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SUPERSEDING
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MILITARY SPECIFICATION

CABLE, TELEPHONE WD-33/U

This specification has been approved by the Department of Defense and is mandatory for use by the Departments of the Army, the Navy, and the Air Force.

1. SCOPE

1.1 This specification covers one type of twisted pair cable designated as Cable, Telephone WD-33/U consisting of two 1022 circular mil (No. 20 AWG) coated copper clad steel wires (see 3.2) separately insulated with a styrene butadiene rubber (SBR) insulating compound followed by a chloroprene rubber (CR) jacketing compound and twisted together to form the finished cable.

2. APPLICABLE DOCUMENTS

2.1 The following specifications and standards, of the issue in effect on date of invitation for bids, form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

J-C-98 — Cable and Wire, Insulated; Methods of Sampling and Testing.

PPP-B-585 — Boxes, Wood, Wirebound

MILITARY

STANDARDS

FEDERAL

Standard No. 601 — Rubber: Sampling and Testing.

MILITARY

MIL-STD-105 — Sampling Procedures and Tables for Inspection by Attributes.

MIL-STD-129 — Marking for Shipment and Storage.

(Copies of specifications and standards required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer).

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise

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indicated, the issue in effect on date of invitation for bids shall apply.

AMERICAN SOCIETY FOR TESTING MATERIALS

B189 — Lead-Coated and Lead Alloy-Coated Soft Copper Wire for Electrical Purposes.

D518 — Resistance to Light Checking and Cracking of Rubber Compounds.

D1149 — Accelerated Ozone Cracking of Vulcanized Rubber.

(Application for copies should be addressed to the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa.)

3. REQUIREMENTS

3.1 **Materials.** The materials used for Cable, Telephone WD–33/U shall be as specified herein.

3.2 **Conductors.** Each conductor shall be coated copper-covered steel as follows:

3.2.1 *Size.* The conductors shall be not less than 0.031 inch nor more than 0.034 inch in diameter (No. 20 AWG).

3.2.2 *Copper covered steel.* The copper covered steel conductors shall be composed of a steel core with a uniform and continuous copper covering thoroughly bonded to it throughout. The core shall be homogeneous open hearth or electric furnace alloy steel. The conductor shall be rated nominally 40 percent conductivity. The thickness of the copper at any point on the finished wire shall be not less than 0.002 inch when determined by the direct measurement method specified in 4.6.1.2. Measurement of minimum copper thickness during manufacture and prior to final draw, when determined either by the direct measurement method specified in 4.6.1.2 or by means of an approved electrical indicating instrument specified in 4.6.1 shall correspond with related wire diameter size ranges as follows:

Wire diameter Inch	*Copper thickness minimum Inch*
.080 to .099	.005
.100 to .109	.006
.110 to .119	.006
.120 to .129	.007
.130 to .139	.008
.140 to .149	.008
.150 to .159	.009
.160 to .179	.010
.180 to .199	.011
.200 to .209	.012
.209 to .219	.013

3.2.3 *Lead or lead alloy coating.* The copper clad steel conductors shall be continuously coated with a lead or lead alloy coating in accordance with ASTM B189.

3.2.4 *Brass coating or adhesive.* The lead or lead alloy coated conductors shall be coated with an electroplated flash coating of brass of sufficient weight to impart a characteristic brass color to the conductors. The plating technique shall be that calculated to yield a coating of brass containing 75 to 80 percent of copper. An adhesive may be used in lieu of brass coating for bonding of insulation to the conductor (see 6.8).

3.2.5 *Finish.* The wire shall be free from kinks, scales, inequalities, splints, splits, knicks, slivers or other injurious defects.

3.2.6 *Joints.* The conductors shall be free from joints in the finished conductors. Joints may be made in the conductors prior to the final drawing operation. These joints shall be the scarf type, brazed with silver alloy solder. The solder shall completely cover the scarfed faces and edges of the joints. The joints shall be smooth, uniform, and free from lumps of solder. The joint shall be a tensile strength of 85 percent of the rated strength of the wire without a joint. The section of the conductor containing a joint shall be capable of being wrapped around a ⅛-inch mandrel without rupture of the brazing material, the copper coating or the steel core of the conductor.

3.2.7 *Breaking strength.* The breaking strength of the conductors shall be not less than 44 pounds and not more than 65 pounds.

3.2.8 *Bonding of copper in flexure.* The coated or uncoated copper-clad steel conductors shall be capable of being bent to rupture back and forth through a 90° angle in each direction over a mandrel $\frac{1}{10}$ inch in diameter without separation of the copper from the steel upon visual examination.

