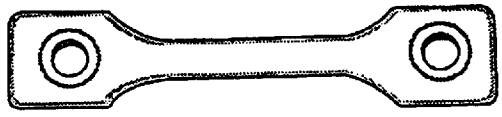


Figure 2-1
DOG BONE



Figure 2-2
DOG BONE WITH PAPER TOWELING

2.2.2 Evaluation

The four specimens shall be examined every four hours for 21 days to determine if breakage has occurred. The date and time that breaks are found shall be recorded. At the end of seven days, the specimens are measured for elongation and resaturated with the chemical being tested, unwrapping those specimens wrapped in polyethylene film and rewrapping them. At the end of 14 days, the previous step is repeated. After 21 days, the specimens are measured for elongation and removed.

2.2.3 Acceptance Standard

After 21 days, the four dog bone specimens must not break or elongate more than 10% in order for the chemical to be considered compatible with the plastic resin used in molding the specimens. For specimens that do not meet this acceptance standard, the time before failure or percentage of elongation after 21 days is simply a relative measure of the degree of chemical incompatibility.

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2.2.4 Discussion

This procedure is purposely designed as a severe test in that the amount of chemical used is acknowledged as being significantly greater than that which is used in actual application conditions. It is intentional because the tensile load applied to the dog bone does not simulate all loads and stresses likely to be applied to the spool or reel by the wire and other variables mentioned in the introduction, which are not present in this test.

The specimens are tested at two tensile loads because environmental stress cracking is directly influenced by the load stresses present.

2.3 TEST PROCEDURES

Four dog bone specimens shall be molded per Figure 2-1 from the same thermoplastic resin used in molding the spool or reel to be evaluated. Double ply paper toweling, 2" X 3-3/4" long, is to be folded in half lengthwise around the neck of each dog bone, and stapled as close to the edge of the dog bone as possible, one staple beside the other—see Figure 2-2.

Clean four test fixtures and their clevis pins of all chemicals to which they have been previously exposed (see Figure 2-3).

Mount a test fixture on the hydraulic test stand mounting plate using a hex head screw (see Figure 2-3).

Install a dog bone specimen (with paper toweling) in the test fixture. Loosen the test fixture stop nut (Figure 2-3, Item 8) to provide sufficient travel to install the dog bone. The ends of the dog bone are to be fitted in the clevis clamp and the clevis pins inserted to hold the dog bone in place. The head end of both clevis pins must be on the same side.

Screw the threaded square nut end of the cylinder rod connector (Figure 2-3, Item 4) three or four turns in the threaded rod of the test fixture by turning the square nut clockwise.

Turn on the power to the hydraulic power supply and turn the directional control valve to extend the hydraulic cylinder. Pivot the latch (Figure 2-3, Item 6) of the cylinder rod connector to engage the cylinder rod yoke (Figure 2-3, Item 7), and then reverse the direction of the cylinder to retract the cylinder rod. At the same time, adjust the pressure regulator to the prescribed pressure.

Two samples shall be set at 12 p.s.i. (the equivalent of 75.4 lbs. of force on the 0.0373 $in.^2$ cross-section of the neck of the dogbone and 2030 p.s.i. tensile load on the dog bone), and two at 18 p.s.i. (the equivalent of 113.1 lbs. of force and 3030 p.s.i. tensile load on the dog bone).

When the prescribed pressure is reached, the cylinder will stop moving. Then screw the stop nut (Figure 2-3, Item 8) by hand until it contacts the test fixture surface. Do not use a wrench to turn the stop nut as this will increase the tensile load above the value preset by the hydraulic cylinder. Turn off the hydraulic power supply and unscrew the square nut from the test fixture threaded rod.

The distance between the inserted ends of the clevis pins shall be recorded to three decimal places with a 6-inch dial or digital caliper.

Specimens shall be saturated with the chemical agent being tested for compatibility using a clean, unused eye dropper. After saturation, two of the four specimens, as indicated in Table 2-1, shall be wrapped with 1-1/2 mil polyethylene film strip 1/2 inch wide X 8 inches long. The polyethylene film strip is applied by holding one end of the strip at the start of the dog bone neck, and tightly wrapping the film strip in a spiral-wound fashion around the paper toweling, progressing toward the opposite end of the dog bone, stopping at the neck, and looping the film strip end to prevent unwinding.

Remove the fixture for storage.

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Repeat the above procedure to produce four specimens:

a. 2030 p.s.i. tensile load - saturated
b. 2030 p.s.i. tensile load - saturated and wrapped with polyethylene film
c. 3030 p.s.i. tensile load - saturated
d. 3030 p.s.i. tensile load - saturated and wrapped with polyethylene film

The four specimens shall be examined every four hours for 21 days to determine if breakage has occurred. The date and time that breaks are found shall be recorded. At the end of 7 days, the specimens are measured for elongation and resaturated with the chemical being tested, unwrapping those wrapped in polyethylene film and rewrapping them. At the end of 14 days, the previous step is repeated. At the end of 21 days, the specimens are measured for elongation and removed.

