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# JOHN F. KENNEDY SPACE CENTER, NASA

# CABLE, ELECTRICAL, SHIELDED, JACKETED

# FOR HARNESS ASSEMBLIES

# GENERAL SPECIFICATION FOR

DESIGN ENGINEERING DIRECTORATE

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# CABLE, ELECTRICAL, SHIELDED, JACKETED FOR HARNESS ASSEMBLIES

## GENERAL SPECIFICATION FOR

## 1. SCOPE

1.1 General. This specification covers the requirements for flexible electrical cables of the following construction:

| | |
|---|---|
| Conductors | Stranded, tin-coated copper |
| Finished Wire | Polyethylene insulated, w/polyamide covering |
| Cabling | 1 to 6 conductors, twisted |
| Shielding | Braided overall shield |
| Jacket | Polyvinyl chloride |
| Voltage Rating | 600 volts RMS |
| Temperature Rating | 75°C maximum continuous |

1.2 Application. Cables covered by this specification are intended for use in fabricating cable harness assemblies, but are suitable for general use in medium-duty applications (see 6.1).

1.3 Detail Requirements. Detail requirements for specific types of cables are contained in individual detail specification sheets. Detail specification sheets are identified by this general specification number followed by a virgule and arabic numeral. Detail specification sheets are listed in Supplement 1 to this specification.

1.4 Classification. Cables covered by this specification are classified by Type and Part Number.

1.4.1 Cable Type. Type classification is established by the number of conductors in the cable. Type designations for cables covered by this specification are as follows:

| CABLE TYPE | NUMBER OF CONDUCTORS |
|---|---|
| SSI | 1 |
| PTSI | 2 |
| TTSI | 3 |
| QTSI | 4 |
| 5TSI | 5 |
| 6TSI | 6 |

1.4.2 Cable Part Number. The cable part number shall consist of the cable type designator suffixed with the AWG size of the conductors.

Example: TTSI #16 (3 #16AWG conductors, twisted, with overall shield and jacket)

## 2. APPLICABLE DOCUMENTS

2.1 Government Publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on the date of issue of invitation for bids or request for proposals shall apply.

SPECIFICATIONS

Federal

| | |
|---|---|
| L-P-390 | Plastic, Molding Material, Polyethylene, Low and Medium Density |
| QQ-S-571 | Solder; Tin-Alloy, Lead-Tin Alloy, and Lead Alloy |

Military

| | |
|---|---|
| MIL-C-12000 | Cable, Cord, and Wire, Electric Packaging of |
| MIL-P-20693 | Molding Plastic, Polyamide, Rigid |

STANDARDS

Federal

| | |
|---|---|
| FED-STD-228 | Cable and Wire, Insulated, Methods of Sampling and Testing |

Military

| | |
|---|---|
| MIL-STD-129 | Marking for Shipment and Storage |

PUBLICATIONS

National Aeronautics and Space Administration (NASA)

| | |
|---|---|
| NPC 200-3 | Inspection System Provisions for Suppliers of Space Materials, Parts, Components or Services |

(Copies of specifications, standards, and publications 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 indicated, the issue in effect on the date of issue of invitation for bids or request for proposals shall apply.

American Society for Testing and Materials (ASTM)

| | |
|---|---|
| ASTM B 33 | Standard Specification for Tinned Soft and Annealed Copper Wire for Electrical Purposes |
| ASTM B 193 | Standard Method for Test of Resistivity of Electrical Conductor Materials |
| ASTM D 374 | Methods of Test for Thickness of Solid Electrical Insulation (Tentative) |
| ASTM D 470 | Methods of Testing Rubber and Thermoplastic Insulated Wire and Cable (Tentative) |
| ASTM D 2220 | Specification for Vinyl Chloride Plastic Insulation for Wire and Cable, 75°C Operation (Tentative) |

(Copies of ASTM publications may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103).

## 3. REQUIREMENTS

3.1 Product Requirements. All cable furnished under this specification shall conform to all requirements specified herein and in the detail specification sheets.

3.2 Test and Inspection Requirements. Unless specifically waived by the procuring activity, all quality assurance and acceptance tests and inspections specified in 4.4 and 4.5 shall be performed on all cable furnished under this specification. Preproduction tests need not be performed unless specified by the procuring activity.

3.3 Materials. The materials to be used in manufacturing cables to this specification shall be as specified in 3.3.1 through 3.3.4.

3.3.1 Copper Strands. Copper strands comprising the conductors and braided shields shall be tinned, soft-annealed, commercially-pure copper conforming to the requirements of ASTM B 33.

3.3.2 Polyethylene. Polyethylene conforming to the requirements for Type II, grade 7 or 7a of L-P-390 shall be used as the conductor primary insulation material.

3.3.3 Polyamide. Polyamide conforming to Type III, grade E of MIL-P-20693 shall be used for insulation covering material.

3.3.4 Polyvinyl Chloride. Polyvinyl chloride conforming to the requirements of ASTM D 2220 shall be used for jacket material.

3.4 Construction. Construction of the cable shall be as specified herein and in the detail specification sheets.

3.4.1 Conductors. Conductors shall be formed by stranding tinned copper wire having a uniformly circular cross section. Finished conductor sizes are specified in the detail specification sheets by the AWG size approximating the finished conductor diameter.

3.4.1.1 Number of Strands. Each conductor size shall contain the number of individual strands specified in Table I.

3.4.1.2 Strand Size. The strands comprising each conductor size shall have the diameters specified in Table I.

3.4.1.3 Stranding and Length of Lay. Conductors shall be formed by concentric lay stranding. It is optional for the direction of lay for the successive layers to be alternately reversed (true concentric lay) or to be in the same direction (unidirectional lay). The strands shall be uniformly laid so as to produce a geometrically arranged conductor, circular in cross section and free of any crossovers, high strands, or other irregularities. The direction of lay of the individual strands in the outer layer of the conductor shall be left hand. The length of lay of the strands in each layer shall be 8 to 16 times the diameter of that layer.

3.4.1.4 Splices. In no case shall the whole conductor be spliced at one point. Splices in individual strands shall be butt-brazed. There shall not be more than one strand-

splice in any 10-foot length of conductor. Strand splices shall be distributed throughout the conductor in such a manner that the physical and electrical properties of the conductor will not be adversely affected.

3.4.2 Conductor Insulation. Polyethylene insulation material shall be extruded concentrically over each conductor in a continuous layer, and so cured, processed, and maintained as to provide accurate centering of the conductor and retention of a circular cross-section. The insulation shall form a close fit over the conductor without adhering to the conductor or to the insulation of other conductors when fabricated into a cable. When stripped, the insulation shall leave the conductor clean and in condition for soldering.

3.4.2.1 Insulation Wall Thickness. The average insulation wall thickness shall be as specified in Table I. The minimum thickness shall be not less than 90 percent of the specified average thickness.

3.4.3 Insulation Covering. Each insulated conductor shall have an insulation covering concentrically applied over the primary insulation. The insulation covering material shall be extruded, clear, heat-stabilized polyamide with a wall thickness of 0.002 inch.

3.4.4 Cabling. The requisite number of insulated conductors, of the size and quantity specified in the detail specification sheets, shall be cabled together with a unidirectional lay.

3.4.4.1 Direction and Length of Lay. The direction of lay of multiple conductors may be either right hand or left hand. The length of lay shall be 8 to 16 times the outside diameter of the multiple.