3.2.9 *Wrapping.* The conductors shall be capable of withstanding, without developing surface cracks, seams, splits, checks, slivers, exposure of steel in the copper clad steel conductors, or other evidence of failure, wrapping for five consecutive turns in a close helix about $\frac{1}{32}$-inch mandrel when wrapped at a rate of approximately 60 turns per minute.

3.2.10 *Kinking.* The conductors shall be capable of withstanding kinking without developing surface cracks, seams, splits, checks, slivers, or exposure of the steel core of the copper clad steel conductors. Two kinks, separated a few inches from each other and with the axis of the wire rotated 90° before forming the second kink, in an 18-inch specimen with one end secured in a vise at an angle of approximately 20° from the horizontal, shall each have an inside diameter of not over 0.016 inch.

3.2.11 *Bonding of copper in torsion.* The coated or uncoated copper-clad steel shall be capable of withstanding a torsional twist to rupture without separation of the copper from the steel upon visual examination.

3.3 Insulation. Each conductor of the wire shall be covered with a styrene butadiene rubber (SBR) insulating compound. All SBR insulating compound used shall be virgin material. The SBR insulating compound shall be made with such fillers, antioxidants, organic accelerators and curing agents as are necessary to provide a compound having long life in service and in storage. The compound used for conductor insulation shall contain not more than 0.5 percent of free sulfur (see 4.3). The material shall be homogeneous, tough, and elastic and shall be properly vulcanized (cured) to conform to the requirements of this specification. It shall be free of blisters, wrinkles, cracks, or other defects that may have a deleterious effect on the finished cable. The insulation thickness shall not be less than 0.013 inch. The diameter of the insulated conductor shall be not less than 0.065 inch.

3.4 Sunproofing wax. Styrene butadiene rubber (SBR), and chloroprene rubber (CR) compounds shall incorporate an acceptable sunproofing wax to protect the insulation and jacket against cracking due to exposure (see 4.3 and 6.6).

3.4.1 *Insulating compound.* Styrene butadiene rubber insulating compound shall contain not less than 2.5 parts by weight of sunproofing wax per 100 parts by weight of base rubber plymer.

3.42 *Jacketing compound.* Chloroprene rubber jacketing compound shall contain not less than 3 parts by weight of sunproofing wax per 100 parts of base rubber polymer.

3.5 Insulation repairs. Faults in the insulation developed during processing or testing may be repaired, but all lengths of wire containing such repairs shall be capable of meeting the requirements of this specification. In making such repairs in the insulation, the insulation shall be removed by tapering cuts on each side of the defect. The cuts shall not nick the conductor. The bared conductor shall be wrapped with a high grade SBR or rubber insulating tape in thin layers until the diameter of the taped section is equal to the original insulation diameter, and then vulcanized. The patch shall be fully bonded to the original insulation.

3.6 Jacket. The individual conductors shall

be individually jacketed with a smooth, continuous, tight-fitting, adherent sheath of black vulcanized chloroprene rubber compound to form a completed conductor capable of withstanding the tests hereinafter specified. All chloroprene rubber compound used shall be virgin material. The thickness of the jacket shall be not less than 0.022 inch. The total thickness of insulation and jacket shall be not less than 0.035 inch. The diameter of the insulated and jacketed conductor shall be not less than 0.111 inch and not more than 0.135 inch. Tracer ridges shall not be included in the above measurements.

3.6.1 *Jacket repairs.* Faults in the jacket, developed during processing or testing, may be repaired, but all lengths of cable containing such repairs shall be capable of meeting the requirements of this specification unless otherwise specified herein. In making such repairs in the jacket, the jacket shall be removed by tapering cuts on each side of the defect. The cuts shall not nick the insulation. The insulation shall be wrapped with a chloroprene rubber jacketing tape and then vulcanized. The patched section shall not exceed 3½ inches in length and 0.155 inch in diameter and shall be not less than the diameter of the adjacent jacket. Edges of the patch shall be well rounded and the ends tapered down and fully bonded to the original jacket.

3.7 Distinguished marks. In order that the two jacketed conductors may be readily distinguished from each other, the jacket of one conductor of the twisted pair shall bear identification marks consisting of two longitudinal ridges. The ridges shall be adjacent or radially spaced from each other approximately 45°. The ridges shall be continuous throughout the length of the cable. The ridges constituting the tracer shall be approximately 0.015 of an inch in height and approximately 0.030 of an inch in width at the junction of the ridge and the round portion of the jacket. The height shall be not less than 0.010 of an inch.

3.8 Twisting. Two completed single conductors, one unmarked and the other marked with longitudinal ridges shall be twisted together with a right-hand lay to form the finished wire. The length of lay shall not exceed three inches.