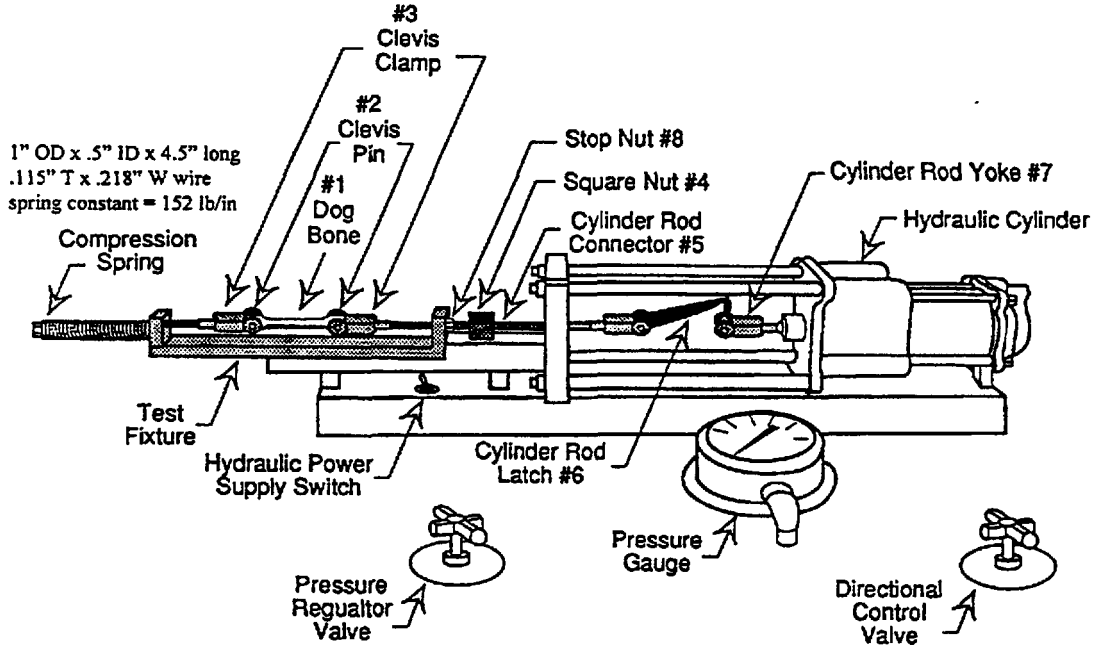


Figure 2-3
APPARATUS FOR CHEMICAL COMPATIBILITY TEST

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Section 3
INSERT PULLOUT STRENGTH TESTING

3.1 SUMMARY

This section provides two methods for determining the ability of a magnet wire spool/reel insert to withstand a pulling force. The Destructive Force method determines the breaking point of an insert as a steadily increasing pullout force is applied (see Figures 3-1), while the Specified Pullout Force method evaluates the ability of an insert to withstand a specified pulling force (see Figure 3-2).

3.2 PREPARATION OF TEST SPECIMENS

Tests shall be made at room temperature (22-26ºC). Spools or reels for test shall be held at the test temperature for at least 7 days prior to testing. Solvent bonded products shall be held 7 days after assembly to ensure a complete bond before they are tested.

3.3 METHODS

3.3.1 Destructive Force Method

Safety Statement: *Mechanical Hazard*—The mechanical equipment used in this test may expose the operator to mechanical hazards. Care must be exercised to protect eyes, fingers, hands, and other body parts from injury.

a. Adjust a tensile test machine to the desired setting for testing of inserts.

b. Cut approximately two inches off the bottom of three reels.

c. Load the test plates and the insert strain rod fixture, as shown in Figure 3-1, and attach the strain rod tee bar onto the moveable side of the tensile fixture.

d. Adjust the tee bar to "0" lash and reset the dial indicators to zero.

e. Stretch the assembly to the breaking point, observing pressure gauges and dial indicators.

f. Repeat this procedure with two additional reels.

3.3.2 Specified Pullout Force Method

Safety Statement: *Mechanical Hazard*—Mechanical equipment used in this test may expose the operator to mechanical hazards. Care must be exercised to protect eyes, fingers, hands, and other body parts from injury. Further, the test weight employed in this method should be contained in an enclosure to protect personnel from a sudden release of the weight in case of test failure.

a. Turn the reel to an inverted position so that the insert is facing upward (see Figure 3-2).

b. Affix a weight that is two times the suggested weight-carrying capacity of the reel to the top of the flange. A device that attaches through the bore and centers the load should be utilized.

c. A similar attachment device is affixed to the bore of the insert. This upper attachment device is connected to a means of lifting the reel and test weight assembly, which may be mechanical, hydraulic, or pneumatic.