3.4.5 Overall Cable Shield. A tight-fitting, closely-woven braid of tinned copper strands shall be applied directly over the cabled conductors. Strand sizes and shield angles shall be as specified in Table III. The braid shall be applied so as to provide an 85 percent minimum coverage over the cabled conductors. The braided strands shall be applied so as to preclude kinks, breaks, abrasions, or other irregularities in the shield strands.

3.4.6 Jacket. A single layer of white polyvinyl chloride shall be extruded over the shielded cable to form a well-centered jacket. The average jacket thickness shall be as specified in the detail specification sheets. Minimum thickness of the jacket at any point shall be not less than 90 percent of the specified average thickness. After extruding, the jacket shall not adher to the underlying shield.

3.5 Performance and Product Characteristics. Finished cables, and all components thereof, shall conform to the requirements specified in 3.5.1 through 3.5.3.

3.5.1 Conductors. Finish conductors shall meet all of the requirements specified in 3.5.1.1 through 3.5.1.3.

3.5.1.1 Elongation. When tested as specified in 4.8.2.1.1, the individual copper strands of the conductors shall meet the elongation requirements specified in Table I in ASTM B 33.

3.5.1.2 Tin Coating (Individual Strands). When tested as specified in 4.8.2.1.2, cracking or parting of the tin coating on the strands, indicated by blackening of the copper, shall be cause for rejection. Blackening within 0.5 inch of the cut end will be permissible.

3.5.1.3 Conductor Resistance. When measured as specified in 4.8.3.3.5, the direct current resistance per 1,000 feet of conductor, at 20 degrees C, shall not exceed the values specified in Table I.

3.5.2 Conductor Insulation. Conductor insulation on finished conductors shall meet all of the requirements specified in 3.5.2.1 through 3.5.2.9.

3.5.2.1 Tensile Strength and Ultimate Elongation. When tested as specified in 4.8.2.2.1, the tensile strength and elongation at rupture shall be as specified in 3.5.2.1.1 and 3.5.2.1.2.

3.5.2.1.1 Initial Requirement. Before accelerated aging, the tensile strength and elongation at rupture shall conform to the "ORIGINAL REQUIREMENT" specified in Table II.

3.5.2.1.2 Aging Requirement. After accelerated aging as specified in 4.8.2.2.1.3, the tensile strength and elongation at rupture shall conform to the "AGING REQUIREMENT" specified in Table II.

3.5.2.2 Polyamide Covering. When tested as specified in 4.8.2.2.2, the specimen shall be free from any tears or cracks when examined under 5-power magnification. Wrinkles shall not be cause for rejection.

3.5.2.3 Shrinkage. When tested as specified in 4.8.2.2.3, the shrinkback of insulation from either end of the conductor shall not exceed 1/16 inch.

3.5.2.4 Free Stripping. When tested as specified in 4.8.2.2.4, all insulation shall be easily removable without adhering to the conductor. The solder shall flow freely and shall produce an evenly-tinned surface.

3.5.2.5 Water Absorption. The increase in specific inductive capacity of the insulation material shall not exceed 3 percent when tested in accordance with 4.8.2.2.5. Total capacitance of insulated conductors size 18 AWG and smaller shall not exceed 110 picofarads (pf) per foot at completion of the 7-day test.

3.5.2.6 Cold Bend. When tested as specified in 4.8.3.1, the conductor insulation shall exhibit no electrical breakdown and shall show no visible signs of cracking or other damage when examined under 3-power magnification.

3.5.2.7 Insulation Flaws. When subjected to the electrode spark test specified in 4.8.2.2.6, the conductor insulation shall exhibit no electrical breakdown. If insulation breakdown occurs at any point, the conductor insulation shall not be repaired, but the section of conductor containing the failure point shall be cut out and removed from production.

3.5.2.8 Insulation Dielectric Strength. When tested as specified in 4.8.3.3.2, conductor insulation shall exhibit no electrical breakdown.

3.5.2.9 Insulation Resistance. When tested as specified in 4.8.3.3.3, the insulation resistance of all conductors shall equal or exceed the values specified in Table IV.

3.5.3 Jacket. Polyvinyl chloride jackets on finished cable shall meet all of the requirements specified in 3.5.3.1 through 3.5.3.3.

3.5.3.1 Tensile Strength and Ultimate Elongation. When tested as specified in 4.8.2.3.1, the tensile strength and elongation at rupture shall be as specified in 3.5.3.1.1 through 3.5.3.1.3.

3.5.3.1.1 Initial Requirement. Before accelerated aging and oil immersion, the tensile strength and elongation at rupture shall conform to the "ORIGINAL REQUIREMENT" specified in Table II.

3.5.3.1.2 Aging Requirement. After accelerated aging as specified in 4.8.2.3.1.3, the tensile strength and elongation at rupture shall conform to the "AGING REQUIREMENT" specified in Table II.

3.5.3.1.3 Oil Resistance Requirement. After immersion in oil as specified in 4.8.2.3.1.4, the tension strength and elongation at rupture shall be not less than 85 percent of the "ORIGINAL REQUIREMENT" specified in Table II.

3.5.3.2 Jacket Flaws. When subjected to the jacket flaws test specified in 4.8.3.3.1, the jacket shall exhibit no electrical breakdown. If jacket breakdown occurs at any point, the jacket shall not be repaired, but the section of cable containing the failure point shall be cut out and removed from production.

3.5.3.3 Jacket Resistance. When measured as specified in 4.8.3.3.4, the jacket resistance in megohms for 1,000 feet of cable shall be not less than the value specified in the applicable detail specification sheets.

3.6. Dimensions. Dimensions of the finished cable shall be as specified in the detail specification sheets.

3.7 Cable Marking. The finished cable shall be identified by a printed marking applied to the outer surface of the jacket.

3.7.1 Cable Identification. The cable identification marking applied to the outer surface of the jacket shall consist of the following:

a. Detail specification number.

b. Cable part number (see 1.4).

c. Manufacturer's name or code and the year manufactured.

3.7.2 Method of Marking. Either ink or hot stamp marking shall be employed. Hot stamping, if used, shall be performed prior to subjecting the cable to the jacket flaws and insulation resistance tests. Ink used for identification shall be of the best quality normally used in good commercial practice. Marking shall be repeated at intervals of not more than 24 inches and may be continuous.

3.7.3 Marking Durability. The marking on the jacket shall be capable of withstanding 100 cycles (200 strokes) of abrasive action when tested as specified in 4.8.3.2. All letters and numerals within the tested area shall be legible at completion of the test.

3.8 Workmanship. Workmanship shall be such that the completed cable is capable of meeting all requirements of this specification, the detail specification sheets, and any referenced subsidiary specification or other document when subjected to the inspections and tests specified in Section 4.

## 4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection. The supplier is responsible for the performance of all inspection requirements specified herein. The procuring activity, or its designated representative, reserves the right to perform any or all of the inspections set forth in this specification to assure that the end item conforms to all specified requirements.

4.2 Lot. A lot shall consist of all cable of any one design produced under substantially the same conditions and offered for acceptance inspection at any one time. One lot shall not be greater than one month's production or 10,000 feet, whichever is smaller.

4.3 Samples. Samples furnished for preproduction, quality assurance, and acceptance tests and inspections shall be finished cable in accordance with 4.3.1 through 4.3.3.

4.3.1 Preproduction Test Sample. The preproduction test sample, when required, shall consist of one 100-foot length of cable representative of the identical material and manufacturing processes to be used in production of cables covered by this specification.