3.9 Insulation adhesion. The adhesion of the insulation to the conductor in any length of the completed insulated and jacketed conductor shall be such that a force of not less than 12 pounds applied parallel to the axis of the conductor will be required to strip a 1-inch length of insulation and jacket from the conductor, when tested as specified in 4.10. The adhesion of insulation after aging specified in 4.11 shall average not less than 90 percent of the unaged values of these specimens.

3.10 Insulation and jacket adhesion. The adhesion of the sheath to the insulation and the insulation to the conductor shall be such as to withstand a load equal to the breaking load of the single conductor without buckling of the insulation or sheath or slippage of the conductor, when tested as specified in 4.12.

3.11 Compression characteristics. Each of the completed single insulated and jacketed conductors shall be capable of satisfying the following compression requirements, when tested as specified in 4.13.

3.11.1 *Compression before aging.* For any length of unaged completed insulated and jacketed single conductor, the load required to produce crushing shall be not less than 800 pounds.

3.11.2 *Compression after 48 hour aging.* For any length of completed insulated and jacketed single conductor which has been subjected for 48 hours to the accelerated aging specified in 4.13 the load required to produce crushing shall be not less than 600 pounds, provided that in no case shall this crushing load be less than 0.70 of the crush-

ing value obtained on the same specimen prior to accelerated aging.

3.11.3 *Compression after 10 days aging.* Any length of completed insulated and jacketed single conductor which has been subjected for 10 days to accelerated aging, specified in 4.13 shall be capable of withstanding, without crushing, a load of not less than 0.50 of the crushing load obtained on the same specimen prior to accelerated aging.

3.12 Low temperature characteristics. Specimens of the completed insulated and jacketed conductors shall be capable of being wound around a mandrel of ¼ inch diameter at —40°±2° F. without cracking the conductor insulation or jacket, when tested as specified in 4.14.

3.13 Ozone resistance. After testing in accordance with 4.22 the jacket of Cable, Telephone WD-33/U shall exhibit no visible cracks when viewed under seven-power optical magnifier.

3.14 High Voltage spark. All of the completed cable shall be capable of withstanding without dielectric failure a spark test potential of not less than 6,100 volts rms, ac, applied for a period of not less than 0.25 of a second, when tested as specified in 4.20.

3.15 Electrical characteristics during water immersion. Any length of completed cable shall be capable of conforming to the following voltage, insulation resistance, and mutual capacitance requirements while immersed in tap water under conditions to insure complete wetting of the surface of the cable. The period of immersion shall be not less than 12 hours.

3.15.1 *Voltage.* A potential of 1,500 volts rms, ac, shall be maintained between each conductor and the surrounding water for a period of 1 minute, without showing any evidence that rupture of the insulation has occurred, when tested as specified in 4.15. Following the application of the voltage test, the cable shall satisfy the insulation resistance requirements specified in 3.15.2.

3.15.2 *Insulation resistance.* The insulation resistance of each conductor to the water shall be not less than 500 megohms-thousand feet at, or corrected to +60° F., when tested as specified in 4.16.

3.15.3 *Mutual capacitance.* The mutual capacitance of the cable shall be not more than 0.11 microfarad per 1,000 feet when measured at a frequency of approximately 900 or 1,000 cycles per second, when tested as specified in 4.17.

3.16 Jacket longitudinal resistance. In any length of the completed single conductor, the longitudinal resistance of the coverings shall be not less than 1,000 megohms per foot of conductor, when tested as specified in 4.18.

3.17 Dc resistance. The dc resistance of each conductor of the cable shall be not more than 30.0 ohms per thousand feet at, or corrected to 68° F., when tested as specified in 4.19.

3.18 Coils. Cable, Telephone WD-33/U shall be furnished in coils of one continuous length of not less than 900 feet and not more than 1,100 feet. The coils of cable, as formed, shall have an eye capable of receiving a mandrel 14½ inches in diameter. The traverse in coiling shall be not greater than 4¼ inches. Both ends of the wire in each coil shall be readily accessible.

3.18.1 *Odd lengths.* Odd lengths of cable shall be accepted in coils of 300 feet to 900 feet in length and 1,100 to 1,500 feet in length. Odd lengths shall comprise not more than 5 percent of the total number of coils of cable furnished.

3.19 Workmanship. Cable, Telephone WD-33/U shall be manufactured and finished in

accordance with all applicable requirements of this specification.

4. QUALITY ASSURANCE PROVISIONS

4.1 Contractor's responsibility. The supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own or any other inspection facilities and services acceptable to the Government. Inspection records of the examinations and tests shall be kept complete and available to the Government as specified in the contract or order. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Inspection conditions. Unless otherwise specified herein, all inspection shall be made at room ambient temperature, pressure, and humidity.