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d. The test is initiated by applying a tensile load sufficient to lift the test weight one inch off the surface on which it is resting. The reel shall remain in tension for two minutes.

3.4 EVALUATION

3.4.1 Destructive Force Method

The minimum tensile load which the insert must withstand shall be determined by mutual agreement between the spool/reel supplier and magnet wire producer.

3.4.2 Specified Pullout Force Method

Any movement of the insert during the time the reel is suspended from its resting surface shall constitute a failure.

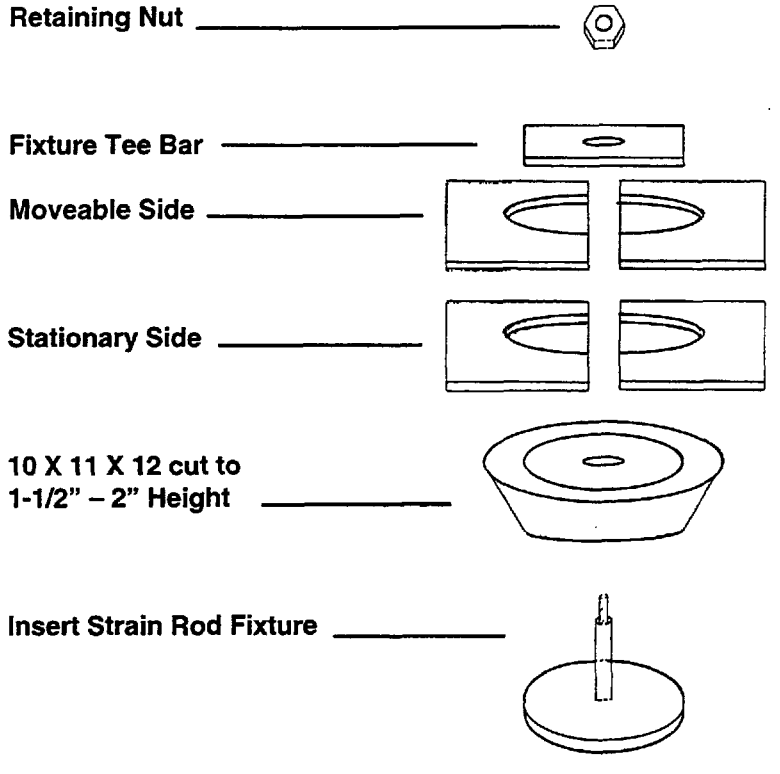


Figure 3-1
TEST APPARATUS, DESTRUCTIVE FORCE METHOD

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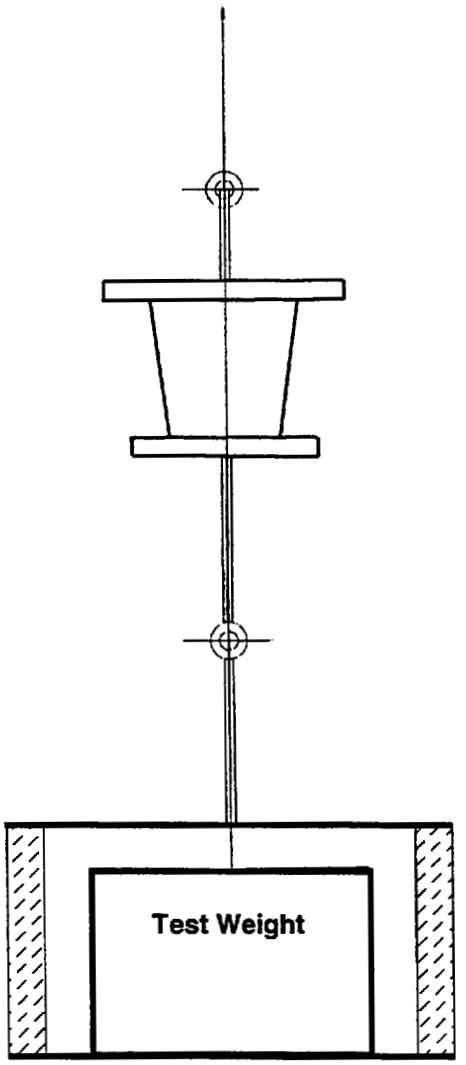


Figure 3-2
ATTACHMENT LIFTING DEVICE—SPECIFIED PULLOUT FORCE METHOD

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Section 4
IMPACT TESTING

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