4.3.2 Quality Assurance Test Sample. The quality assurance test sample shall be selected at random from each production lot submitted for acceptance. The number and length of quality assurance test samples to be submitted shall be as required to perform all quality assurance tests and inspections specified herein.

4.3.3 Acceptance Test Sample. Unless otherwise specified by the procuring activity, acceptance tests shall be performed on all cable submitted for acceptance. One 5-foot sample from each production lot of cable shall be submitted for the visual and dimensional examinations. When specified in the contract, additional samples, of the number and length specified in the contract, shall be furnished to the procuring activity.

4.4 Visual and Mechanical Inspection Requirements. Cable shall be examined to determine conformance to 3.4. 3.6, 3.7, and 3.8. The examinations specified in Table VI shall be performed. After testing, packaging, packing and marking shall be examined to determine conformance to the requirements of Section 5.

4.5 Testing Requirements. Tests shall be performed as specified in 4.5.1 through 4.5.3. Test methods shall be as specified in 4.8. All cable submitted for testing shall have passed the visual and mechanical inspections specified in 4.4.

4.5.1 Preproduction Tests. Preproduction tests, when required, shall consist of all the tests and inspections specified in Table VII. The preproduction test sample shall meet all requirements specified herein. Preproduction examinations and tests shall be performed by the contractor under government surveillance, or as directed by the procuring activity, at the installation designated in the contract. Cables subjected to these tests shall be considered unserviceable but may be retained for examination by the procuring activity.

4.5.1.1 Preproduction Test Rejection. If the preproduction sample fails to meet the requirements of any test or inspection specified herein, the preproduction sample shall be rejected. Before a new preproduction sample is submitted, a detailed report shall be forwarded to the procuring activity covering the rejection and the action taken to prevent recurrence of the defect causing failure. A reworked preproduction sample shall not be submitted. Production lots will not be considered for acceptance until the preproduction sample has been approved.

4.5.2 Quality Assurance Tests. Unless otherwise specified in the contract, quality assurance tests and inspections shall be performed on samples from each production lot. The quality assurance tests shall consist of all of the tests and inspections specified in Table VII. Cable subjected to the quality assurance tests shall be considered unserviceable but may be retained for examination by the procuring activity.

4.5.2.1 Quality Assurance Test Rejection. If a quality assurance sample fails any of the tests or inspections specified herein, the entire lot represented by the sample shall be rejected. Before the rejected lot, or any subsequent lot of the same design, can be resubmitted for acceptance, a detailed report shall be forwarded to the procuring activity covering the rejection, the action taken to prevent recurrence of the defect causing failure, and the proposed corrective action on the lot represented by the rejected sample. The nature of the defect causing failure and the corrective action taken will be the basis for permitting resubmittal. Any reworked lot must be accompanied by a detailed report covering the previous rejection and corrective action taken.

4.5.3 Acceptance Tests. Acceptance tests and inspections shall consist of all of the examinations and tests specified in Table VI and Table VIII. Acceptance tests and inspections shall be performed on all cable in each lot. The electrode spark test shall be performed on all finished conductors prior to cabling. One sample from each lot of cable shall be inspected for visual and dimensional requirements.

4.5.3.1 Acceptance Test Rejection. Any cable that fails any acceptance test or inspection shall be rejected. Rejected cable may be resubmitted at the discretion of the procuring activity, after corrective action has been taken. The number and type of defects shall be the basis for permitting resubmittal. Any reworked cable shall be accompanied by a detailed report concerning the previous rejection and corrective action taken. After rework, all previously rejected cable shall be subjected to all acceptance tests and inspections specified herein.

4.6 Test Reports and Certification. Certification and reports of tests and inspections performed in accordance with the requirements of this specification shall be furnished to the procuring activity as specified in 4.6.1 and 4.6.2. Certifications and test reports shall be validated by the cognizant government inspector. When such certifications or reports are required, no cable shall be accepted for delivery by the procuring activity prior to receipt of the certification or reports.

4.6.1 Component Materials Certification. The supplier shall certify to the procuring activity that the component materials listed in Table V, used in the manufacture of cables furnished under this specification, are in accordance with the applicable referenced specifications and requirements. When requested, reports of tests verifying conformance with the applicable referenced specifications and requirements shall be furnished to the procuring activity.

4.6.2 Test and Inspection Certification. The supplier shall certify to the procuring activity that all test and inspection requirements specified herein have been complied with, and that all cable furnished conforms to all requirements specified herein. When requested, reports of tests and inspections shall be furnished to the procuring activity.

4.7 Reinspection. The procuring activity reserves the right to reinspect and retest the cable for any necessary requirement after delivery, and before final acceptance. Any or all of the inspections and tests specified herein may be performed to determine conformance to prescribed requirements. Final acceptance shall depend upon evaluation of test results.

4.8 Test Methods and Conditions. All tests shall be performed in accordance with the methods and under the conditions specified in 4.8.1 through 4.8.3.

4.8.1 Test Conditions. Unless otherwise specified, tests shall be performed at temperatures of 20 to 28 degrees C and a relative humidity of 70 percent maximum.

4.8.2 Cable Component Tests. Unless otherwise specified, all tests specified herein shall be performed on cable components which have been removed from finished cables.

4.8.2.1 Conductor Tests. Cable conductors shall be tested as specified in 4.8.2.1.1 through 4.8.2.1.3.

4.8.2.1.1 Elongation. Elongation of the copper conductor strands shall be measured in accordance with ASTM B 33. Seven strands taken from any one conductor of the sample shall be tested to determine conformance to 3.5.1.1. If the results of the elongation tests on the strands are found to be below the specified value, the remainder of the strands in the conductor shall be tested. The average of all the strands tested shall determine acceptance or rejection of the lot.

4.8.2.1.2 Coating Test. Tests for continuity and adherence of tin coating on strands shall be in accordance with ASTM B 33. A minimum of eight specimens from the sample shall be tested to determine conformance to 3.5.1.2.

4.8.2.2 Conductor Insulation Tests. Conductor insulation shall be tested as specified in 4.8.2.2.1 through 4.8.2.2.6.

4.8.2.2.1 Tensile Strength and Ultimate Elongation Tests. Tensile strength and ultimate elongation of conductor insulation shall be measured before and after accelerated aging by the methods specified in 4.8.2.2.1.1 and 4.8.2.2.1.2 to determine conformance to 3.5.2.1.

4.8.2.2.1.1 Tensile Strength. The tensile strength tests shall be made in accordance with Method 3021 of FED-STD-228.

4.8.2.2.1.2 Ultimate Elongation. The ultimate elongation tests shall be made in accordance with Method 3031 of FED-STD-228.

4.8.2.2.1.3 Accelerated Aging. Accelerated aging shall be in accordance with ASTM D 470. Specimens of polyethylene shall be oven-aged for 48 hours at a temperature of 100 ± 1 degrees C.

4.8.2.2.2 Polyamide Insulation Covering Test. A specimen of finished conductor of sufficient length shall be wrapped for 2½ turns around a metal mandrel of a diameter which is six times the outside diameter of the specimen, and secured in this position by tape or other means to prevent unwrapping during tests. The specimen and the mandrel shall be placed in a gravity convection type oven at a temperature of 94 ± 5 degrees C for a period of 24 ± 1 hours. Remove specimen and mandrel from oven and cool to room temperature in a silica gel desiccator, or equivalent. Remove from desiccator and straighten specimen. Examine specimen under 5-power magnification to determine compliance to 3.5.2.2.