4.3 Verification of material. For all finished cable submitted to the Government for acceptance, the contractor shall furnish a certificate of compliance for the compound used in the composition of the insulation and jacket. This certification shall indicate compliance with the requirements of 3.3, 3.4, and 3.5, as follows:

4.3.1 *Sunproofing wax.* The quantity of sunproofing wax used per 100 parts by weight of base rubber polymer and identification of a acceptable sunproofing wax used, by manufacturer's name and trademark or number shall be stipulated.

4.3.2 *Virgin material.* Virgin material shall be 100 percent new material which has been through processes essential to its manufacture one time only. Any material which has previously been processed in any other manner or which has additives processed in any other manner is considered nonvirgin material. This shall apply to the manufacture of all ingredients and components used. The contractor shall certify that the materials used meet the above conditions.

4.3.3 *From elemental sulfur content.* The free elemental sulfur content shall be determined in accordance with method 16211 of Federal Standard No. 601 except that where great sensitivity is required, a 0.01 iodine solution shall be used and the blue and point shall last 3 to 4 seconds.

4.4 Classification of inspection. Inspection shall be classified as follows:

(a) Acceptance inspection.
  (1) Acceptance inspection of equipment before preparation for delivery (see 4.5).
  (2) Acceptance inspection of preparation for delivery (see 4.24).

4.5 Acceptance inspection of equipment before preparation for delivery. The contractor, to demonstrate compliance with specified requirements, shall perform the inspection specified in 4.5.1 through 4.23. This does not relieve the contractor of his responsibility for performing any additional inspection which is necessary to control the quality of the product and to assure compliance with all specification requirements. The Government will review and evaluate the contractor's inspection procedures and examine the contractor's inspection records. In addition, the Government—at its discretion—may perform all or any part of the specified inspection, to verify the contractor's compliance with specified requirements (see 6.3).

4.5.1 *Group A inspection.* This inspection (including sampling) shall conform to table I and the ordinary inspection procedures of Standard MIL-STD-105.

4.5.2 *Groug B inspection.* Group B inspection shall consist of the examinations and tests specified in table II.

4.5.2.1 *Sampling procedure.* The sampling procedure shall be in accordance with Stand-

ard MIL-STD-105 for the inspection listed. Unless otherwise specified herein, normal inspection shall be used at the start of the contract. The reduced inspection procedure shall be R-1. The AQL shall be as shown in table II.

4.5.2.2 *Procedure in case of failure.* When an inspection lot fails, the contractor shall immediately investigate the cause of failure and take corrective action to assure that subsequent lots do not contain the same defect or defects.

TABLE I. *Group A inspection*

Inspection	Requirement paragraph	Inspection paragraph	AQL	
			Major	Minor
Visual and mechanical:				
Conductor				
Size	3.2.1	4.6	15% for the group	4.0% for the group
Finish	3.2.5	4.6		
Insulation	3.3 and 3.5	4.7 and 4.21		
Jacket	3.6 and 3.6.1	4.7 and 4.21		
Distinguishing marks	3.7	4.7		
Twisting	3.8	4.8		
Electrical				
Voltage	3.15.1	4.15	1% for the group.	(*)
Insulation resistance	3.15.2	4.16		
Mutual capacitance	3.15.3	4.17		
Dc resistance	3.17	4.19		

* There are no minor classification of electrical defects.

TABLE II. *Group B inspection*

Inspection	Requirement paragraph	Inspection paragraph	Sampling plan
Conductors	3.2	4.6	
Copper covered steel	3.2.2	4.6	6.5% for the group combined L-7 (normal and tightened) and L-4 (reduced).
Lead or lead alloy coating	3.2.3	4.6	
Brass coating	3.2.4	4.6	
Breaking strength	3.2.7	4.6.2	6.5% — L-7 (normal and tightened) and L-4 (reduced).
Wrapping	3.2.9	4.6	6.5% for the group combined L-7 (normal and tightened) and L-4 (reduced).
Kinking	3.2.10	4.6	
Bonding of copper in flexure	3.2.8	4.6	6.5% for the group combined L-7 (normal and tightened) and L-4 (reduced).
Bonding of copper in torsion	3.2.11	4.6	
Jacket longitudinal resistance	3.16	4.18	6.5% — L-7 (normal and tightened) and L-4 (reduced).
Insulation adhesion	3.9	4.10	6.5% — L-7 (normal and tightened) and L-4 (reduced).
Insulation and jacket adhesion	3.10	4.12	6.5% — L-7 (normal and tightened) and L-4 (reduced).
Compression of insulation	3.11	4.13	6.5% — L-7 (normal and tightened) and L-4 (reduced).
Before aging	3.11.1	4.13.1	
After 48 hour aging	3.11.2	4.13.2	
Low temperature	3.12	4.14	6.5% — L-7 (normal and tightened) and L-4 (reduced).