4.8.2.2.3 Insulation Shrinkage Test. An 8-inch specimen shall be cut from a finished conductor, and the polyamide covering removed. The specimen shall then be cut to 6 inches, leaving the conductor flush with the insulation on each end. The specimen shall be heated in a forced convection air oven at 99 ± 1 degrees C for 24 ± 1 hours. The specimen shall be removed and allowed to cool to room temperature. Insulation shrinkback from conductor ends shall be measured to determine conformance to 3.5.2.3.

4.8.2.2.4 Insulation Stripping Test. Three specimens, 6 inches in length, shall be cut from a finished conductor. A ½-inch length of insulation shall be stripped from one end of each specimen. The stripped end of each specimen shall be dipped in a solder pot containing SN-60 solder without flux, conforming to QQ-S-571, at a temperature of 320 degrees C for 5 seconds. Examine to determine conformance to 3.5.2.4.

4.8.2.2.5 Water Absorption Test. The increase in specific inductive capacity of the insulation material due to water absorption shall be measured in accordance with ASTM D 470, "Accelerated Water Absorption Test - EM1000." The insulation covering shall not be removed from the test specimen. The test shall be performed with a water bath temperature of 50 ± 1 degrees C for a duration of 7 days. Determine conformance with 3.5.2.5.

4.8.2.2.6 Electrode Spark Test. After extrusion of the polyethylene insulation material, and before covering the insulation with polyamide, each length of finished conductor to be used in cable manufacture shall pass through an electrode spark device that will subject 100 percent of the insulation surface to the test voltage specified in Table IV. Method 6211 of FED-STD-228 shall be used in conducting this test. Speed of travel through the device shall be adjusted so that every point on the insulation surface shall be in contact with the electrode for not less than 0.25 second. Determine conformance with 3.5.2.7.

4.8.2.3 Jacket Tests. The polyvinyl chloride cable jacket shall be tested as specified in 4.8.2.3.1.

4.8.2.3.1 Tensile Strength and Ultimate Elongation Tests. Tensile strength and ultimate elongation of cable jacket material shall be measured before and after accelerated aging and oil immersion by the methods specified in 4.8.2.3.1.1 and 4.8.2.3.1.2 to determine conformance to 3.5.3.1.

4.8.2.3.1.1 Tensile Strength. The tensile strength tests shall be made in accordance with Method 3021 of FED-STD-228.

4.8.2.3.1.2 Ultimate Elongation. The ultimate elongation tests shall be made in accordance with Method 3031 of FED-STD-228.

4.8.2.3.1.3 Accelerated Aging. Accelerated aging shall be in accordance with ASTM D 470 and ASTM D 2220.

4.8.2.3.1.4 Oil Immersion. The oil immersion procedure shall be in accordance with ASTM D 2220.

4.8.3 Finished Cable Tests. Finished cables shall be tested as specified in 4.8.3.1 through 4.8.3.3.

4.8.3.1 Cold Bend Test. Two specimens of cable shall be subjected to cold bend testing at a temperature of minus 30 ± 1 degrees C. The specimens shall be placed in the cold chamber in an unflexed position and maintained at the required temperature for a minimum of 4 hours. While at that temperature, each specimen shall be bent around a mandrel at a rate of two turns per minute for one complete turn. The mandrel diameter shall be not greater than 8 times the outside diameter of the finished cable. The insulated conductors shall then be removed from the sheath, examined under 3-power magnification, and tested by application of the inspection test voltage specified in Table IV for one minute while submerged in water to determine conformance with 3.5.2.6.

4.8.3.2 Marking Durability Test. A short specimen of finished cable shall be firmly clamped in a horizontal position with the surface area containing the marking freely exposed. A small steel mandrel (.025±001 inch diameter) shall be repeatedly rubbed over the surface at the marking so that the longitudinal axis of the mandrel and specimen will be at right angles to each other. A weight shall be affixed to the jig holding the rubbing mandrel so that the combined jig and weight exerts a 500-gram thrust normal to the surface. A motor-driven reciprocating cam mechanism and counter shall be used to permit an accurately measured number of abrasion strokes. The length of the stroke in one direction shall be 3/8 inch and the frequency of the stroke shall be 120 strokes per minute (each stroke consisting of a 180-degree rotation of the eccentric drive mechanism). Direction of motion shall be along the axis of the cable and perpendicular to the axis of the mandrel. Determine conformance to 3.7.3.

4.8.3.3 Electrical Tests (Completed Cable). Unless otherwise specified in the contract, every length of cable in every lot shall be subjected to the electrical tests specified in 4.8.3.3.1 through 4.8.3.3.5. The tests shall be performed on the completed cable in the sequence listed herein.

4.8.3.3.1 Jacket Flaws. The finished cable shall pass through a spark test device that will subject 100 percent of the jacket surface to the test voltage specified in the individual cable specification sheets applied between the jacket and the cable shield. The speed of travel through the device shall be adjusted so that every point on the jacket surface shall be in contact with the test voltage for not less than 0.20 second. Determine conformance with 3.5.3.2.

4.8.3.3.2 Dielectric Strength. Voltage shall be applied between adjacent conductors and between conductors and shield for a period of not less than 30 seconds on each completed length of cable. Conductors may be tested singly against all other conductors or arranged in two or more groups, provided that full voltage is impressed between adjacent conductors and each conductor and the shield. The test voltage shall be attained by raising the inspection test voltage from zero to the value specified in Table IV within 20 seconds. Determine conformance with 3.5.2.8.

4.8.3.3.3 Insulation Resistance. Each conductor of every length of finished cable shall be tested for insulation resistance in accordance with ASTM D 470. The test potential shall be 500 volts dc minimum. Temperature correction factors shall be applied as applicable. Determine conformance to 3.5.2.9.

4.8.3.3.4 Jacket Resistance. Jacket resistance shall be measured by immersing each completed length of cable in a conductive container of water and measuring the resistance between the overall shield of the cable and the conductive container. The water temperature shall be maintained at 20±1°C for the duration of the test. The cable shall be completely immersed in the water, except for approximately one foot at each end. The cable shall be suspended in the bath as near to the center of the container as possible. The cable jacket shall not be in contact with the container. Tests shall be performed with a megohmmeter with an output voltage of 500 volts dc minimum capable of resistance measurements between 0.5 and 10,000 megohms or greater with a measurement accuracy of 5 percent or better. The instrument shall provide for the use of guard rings for cancellation of surface leakage currents. The two ends of the overall shield shall be connected together and the test voltage applied between the shield ends and the container. Resistance measurements shall be made after an electrification period of one minute. Determine conformance to 3.5.3.3.

4.8.3.3.5 Conductor Resistance Tests. Conductor resistance shall be measured in accordance with ASTM B 193, except that the measurements shall be made with an accuracy of 0.1 percent. To determine the added length of conductor due to cabling, conductors shall be removed from a 5-foot length of cable. The straightened length of the conductors shall be measured, and the ratio of straightened length of conductor to original length of cable shall be computed. Every conductor in every cable shall be tested to determine conformance to 3.5.1.3.

## 5. PREPARATION FOR DELIVERY

5.1 Packaging, Packing, and Marking. Packaging, packing, and marking shall be in accordance with MIL-C-12000, and as specified herein.

5.1.1 Packaging. Packaging shall be in accordance with the Level A requirements of MIL-C-12000 and as follows:

5.1.1.1 Reels and Spools. Cable shall be delivered on non-returnable reels or spools. The cable shall be wound on the reel or spool in a manner such that both ends are accessible for testing.

5.1.1.2 Cable Lengths. Cable cutting lengths shall be as specified in the contract. Each individual continuous length of cable shall be packaged on a separate reel or spool.

5.1.2 Packing. Unless otherwise specified in the contract, packing shall be in accordance with the Level C requirements of MIL-C-12000.

5.1.3 Marking. Cable reels or spools and exterior shipping containers shall be marked in accordance with MIL-C-12000 and MIL-STD-129. The identification shall include the following information:

Cable Part Number

Specification KSC-SPEC-E-0024/x

Length ( ) feet

Date of Manufacture

Name of Manufacturer

6. NOTES

6.1 Intended Use. Cables covered by this specification are suitable for use in wet or dry locations in applications where they will not be subjected to severe mechanical abuse. The cables are designed to operate with a maximum continuous surface temperature of 75°C and at a maximum voltage of 600 volts RMS. The cables are not recommended for use in applications where they will be subject to heavy impact or abrasive wear such as frequent foot or vehicle traffic, nor for direct burial as a permanent installation.

6.2 Ordering Data. Procurement documents should specify the following:

a. Title, number, and date of this specification, and the applicable detail specification number.

b. Cable Part Number.

c. Total length of cable required.

d. Minimum cutting lengths.

e. If a preproduction sample is required (see 4.3.1).

f. Where preproduction tests will be accomplished (see 4.5.1).

g. If acceptance inspection samples are required to be furnished to the procuring activity, (see 4.3.3).

h. Number and length of inspection samples (see 4.3.3).

i. If special packing is required, (see 5.1.2).

6.3 Detail Cable Specification Sheets. A listing of detail specification sheets is given in Supplement 1 to this general specification.

6.4 Definitions. The following definitions apply when the terms listed are used in this document.

6.4.1 Cable. Two or more conductors insulated from each other and contained in a common covering; two or more conductors insulated from each other and twisted or molded together without a common covering; or one insulated conductor with a metallic covering, shield or outer conductor.

6.4.2 Completed or Finished Cable. Cable on which all manufacturing operations have been completed and which is ready to be submitted for inspection and testing.

6.4.3 Concentric Lay. A conductor or cable buildup composed of a central core surrounded by one or more layers of helically wound strands or insulated conductors. Successive layers are laid in a reverse direction.

6.4.4 Conductor. A bare wire or combination of bare wires suitable for carrying an electric current.

6.4.5 Cutting Length. The continuous, unspliced length in which cable is to be furnished.

6.4.6 Direction of Lay. The lateral direction, either right-hand or left-hand, in which a strand or insulated conductor passes over the top as it recedes from an observer looking along the axis of the conductor or cable.

6.4.7 Elongation. Extension between bench marks produced by a tensile force applied to a specimen and expressed as a percentage of the original distance between the marks on the unstressed specimen. Ultimate elongation is the elongation at the moment of rupture.

6.4.8 Finished Conductor. The metal conductor with insulation and any insulation covering applied.

6.4.9 Insulation. Materials molded or extruded onto conductors, and offering very high resistance to current flow.

6.4.10 Insulation Covering. A covering applied over the insulation for the purpose of protecting the insulation.

6.4.11 Insulation Resistance. The electrical resistance offered by insulating material to an impressed direct-current potential tending to produce a leakage current through the material.

6.4.12 Length of Lay. The axial length of one complete turn of any helically wound strand or insulated conductor.

6.4.13 Stranded Conductor. A conductor composed of two or more bare wires.

6.4.14 Tensile Strength. The force, per unit of original cross-sectional area of the unstressed specimen, required to stretch the specimen to a stated elongation.

6.4.15 Unidirectional Lay. Concentric lay construction with successive layers laid in the same direction.

6.4.16 Wire. A single conductor, either solid or stranded, capable of carrying current in an electrical circuit. A wire may be bare or insulated but does not have a metallic covering, sheath or shield. Bare "wire" and "conductor" are synonymous.

6.5 Abbreviations. Abbreviations used herein and in the detail specification sheets have the following meanings:

NOTE: All conductors are considered to be insulated.

SSI - One (single) conductor, shielded, with jacket (insulation) over shield.

PTSI - Two conductors (pair), twisted together, with overall shield, and jacket over shield.

TTSI - Three conductors (triple), twisted together, with overall shield, and jacket over shield.

QTSI - Four conductors (quad), twisted together, with overall shield, and jacket over shield.

5TSI - Five conductors, twisted together, with overall shield, and jacket over shield.

6TSI - Six conductors, twisted together, with overall shield, and jacket over shield.

KSC-SPEC-E-0024
April 15, 1970

NOTICE: When government drawing, 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 drawing, 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.

| Custodian: | Preparing Activity: |
| --- | --- |
| NASA - John F. Kennedy Space Center | John F. Kennedy Space Center<br>Electrical and Electronic Design Division<br>Design Engineering Directorate |

TABLE I. CONDUCTOR REQUIREMENTS

| CONDUCTOR SIZE (AWG) | STRANDING REQUIREMENTS | | PRIMARY INSULATION THICKNESS (INCHES) | MAX. DC RESISTANCE AT 20°C (OHMS/1000 FT) |
|---|---|---|---|---|
| | NUMBER OF STRANDS | STRAND SIZE (INCHES) | | |
| 24 | 19 | .0050 | .010 | 24.90 |
| 22 | 19 | .0063 | .010 | 15.50 |
| 20 | 19 | .0080 | .010 | 9.70 |
| 18 | 19 | .0100 | .015 | 6.08 |
| 16 | 19 | .0113 | .015 | 4.76 |
| 14 | 19 | .0142 | .020 | 2.99 |
| 12 | 19 | .0179 | .020 | 1.88 |

NOTE: The finished conductor sizes approximate the AWG sizes shown.

TABLE II. PHYSICAL REQUIREMENTS FOR INSULATION AND JACKET MATERIALS

| PHYSICAL PROPERTY | POLYETHYLENE | POLYVINYL CHLORIDE |
|---|---|---|
| Original Requirement | | |
| Tensile Strength, Min. (PSI) | 1400 | 2000 |
| Elongation at Rupture, Min. (Percent) | 350 | 150 |
| Aging Requirement | | |
| Tensile Strength, Min. Percent of Original Value | 75 | 80 |
| Elongation at Rupture, Min. Percent of Original Value | 75 | 75 |

TABLE III. SHIELD REQUIREMENTS

| DIAMETER UNDER SHIELD (INCHES) | STRAND DIAMETER (INCHES) | BRAID ANGLE (+5°, -10°) |
|---|---|---|
| 0.250 and Under | .0050 | 30 |
| 0.251 to 0.350 | .0063 | 30 |
| 0.351 to 0.400 | .0063 | 35 |
| 0.401 to 0.500 | .0063 | 40 |

TABLE IV. INSULATION TEST REQUIREMENTS

| CONDUCTOR SIZE (AWG) | SPARK TEST VOLTAGE (KILOVOLTS) | INSPECTION TEST VOLTAGE (KILOVOLTS) | MIN. INSULATION RESISTANCE AT 20°C (MEGOHMS/1000 FT.) |
|---|---|---|---|
| 24 | 3.0 | 1.5 | 12,765 |
| 22 | 3.0 | 1.5 | 10,610 |
| 20 | 3.0 | 1.5 | 8,805 |
| 18 | 3.0 | 1.5 | 10,205 |
| 16 | 3.0 | 1.5 | 9,235 |
| 14 | 4.0 | 2.0 | 9,265 |
| 12 | 4.0 | 2.0 | 8,070 |