4.5.3 *Group C inspection.* This inspection shall be as listed in table III and shall normally be performed on sample units that have been subjected to and met group A and group B inspection.

TABLE III. *Group C inspection*

Inspection	Requirement paragraph	Inspection paragraph
Compression of insulation after 10 days aging	3.11.3	4.13.2
Ozone resistance	3.13	4.22

4.5.3.1 *Sampling.* Six specimens for each group C inspection shall be selected every 2 weeks, without regard to their quality.

4.5.3.2 *Noncompliance.* It a sample fails to pass group C inspection, the manufacturer shall take corrective action on the process and on all units of product which can be corrected and which were manufactured with the same conditions, materials, processes, etc., and are considered subject to the same test failure. Acceptance inspection shall be discontinued until corrective action has been taken. After the corrective action, sample units shall be subjected to the necessary group C inspection, (all inspections, or the failed inspectors) at the option of the Government. Group A and B inspections may be reinstated; however, final acceptance shall be withheld until the group C inspection has shown that the corrective action was successful.

4.6 **Conductors.** Specimens of the conductors taken from each sample unit shall be tested for compliance with 3.2.1 to 3.2.5 and 3.2.8 to 3.2.11, inclusive.

4.6.1 *Measurement of copper thickness.* Measurement of minimum copper thickness shall be made on both ends of the sample coils. Copper thickness shall be determined by one of the following methods:

(a) By the use of an approved electromagnetic instrument designed for inspecting copper thickness on diameters larger than 0.080 inches prior to drawing to final size.

(b) By cutting off the wire, grinding smooth, and etching its exposed cross section, and then gaging with suitable accurate apparatus. This is the only method available for determination of copper thickness in final size smaller than 0.080 inch diameter. It may be used for inspection of wire in process where more suitable equipment is not available.

4.6.1.1 *Electromagnetically.* This is the most dependable and practical method for the inspection of copper thickness where such equipment is available. A calibrated standard having a known minimum copper thickness shall be used. The copper thickness shall be measured during manufacture of the wire, prior to the final drawings operation. The copper thickness when so measured shall be as specified in 3.2.2. In this method a calibrated standard having a known minimum copper thickness shall be used. With this standard, the machine shall be adjusted, so that a reading, such as figure "50" shown on the dial of the instrument, indicates the minimum copper thickness which will be acceptable for this material. In the inspection procedure all material for which the meter reading is 50 or less shall be accepted and materials for which the reading is higher than 50 shall be rejected. Readings may be taken on both ends of a coil and where necessary, the ends of the coil cut back until a copper thickness is obtained conforming to the specification requirements. Due to the nature of the commodity, inspection of both ends shall be sufficient to determine the acceptance or rejection of the coil. This may be demonstrated to the inspector because the instrument allows readings to be made at any intermediate point in the coil.

4.6.1.2 *Microscopically.* This testing method requires polishing equipment, similar to that for preparing microscopic samples, and a toolmaker's microscope. The necessary equipment is available in most laboratories where various types of material are tested and inspected. The method however, requires considerable time in the preparing of specimens, and consequently, is only practical for use on a limited number of samples. It is used mainly for making check tests and to permit inspectors to satisfy themselves of the accuracy of inspection made by the electromagnetic method. This method will also permit the inspector to make an optional test to satisfy himself that, for wire which has been process inspected for copper thickness in a larger size and subsequently drawn to .040 inch diameter, the copper thickness shall conform to 3.2.2 and that further inspection for copper thickness shall not be necessary in these finished sizes.

4.6.1.3 All measurements shall be recorded to the nearest whole thousandth of an inch; for example, readings 0.0054 inch or 0.0046 inch shall be recorded as 0.005 inch.

4.6.2 *Breaking strength.* Specimens of the conductors taken from each sample unit shall be tested in accordance with method 3212 of Specification J-C-98 for compliance with 3.2.7.

4.7 Insulation and jacketing. Specimens of insulated and jacketed conductor taken from each sample unit shall be inspected for compliance with 3.3 to 3.7, inclusive.

4.8 Twisting. Specimens of the completed cable taken from each sample unit shall be tested for compliance with 3.8. The length of lay shall be measured on a specimen of the completed cable over a length between 4½ and 5 feet and shall be taken as the average length of lay in this distance.