TABLE V. COMPONENT MATERIALS INSPECTION

| MATERIAL | REQUIREMENT PARAGRAPH | INSPECTION METHOD |
|---|---|---|
| Copper Strands | 3.3.1 | In accordance with the applicable referenced specification unless otherwise specified herein. |
| Polyethylene | 3.3.2 | |
| Polyamide | 3.3.3 | |
| Polyvinyl Chloride | 3.3.4 | |

TABLE VI. VISUAL AND MECHANICAL EXAMINATIONS

| TEST | REQUIREMENT PARAGRAPH | INSPECTION METHOD |
|---|---|---|
| Minimum Thickness of Insulation | 3.4.2.1 | ASTM D 374, Methods A and C |
| Length of Lay | 3.4.4.1 | FED-STD-228 Method 1521 |
| Shield Coverage | 3.4.5 | FED-STD-228, Method 8121 |
| Minimum and Average Thickness of Jacket | 3.4.6 | FED-STD-228, Method 1331 |
| Maximum Diameter of Completed Cable | 3.6 | Direct Measurement |
| Cable Marking | 3.7 | Visual |
| Workmanship | 3.8 | Visual |

TABLE VII. PREPRODUCTION AND QUALITY ASSURANCE TESTS

| TEST | REQUIREMENT PARAGRAPH | METHOD & CONDITION PARA. |
|---|---|---|
| Visual & Mechanical Examination | 3.4, 3.6. 3.7, and 3.8 | 4.4 |
| Conductor: | | |
| Elongation of Strands | 3.5.1.1 | 4.8.2.1.1 |
| Coating | 3.5.1.2 | 4.8.2.1.2 |
| Conductor Resistance | 3.5.1.3 | 4.8.3.3.5 |
| Insulation: | | |
| Tensile Strength | 3.5.2.1 | 4.8.2.2.1 |
| Ultimate Elongation | 3.5.2.1 | 4.8.2.2.1 |
| Melting Point of Polyamide | 3.5.2.2 | 4.8.2.2.2 |
| Shrinkage | 3.5.2.3 | 4.8.2.2.3 |
| Stripping | 3.5.2.4 | 4.8.2.2.4 |
| Water Absorption | 3.5.2.5 | 4.8.2.2.5 |
| Cold Bend | 3.5.2.6 | 4.8.3.1 |
| Insulation Flaws | 3.5.2.7 | 4.8.2.2.6 |
| Dielectric Strength | 3.5.2.8 | 4.8.3.3.2 |
| Insulation Resistance | 3.5.2.9 | 4.8.3.3.3 |
| Sheath: | | |
| Ultimate Elongation | 3.5.3.1 | 4.8.2.3.1 |
| Tensile Strength | 3.5.3.1 | 4.8.2.3.1 |
| Accelerated Aging | 3.5.3.1.2 | 4.8.2.3.1.3 |
| Oil Resistance | 3.5.3.1.3 | 4.8.2.3.1.4 |
| Jacket Flaws | 3.5.3.2 | 4.8.3.3.1 |
| Jacket Resistance | 3.5.3.3 | 4.8.3.3.4 |
| Cable: | | |
| Marking Durability Sheath | 3.7.3 | 4.8.3.2 |

TABLE VIII. ACCEPTANCE TESTS

| TEST | REQUIREMENT PARAGRAPH | METHOD & CONDITION PARAGRAPH |
|---|---|---|
| Visual and Mechanical Examination | 3.4, 3.6, 3.7, and 3.8 | 4.4 |
| Electrical: | | |
| Conductor Resistance | 3.5.1.3 | 4.8.3.3.5 |
| Insulation Flaws | 3.5.2.7 | 4.8.2.2.6 |
| Dielectric Strength | 3.5.2.8 | 4.8.3.3.2 |
| Insulation Resistance | 3.5.2.9 | 4.8.3.3.3 |
| Jacket Flaws | 3.5.3.2 | 4.8.3.3.1 |
| Jacket Resistance | 3.5.3.3 | 4.8.3.3.4 |

JOHN F. KENNEDY SPACE CENTER, NASA

# CABLE, ELECTRICAL, SHIELDED, JACKETED FOR HARNESS ASSEMBLIES GENERAL SPECIFICATION FOR

This supplement, which lists the detail specification sheets for specific cable types, forms a part of KSC-SPEC-E-0024.

## DETAIL SPECIFICATIONS

| | |
|---|---|
| KSC-SPEC-E-0024/1 | Cable, Electrical, Shielded, Jacketed, Type SSI |
| KSC-SPEC-E-0024/2 | Cable, Electrical, Shielded, Jacketed, Type PTSI |
| KSC-SPEC-E-0024/3 | Cable, Electrical, Shielded, Jacketed, Type TTSI |
| KSC-SPEC-E-0024/4 | Cable, Electrical, Shielded, Jacketed, Type QTSI |
| KSC-SPEC-E-0024/5 | Cable, Electrical, Shielded, Jacketed, Type 5TSI |
| KSC-SPEC-E-0024/6 | Cable, Electrical, Shielded, Jacketed, Type 6TSI |

JOHN F. KENNEDY SPACE CENTER, NASA

# CABLE, ELECTRICAL, SHIELDED, JACKETED TYPE SSI DETAIL SPECIFICATION FOR

This detail specification sheet forms a part of the latest issue of KSC-SPEC-E-0024.

## 1. SCOPE

1.1 This specification covers the detail requirements for single conductor, shielded, jacketed, electrical cable.

## 2. APPLICABLE DOCUMENTS

2.1 The following document, of the issue in effect on the date of issue of invitation for bids or request for proposals, forms a part of this specification.

John F. Kennedy Space Center

| | |
|---|---|
| KSC-SPEC-E-0024 | Cable, Electrical, Shielded, Jacketed, General Specification For |

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

## 3. REQUIREMENTS

3.1 General Requirements. The cable shall be in accordance with KSC-SPEC-E-0024 and as specified herein.

3.2 Classification. Cables manufactured to this specification shall be classified by type and part number, as follows:

3.2.1 Type. SSI

3.2.2 Part Number. Type designation suffixed with conductor AWG size, as shown in Table I.

3.3 Materials. All materials shall be as specified in KSC-SPEC-E-0024.

3.4 Configuration. The cable configuration shall be as follows:

(a) A single insulated conductor.

(b) A shield over the insulated conductor.

(c) A jacket over the shield.

3.5 Construction. The cable shall be constructed in accordance with KSC-SPEC-E-0024 and the requirements in Table I.

TABLE I. CABLE CONSTRUCTION - TYPE SSI

| Part Number | Conductor Size (AWG) | Jacket Thickness (Inches) | Max. Cable Diameter (Inches) | Jacket Test Vltg. (Kilovolts) | Insulation Resistance (Mohms/1000') |
|---|---|---|---|---|---|
| SSI #24 | 24 | .015 | .105 | 2.0 | 300 |
| SSI #22 | 22 | .015 | .115 | 2.0 | 270 |
| SSI #20 | 20 | .015 | .123 | 2.0 | 240 |
| SSI #18 | 18 | .015 | .144 | 2.0 | 210 |
| SSI #16 | 16 | .015 | .151 | 2.0 | 190 |
| SSI #14 | 14 | .015 | .176 | 2.0 | 160 |
| SSI #12 | 12 | .015 | .195 | 2.0 | 150 |

## 4. QUALITY ASSURANCE PROVISIONS

4.1 Test and inspection requirements shall be as specified in KSC-SPEC-E-0024. The jacket flaws test voltage shall be as specified in Table I.