4.9 Joints. The supplier's jointing process shall be verified for the requirements of 3.2.6. At the beginning of production, each operator making joints shall be qualified by successfully preparing six joints which shall be drawn down and examined for compliance with 3.2.6. Successful passage of the joint through the drawing process shall constitute compliance with the tensile strength requirement. The Government inspector shall have the right to examine joints taken from production for compliance with 3.2.6. When testing sample joints periodically requested by the Government inspector from the supplier, conductors shall be wrapped around their respective test mandrels for at least five turns at a rate of approximately one turn per second for at least five close turns to include the whole splice, and the conductor immediately adjacent to the splice.

4.10 Insulation adhesion. Specimens of the completed cable taken from each sample unit shall be inspected for compliance with 3.9. The specimens used in making this test shall have had the insulation and jacket removed from the conductor for several inches of its length and the 1-inch test length of insulation to be tested shall be at one end of the specimen. The stripped conductor shall be passed through a die having an aperture of not less than 0.040 nor more than 0.044 inch in diameter. The tension shall be applied to the conductor and to the die. The tensile force shall be applied through a spring having a constant of approximately 6 pounds per inch, moving away from the fixed end of the sample at a speed of approximately 6 inches per minute, or though an equivalent mechanical arrangement yielding an equal testing machine speed.

4.11 Air oven aging of insulation. Specimens of the single insulated conductor from which the jacket has been removed without injury to the insulation, shall be subjected to the air oven aging specified in method 4031 of Specification J-C-98 at a temperature of 212°F. for a period of 166±1 hour. The adhesion of insulation after aging shall conform to 3.9.

4.12 Insulation and jacket adhesion. Speci-

mens of the single insulated and jacketed conductors taken from each sample unit shall be tested for compliance with 3.10. The testing machine shall be equipped with parallel plate toggle-type jaws with effective corrugated faces two and one-half inches in length and at least one-half inch in width. The rate of separation of the jaws shall be approximately 4 inches per minute. The jaws shall be set from 9 to 12 inches apart prior to test. One end of a sample of finished single conductor shall be knotted and placed in one jaw. The second jaw shall be tightly clamped upon the sample in such a manner that the force will be applied directly in line with the conductor. The distance from the second jaw to the free end of the sample shall be 6 inches. Buckling of the jacket between the second jaw and the free end during test or slippage of the sheath or insulation from the conductor at the free end under load of less than the breaking load of the conductor shall constitute a failure. Slippage of the jaws over the sheath shall not constitute failure, but shall call for a retest.

4.13 **Compression.** Specimens of the completed insulated and jacketed single conductors taken from each sample unit shall be tested for compliance with 3.11 as follows:

4.13.1 *Before aging.* A length of completed single conductor shall be placed longitudinally between the parallel faces of two steel plates, the face of each plate being 2 inches in length. A load resulting from decreasing the separation of the steel plates at an approximately uniform rate shall be applied to the sample held between the plates until the insulation crushes. The speed of the compression testing machine shall be such that, when no sample is between the steel plates, the rate of approach of the plates will be approximately 1½ inches per minute. The crushing load shall be taken as that load which produces the initial abrupt reduction in the separation of the steel plates without a proportionate increase in load. The reduction in thickness of the insulating compound at the crushing load shall be sufficiently abrupt to indicate definitely the failure. The crushing load shall be determined at 75°F. or, alternatively, at a temperature between 50° and 100°F. and corrected to a temperature of 75°F. The temperature coefficient employed in correcting observed values to the reference temperature, shall be approved for the specific compounds employed.

4.13.2 *Accelerated aging.* Specimens of completed single conductor shall be subjected to an atmosphere of oxygen at a pressure of not less than 290 pounds per square inch and not more than 310 pounds per square inch and a temperature not less than 156°F. and not more than 160°F. The accelerated aging shall be continuous for the periods specified in 3.11.2 and 3.11.3.

4.14 **Low temperature.** Specimens of the completed insulated and jacketed conductors taken from each sample unit shall be tested for compliance with 3.12. The specimens shall be wrapped around their respective test mandrels for at least five turns at a rate of approximately one turn per second. Both the test mandrels and the specimens shall be maintained at —40 ±2°F. for at least 20 hours prior to and during the test. At the conclusion of the bending operation, there shall be no evidence of cracking of the insulation or jacket when the specimen is examined through a lens having a magnification of three diameters.

4.15 **Voltage.** The completed cable taken from each sample unit shall be tested in accordance with method 6111 of Specification J–C–98 under the conditions specified in 3.15 for compliance with 3.15.1. The source of potential shall be a generator or transformer capable of delivering at least five kva at normal load. The frequency of the alternating voltage shall be not less than 25 cycles per second.

4.16 **Insulation resistance.** The completed cable shall be tested in accordance with

method 6031 of Specification J-C-98 under the conditions specified in 3.16 for compliance with 3.15.2. The insulation resistance shall be measured using a galvanometer with a potential of not less than 100 volts dc. The insulation resistance shall be computed from the galvanometer deflection obtained after an electrification of 1 minute with the negative pole of the source of potential connected to the conductor. The insulation resistance may be measured prior to 1 minute if the galvanometer ceases fluctuating, its reading indicates that a steady or increasing resistance value has been obtained, and the insulating resistance is in excess of that specified in 3.15.2.

4.17 Mutual capacitance. The mutual capacitance of the completed cable shall be measured, using a capacitance bridge, under the conditions specified in 3.15, for compliance with 3.15.3.

4.18 Jacket longitudinal resistance. The jacket longitudinal resistance of the completed cable shall be measured with a megger, megohm bridge, or galvanometer, using a potential of not less than 100 volts dc, for compliance with 3.16. The jacket longitudinal resistance shall be measured between two electrodes, each consisting of a single circumferential loop of approximately 642 circular mil (No. 22 AWG) soft copper wire so placed around the jacket as to make intimate contact with the jacket surface.

4.19 Dc resistance. The dc resistance of the completed cable shall be measured in accordance with method 6021 of Specification J-C-98 for compliance with 3.17.

4.20 High voltage spark. The completed cable shall be spark tested in accordance with method 6211 of Specification J-C-98 for compliance with 3.14.

4.21 Insulation and jacket repairs. The Government shall ascertain compliance with 3.5 and 3.6.1 on repairs made on the cable in production. As an alternative to inspection during production, the Government shall ascertain compliance with 3.5 and 3.6.1 by inspection of sample repairs made on specimens of cable in the same manner as those repairs which will be made, or have been made in production. The Government reserves the right to inspect any repairs made in production.

4.22 Ozone resistance test.

4.22.1 *General procedure.* The test for ozone resistance shall be performed in accordance with the procedures prescribed in ASTM D1149 with the following exceptions. This test shall be carried out using a suitable chamber in which the ozone concentration can be controlled to within ±3 parts of ozone per hundred million parts of air and in which the temperature can be controlled to within ±2°F.

4.22.2 The ozone concentration used in this test shall be 50±3 parts of ozone per 100,000,000 parts of air.

4.22.3 The temperature of the chamber shall be 100 ±2°F.

4.22.4 *Test specimens.*

4.22.4.1 *Preparation.* Test specimens shall be prepared by one of the following methods. Not less than three specimens from the jacket shall be tested.

(a) The specimens shall be formed by slitting the jacket lengthwise and after removal from the wire, the specimens shall be mounted in accordance with the requirements of ASTM D518, method B except that the length of the clamping strips shall be such as to facilitate placement within the test chamber and elongated to give an elongation of 20 percent for exposure in the chamber.

(b) A length of the completed wire shall be wrapped around a man-

drel four times the diameter of the wire and exposed thus in the chamber.

4.22.4.2 *Conditioning of specimens.* The specimens shall be aged at room temperature in a closed cabinet for 24 hours before exposure in the testing chamber.

4.22.4.3 *Exposure.* The specimens shall be exposed for 7 days to the ozone concentration and the temperature specified in 4.22.2 and 4.22.3, respectively.

4.22.5 *Results.* At the end of the exposure time and while still elongated, the jacket shall be examined for compliance with 3.13.

4.23 **Coils and odd lengths.** Cable furnished in coils shall be inspected for compliance with 3.18 and 3.18.1.

4.24 **Acceptance inspection of preparation for delivery.** Shipments shall be inspected to insure compliance with section 5 requirements.

5. PREPARATION FOR DELIVERY

5.1 **Preservation and packaging.**

5.1.1 *Level A.* Telephone cable coiled as specified in the section 3 requirements, shall be securely tied or taped to prevent unwinding.

5.1.2 *Level C.* Cable, Telephone WD–33/U shall be preserved and packaged in accordance with the suppliers standard practice.

5.2 **Packing.**

5.2.1 *Level A.* Cable, Telephone WD–33/U shall be packed as follows: Place 4 coils of cable within a style 2 or style 3 wirebound box, designed for class 3 use, conforming to Specification PPP–B–585.

5.2.1.1 *Metal strapping.* Shipping containers shall be strapped with flat steel strapping in conformance with the requirements of the appendix of the container specification.

5.2.2 *Level B.* Cable, Telephone (WD–33/U) shall be packed in accordance with the procedures specified in 5.2.1.