## 5. PREPARATION FOR DELIVERY

5.1 Preparation for delivery shall be as specified in KSC-SPEC-E-0024.

## 6. NOTES

6.1 The notes contained in KSC-SPEC-E-0024 shall apply.

Custodian:

NASA - John F. Kennedy Space Center

Preparing Activity:

John F. Kennedy Space Center
Electrical & Electronic Design Division
Design Engineering Directorate

JOHN F. KENNEDY SPACE CENTER, NASA

# CABLE, ELECTRICAL, SHIELDED, JACKETED TYPE PTSI DETAIL SPECIFICATION FOR

This detail specification sheet forms a part of the latest issue of KSC-SPEC-E-0024.

## 1. SCOPE

1.1 This specification covers the detail requirements for two conductor electrical cable, with overall shield and jacket.

## 2. APPLICABLE DOCUMENTS

2.1 The following document, of the issue in effect on the date of issue of invitation for bids or request for proposals, forms a part of this specification.

John F. Kennedy Space Center

| | |
|---|---|
| KSC-SPEC-E-0024 | Cable, Electrical, Shielded, Jacketed General Specification For |

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

## 3. REQUIREMENTS

3.1 General Requirements. The cable shall be in accordance with KSC-SPEC-E-0024 and as specified herein.

3.2 Classification. Cables manufactured to this specification shall be classified by type and part number, as follows:

3.2.1 Type. PTSI

3.2.2 Part Number. Type designation suffixed with conductor AWG size, as shown in Table I.

3.3 Materials. All materials shall be as specified in KSC-SPEC-E-0024.

3.4 Configuration. The cable configuration shall be as follows:

(a) Two insulated conductors, twisted together.

(b) An overall shield over the cabled conductors.

(c) A jacket over the shield.

3.5 Construction. The cable shall be constructed in accordance with KSC-SPEC-E-0024 and the requirements in Table I.

TABLE I. CABLE CONSTRUCTION - TYPE PTSI

| Part Number | Conductor Size (AWG) | Jacket Thickness (Inches) | Max. Cable Diameter (Inches) | Jacket Test Vltg. (Kilovolts) | Insulation Resistance (Mohms/1000') |
|---|---|---|---|---|---|
| PTSI #24 | 24 | .015 | .161 | 2.0 | 180 |
| PTSI #22 | 22 | .015 | .174 | 2.0 | 160 |
| PTSI #20 | 20 | .015 | .191 | 2.0 | 150 |
| PTSI #18 | 18 | .020 | .243 | 2.0 | 160 |
| PTSI #16 | 16 | .022 | .260 | 2.0 | 160 |
| PTSI #14 | 14 | .027 | .326 | 2.5 | 160 |
| PTSI #12 | 12 | .031 | .371 | 3.0 | 160 |

4. QUALITY ASSURANCE PROVISIONS

4.1 Test and inspection requirements shall be as specified in KSC-SPEC-E-0024. The jacket flaws test voltage shall be as specified in Table I.

5. PREPARATION FOR DELIVERY

5.1 Preparation for delivery shall be as specified in KSC-SPEC-E-0024.

6. NOTES

6.1 The notes contained in KSC-SPEC-E-0024 shall apply.

Custodian:

NASA - John F. Kennedy
Space Center

Preparing Activity:

John F. Kennedy Space Center
Electrical & Electronic Design
Division
Design Engineering Directorate

JOHN F. KENNEDY SPACE CENTER, NASA

# CABLE, ELECTRICAL, SHIELDED, JACKETED TYPE TTSI DETAIL SPECIFICATION FOR

This detail specification sheet forms a part of the latest issue of KSC-SPEC-E-0024.

## 1. SCOPE

1.1 This specification covers the detail requirements for three conductor electrical cable, with overall shield and jacket.

## 2. APPLICABLE DOCUMENTS

2.1 The following document, of the issue in effect on the date of issue of invitation for bids or request for proposals, forms a part of this specification.

John F. Kennedy Space Center

| | |
|---|---|
| KSC-SPEC-E-0024 | Cable, Electrical, Shielded, Jacketed, General Specification For |

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

## 3. REQUIREMENTS

3.1 General Requirements. The cable shall be in accordance with KSC-SPEC-E-0024 and as specified herein.

3.2 Classification. Cables manufactured to this specification shall be classified by type and part number, as follows:

3.2.1 Type. TTSI

3.2.2 Part Number. Type designation suffixed with conductor AWG size, as shown in Table I.

3.3 Materials. All materials shall be as specified in KSC-SPEC-E-0024.

3.4 Configuration. The cable configuration shall be as follows:

(a) Three insulated conductors, twisted together.

(b) An overall shield over the cabled conductors.

(c) A jacket over the shield.

3.5 Construction. The cable shall be constructed in accordance with KSC-SPEC-E-0024 and the requirements in Table I.

TABLE I. CABLE CONSTRUCTION - TYPE TTSI

| Part Number | Conductor Size (AWG) | Jacket Thickness (Inches) | Max. Cable Diameter (Inches) | Jacket Test Vltg. (Kilovolts) | Insulation Resistance (Mohms/1000') |
|---|---|---|---|---|---|
| TTSI #24 | 24 | .015 | .169 | 2.0 | 160 |
| TTSI #22 | 22 | .015 | .183 | 2.0 | 160 |
| TTSI #20 | 20 | .017 | .205 | 2.0 | 160 |
| TTSI #18 | 18 | .022 | .260 | 2.0 | 160 |
| TTSI #16 | 16 | .024 | .278 | 2.5 | 160 |
| TTSI #14 | 14 | .029 | .348 | 2.5 | 160 |
| TTSI #12 | 12 | .033 | .396 | 3.0 | 160 |

4. QUALITY ASSURANCE PROVISIONS

4.1 Test and inspection requirements shall be as specified in KSC-SPEC-E-0024. The jacket flaws test voltage shall be as specified in Table I.

5. PREPARATION FOR DELIVERY

5.1 Preparation for delivery shall be as specified in KSC-SPEC-E-0024.

6. NOTES

6.1 The notes contained in KSC-SPEC-E-0024 shall apply.

Custodian:

NASA - John F. Kennedy
Space Center

Preparing Activity:

John F. Kennedy Space Center
Electrical & Electronic Design
Division
Design Engineering Directorate

JOHN F. KENNEDY SPACE CENTER, NASA

# CABLE, ELECTRICAL, SHIELDED, JACKETED TYPE QTSI DETAIL SPECIFICATION FOR

This detail specification sheet forms a part of the latest issue of KSC-SPEC-E-0024.

## 1. SCOPE

1.1 This specification covers the detail requirements for four conductor electrical cable, with overall shield and jacket.

## 2. APPLICABLE DOCUMENTS

2.1 The following document, of the issue in effect on the date of issue of invitation for bids or request for proposals, forms a part of this specification.

John F. Kennedy Space Center

| | |
|---|---|
| KSC-SPEC-E-0024 | Cable, Electrical, Shielded, Jacketed, General Specification For |

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

## 3. REQUIREMENTS

3.1 General Requirements. The cable shall be in accordance with KSC-SPEC-E-0024 and as specified herein.

3.2 Classification. Cables manufactured to this specification shall be classified by type and part number, as follows:

3.2.1 Type. QTSI

3.2.2 Part Number. Type designation suffixed with conductor AWG size, as shown in Table I.

3.3 Materials. All materials shall be as specified in KSC-SPEC-E-0024.

3.4 Configuration. The cable configuration shall be as follows:

(a) Four insulated conductors, twisted together.