5.2.3 *Level C.* Cable, Telephone WD–33/U shall be packed or prepared for shipment in a manner which will insure arrival at destination in satisfactory condition and which will be acceptable to the carriers at lowest rates.

5.3 **Marking.** Interior packages and exterior shipping containers shall be marked in accordance with the applicable provisions of Standard MIL–STD–129.

6. NOTES

6.1 **Intended use.** Cable, Telephone WD–33/U is intended for use in bridling open wire lines, ring wiring on buildings, and block distribution.

6.2 **Ordering data.** Procurement documents should specify the following:

(a) Title, number, and date of this specification and any amendment thereto.

(b) Level of packaging and level of packing required for shipment (level A, level B, or level C).

(c) The specific paragraphs of section 5 which are applicable to the particular procurement.

(d) Place of final inspection.

6.3 **Verification inspection.** Verification by the Government will be limited to the amount deemed necessary to determine compliance with the contract and will be limited in severity to the definitive quality assurance provisions established in this specification and the contract. The amount of verification inspection by the Government will be adjusted to make maximum utilization of the

contractor's quality control system and the quality history of the product, and will normally be identified by the categories listed below:

(a) Type A—The total of that inspection set forth in the Quality Assurance Provisions of this specification or the contract. Included in this category is that amount of inspection referred to as normal and tightened inspection by Military Standard 105.

(b) Type B—That inspection set forth in the Quality Assurance Provisions of this specification or the contract reduced in amount under the reduced inspection provisions of Military Standard MIL-STD-105.

(c) Type C—A reduced inspection procedure resulting in a material reduction in the amount of inspection set forth in the Quality Assurance Provisions of this specification. The amount of inspection is less than that provided for in type B and is based upon a consistently acceptable product resulting from a planned quality control system voluntarily employed by the contractor in the production of the product.

6.4 Group C inspection. Approval to ship may be withheld, at the discretion of the Government, pending the decision from the contracting officer on the adequacy of corrective action (see 4.5.3.2).

6.5 Definitions. The inspection terms used herein conform to Standard MIL-STD-109, and are as follows:

6.5.1 *Unit of product.* A unit of product is defined as a continuous length of bare conductor or a coil of finished wire.

6.5.2 *Specimen.* A speciment is an individual piece of finished wire or any part removed from the finished wire such as conductors, insulation, insulated conductors, cotton cover, and jacket, which is taken from a sample unit and subjected to inspection.

6.5.3 *Finished wire.* Finished wire is wire on which all manufacturing operations have been completed and which is ready to be submitted for inspection.

6.6 Acceptance sunproofing waxes. Acceptable sunproofing waxes are "Heliozone" as made by the E. I. Dupont de Nemours and Co., Inc., Wilmington, Del.; "Sunproof, Improved Sunproof, Sunproof No. 713 and No. 718" was made by the Naugatuck Chemical Division of the U. S. Rubber Co., Naugatuck, Conn.; "Sunolite" as made by the Witco Chemical Co., 295 Madison Ave., New York 17, N.Y.; "Antisun Wax and Antisun XX Wax" as made by the Cary Chemicals Co. Inc., New Brunswick, N.J.; "Sunoco Anti-Check" as made by the Sun Oil Co., 1606 Walnut Street, Philadelphia 3, Pa.; "Sunproofing Wax Type AA-1177" as made by the Allied Asphalt and Mineral Corp., 217 Broadway, New York 17, N.Y.; "Sunproofing Wax #1343 and #1344" as made by Frank B. Ross Co. Inc., 6-10 Ash Street, Jersey City, N.J.; and "Microflake Wax" as made by the Genseke Brothers, West 48th Place and Whipple Street, Chicago, Ill.; or equal. Information pertaining to approval of additional sources for sunproofing waxes and any changes or deletions in the above sources should be obtained from the U. S. Army Signal Material Support Agency, For Monmouth, N. J.

6.7 Information on antiozonants. Experience has shown that jacket compounds containing 3 parts of an acceptable antiozonant such as (N'N' Di-3) (5-methylkeptyl) p-phenlene diamine and proper quantities of wax on 100 parts of the rubber have passed the test satisfactorily. This information is not a requirement of this specification.

6.8 Information on adhesives. An adhesive such as "Typly," as made by the Marbon

Chemical Division of the Borg Warner Corporation, Gary, Ind., or equal may be used for bonding of insulation to the conductor (see 3.2.4).

Notice. When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder, or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

Custodians:
Army—Signal Corps
Navy—Bureau of Yards and Docks
Air Force—Rome Air Materiel Area

Preparing activity:
Army—Signal Corps