(b) An overall shield over the cabled conductors.

(c) A jacket over the shield.

3.5 Construction. The cable shall be constructed in accordance with KSC-SPEC-E-0024 and the requirements in Table I.

TABLE I. CABLE CONSTRUCTION - TYPE QTSI

| Part Number | Conductor Size (AWG) | Jacket Thickness (Inches) | Max. Cable Diameter (Inches) | Jacket Test Vltg. (Kilovolts) | Insulation Resistance (Mohms/1000') |
|---|---|---|---|---|---|
| QTSI #24 | 24 | .015 | .183 | 2.0 | 160 |
| QTSI #22 | 22 | .017 | .202 | 2.0 | 160 |
| QTSI #20 | 20 | .019 | .227 | 2.0 | 160 |
| QTSI #18 | 18 | .024 | .287 | 2.5 | 160 |
| QTSI #16 | 16 | .026 | .307 | 2.5 | 160 |
| QTSI #14 | 14 | .032 | .386 | 3.0 | 160 |

4. QUALITY ASSURANCE PROVISIONS

4.1 Test and inspection requirements shall be as specified in KSC-SPEC-E-0024. The jacket flaws test voltage shall be as specified in Table I.

5. PREPARATION FOR DELIVERY

5.1 Preparation for delivery shall be as specified in KSC-SPEC-E-0024.

6. NOTES

6.1 The notes contained in KSC-SPEC-E-0024 shall apply.

Custodian:

NASA - John F. Kennedy
Space Center

Preparing Activity:

John F. Kennedy Space Center
Electrical & Electronic Design
Division
Design Engineering Directorate

KSC-SPEC-E-0024/5
April 15, 1970

JOHN F. KENNEDY SPACE CENTER, NASA

# CABLE, ELECTRICAL, SHIELDED, JACKETED TYPE 5TSI DETAIL SPECIFICATION FOR

This detail specification sheet forms a part of the latest issue of KSC-SPEC-E-0024.

## 1. SCOPE

1.1 This specification covers the detail requirements for five conductor electrical cable with overall shield and jacket.

## 2. APPLICABLE DOCUMENTS

2.1 The following document, of the issue in effect on the date of issue of invitation for bids or request for proposals, forms a part of this specification.

John F. Kennedy Space Center

| | |
|---|---|
| KSC-SPEC-E-0024 | Cable, Electrical, Shielded, Jacketed, General Specification For |

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

## 3. REQUIREMENTS

3.1 General Requirements. The cable shall be in accordance with KSC-SPEC-E-0024 and as specified herein.

3.2 Classification. Cables manufactured to this specification shall be classified by type and part number, as follows:

3.2.1 Type. 5TSI

3.2.2 Part Number. Type designation suffixed with conductor AWG size, as shown in Table I.

3.3 Materials. All materials shall be as specified in KSC-SPEC-E-0024.

3.4 Configuration. The cable configuration shall be as follows:

(a) Five insulated conductors, twisted together.

(b) An overall shield over the cabled conductors.

(c) A jacket over the shield.

3.5 Construction. The cable shall be constructed in accordance with KSC-SPEC-E-0024 and the requirements in Table I.

TABLE I. CABLE CONSTRUCTION - TYPE 5TSI

| Part Number | Conductor Size (AWG) | Jacket Thickness (Inches) | Max. Cable Diameter (Inches) | Jacket Test Vltg. (Kilovolts) | Insulation Resistance (Mohms/1000') |
|---|---|---|---|---|---|
| 5TSI #24 | 24 | .017 | .202 | 2.0 | 160 |
| 5TSI #22 | 22 | .019 | .224 | 2.0 | 160 |
| 5TSI #20 | 20 | .021 | .251 | 2.0 | 160 |
| 5TSI #18 | 18 | .027 | .319 | 2.5 | 160 |
| 5TSI #16 | 16 | .029 | .346 | 2.5 | 160 |
| 5TSI #14 | 14 | .036 | .428 | 3.0 | 160 |

4. QUALITY ASSURANCE PROVISIONS

4.1 Test and inspection requirements shall be as specified in KSC-SPEC-E-0024. The jacket flaws test voltage shall be as specified in Table I.

5. PREPARATION FOR DELIVERY

5.1 Preparation for delivery shall be as specified in KSC-SPEC-E-0024.

6. NOTES

6.1 The notes contained in KSC-SPEC-E-0024 shall apply.

Custodian:

NASA - John F. Kennedy Space Center

Preparing Activity:

John F. Kennedy Space Center
Electrical & Electronic Design Division
Design Engineering Directorate

JOHN F. KENNEDY SPACE CENTER, NASA

# CABLE, ELECTRICAL, SHIELDED, JACKETED TYPE 6TSI DETAIL SPECIFICATION FOR

This detail specification sheet forms a part of the latest issue of KSC-SPEC-E-0024.

## 1. SCOPE

1.1 This specification covers the detail requirements for six conductor electrical cable with overall shield and jacket.

## 2. APPLICABLE DOCUMENTS

2.1 The following document, of the issue in effect on the date of issue of invitation for bids or request for proposals, forms a part of this specification.

John F. Kennedy Space Center

| | |
|---|---|
| KSC-SPEC-E-0024 | Cable, Electrical, Shielded, Jacketed General Specification For |

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

## 3. REQUIREMENTS

3.1 General Requirements. The cable shall be in accordance with KSC-SPEC-E-0024 and as specified herein.

3.2 Classification. Cables manufactured to this specification shall be classified by type and part number, as follows:

3.2.1 Type. 6TSI

3.2.2 Part Number. Type designation suffixed with conductor AWG size, as shown in Table I.

3.3 Materials. All materials shall be as specified in KSC-SPEC-E-0024.

3.4 Configuration. The cable configuration shall be as follows:

(a) Six insulated conductors, twisted together.

(b) An overall shield over the cabled conductors.

(c) A jacket over the shield.

3.5 Construction. The cable shall be constructed in accordance with KSC-SPEC-E-0024 and the requirements in Table I.

TABLE I. CABLE CONSTRUCTION - TYPE 6TSI

| Part Number | Conductor Size (AWG) | Jacket Thickness (Inches) | Max. Cable Diameter (Inches) | Jacket Test Vltg. (Kilovolts) | Insulation Resistance (Mohms/1000') |
|---|---|---|---|---|---|
| 6TSI #24 | 24 | .018 | .220 | 2.0 | 160 |
| 6TSI #22 | 22 | .020 | .243 | 2.0 | 160 |
| 6TSI #20 | 20 | .023 | .275 | 2.5 | 160 |
| 6TSI #18 | 18 | .030 | .357 | 3.0 | 160 |
| 6TSI #16 | 16 | .032 | .380 | 3.0 | 160 |
| 6TSI #14 | 14 | .039 | .472 | 3.0 | 160 |

4. QUALITY ASSURANCE PROVISIONS

4.1 Test and inspection requirements shall be as specified in KSC-SPEC-E-0024. The jacket flaws test voltage shall be as specified in Table I.

5. PREPARATION FOR DELIVERY

5.1 Preparation for delivery shall be as specified in KSC-SPEC-E-0024.

6. NOTES

6.1 The notes contained in KSC-SPEC-E-0024 shall apply.

KSC-SPEC-E-0024/6
April 15, 1970

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