APPENDIX C

WIRES, ELECTRIC, FLUORINE RESIN/POLYIMIDE INSULATED

This specification was originally written and established in the Japanese language. This specification has been translated into English for international users. Note that this document is a working document for international users and is not subject to configuration control by JAXA. Any discrepancies found in this document should be verified against the latest Japanese document before any significant decisions are made.

APPENDIX C

WIRES, ELECTRIC, FLUORINE RESIN/POLYIMIDE INSULATED

C.1. General

C.1.1 Scope

This specification establishes the general requirements and quality assurance provisions for fluorine resin/polyimide insulated, electric wires among electrical wires and cables. This appendix also covers cables (hereinafter referred to as “wires” or "cables").

C.1.2 Part Number

The part number shall be as follows. The details shall be in accordance with the detail specification.

C.1.2.1 Part Number for Wires

The part number for wires shall be as follows.

Example: NASDA[(1)] 2120 / 101 - 22 - 6

- 6 — Color code (paragraph C.1.2.1.3)
- 22 — Conductor size (paragraph C.1.2.1.2)
- 101 — Individual identification (paragraph C.1.2.1.1)
- 2120 — Generic specification number

Note: [(1)] "NASDA" indicates the part is for space use and may be abbreviated “N”.

C.1.2.1.1 Individual Identification

Unless otherwise specified, the individual identification shall be the detail specification number and specified in accordance with paragraph A.2.2.2.3 of JAXA-QTS-2000. An individual identification shall be a three-digit number and the first digit represents the QML manufacturer and the remaining two digits are a series number specified by the manufacturer.

C.1.2.1.2 Conductor Size

The conductor size is specified in American Wire Gauge (AWG).

C.1.2.1.3 Color Code

The color code indicates the color of the primary insulation layer and is designated by a digit. The color is six colors and the code is as specified in Table C-1.

Table C-1. Color Code

Color	Black	Red	Orange	Green	Blue	White
Code	0	2	3	5	6	9

C.1.2.2 Part Number for Cables

The part number for cables shall be as follows.

Example: NASDA(1) 2120 / 201 - 22 - 2 S J

- Jacket material code (paragraph C.1.2.2.5)
- Shield braid code (paragraph C.1.2.2.4)
- Number of strands in core (paragraph C.1.2.2.3)
- Conductor size (paragraph C.1.2.2.2)
- Individual identification (paragraph C.1.2.2.1)
- Generic specification number

Note: (1) "NASDA" indicates the part is for space use and may be abbreviated “N”.

C.1.2.2.1 Individual Identification

Unless otherwise specified, the individual identification shall be the detail specification number and specified in accordance with paragraph A.2.2.2.3 of JAXA-QTS-2000. An individual identification shall be a three-digit number and the first digit represents the QML manufacturer and the remaining two digits are a series number specified by the manufacturer.

C.1.2.2.2 Conductor Size

The conductor size is specified in American Wire Gauge (AWG).

C.1.2.2.3 Number of Strands

The number of strands in the cable is specified by a number.

C.1.2.2.4 Shield Braid Code

Code “S” shall be given when the cable has a shield braid.

C.1.2.2.5 Jacket Material Code

Code “J” shall be given when the cable has a jacket.

C.2. Applicable Documents

C.2.1 Applicable Documents

The applicable documents shall be in accordance with paragraph 2.1.

C.2.2 Reference Documents

In addition to paragraph 2.2, the following document shall be a reference document of this appendix.

a) SSQ 21656 Wire and Cable, Electric, Fluoropolymer-Insulated, Nickel Coated Copper or Copper Alloy, General Specification for

C.3. Requirements

C.3.1 Certification

C.3.1.1 Qualification Coverage

The qualification coverage shall be as follows. If necessary, additional qualification coverage shall be specified in the detail specification.

C.3.1.1.1 Qualification Coverage for Wires

Qualification of each wire size specified in Table C-7 is granted if any representative sample unit of the wire size is qualified.

C.3.1.1.2 Qualification Coverage for Cables

Qualification of each cable specified in Table C-8 is granted if any representative sample unit of the number of strands and wire size is qualified.

C.3.2 Materials

The materials shall be as follows and as specified in paragraph 3.3.

C.3.2.1 Conductor Materials

Strands shall be high strength copper alloy wires or oxygen-free copper wires conforming to ASTM B 170 and shall be nickel-plated. The nickel coating shall meet the following requirements when tested in accordance with paragraph C.4.4.2.

a) Thickness: The coating thickness shall be a minimum of 1.27μm.
b) Continuity: The sample surface shall be free of defects such as blackening.
c) Adhesion: No evidence of cracks or peeling.
d) Adhesion against heat: The sample surface shall be free of defects such as blackening.

C.3.2.2 Dielectric Core Materials

C.3.2.2.1 Tensile Strength and Elongation

The wires and cables tested in accordance with paragraph C.4.4.3 shall satisfy the values shown in Table C-2.

Table C-2. Characteristics of Insulation and Jacket Materials

Wire / Cable	Primary insulation	Whole insulation
Cable	Jacket	-
Tensile strength (average of minimum values) MPa {Kgf/mm^2}	13.7 {1.4}	20 {2.04}
Elongation (average of minimum values) (%)	150	50

Note: (1) The values in { } are reference values.

C.3.2.2.2 Outgassing

If requirements are not specified for each material, the finished wires or cables shall meet the following requirements when tested for outgassing. Materials for the dielectric cores (paragraph C.3.3.1b)) and jacket (paragraph C.3.3.2a)) shall also satisfy the following requirements when tested as specified in paragraph C.4.4.6.

a) TML (Total Mass Loss): 1.0% or less
b) CVCM (Collected Volatile Condensable Material): 0.1% or less

C.3.2.3 Shield Materials

The shield shall consist of nickel plated oxygen-free copper wires (paragraph C.3.3.2b)) which satisfy the following requirements when tested in accordance with paragraph C.4.4.4.

a) Coating: requirements a) to d) of paragraph C.3.2.1.
b) Elongation: 6% minimum

C.3.2.4 Jacket Materials

Jacket materials shall satisfy the characteristic requirements shown in Table C-2, when tested in accordance with paragraph C.4.4.5.

C.3.3 Design and Construction

C.3.3.1 Wires

a) Conductors shall be stranded wires of nickel-plated oxygen-free copper, or high strength copper alloy.
b) The dielectric cores shall consist of double composite insulation layers. As shown in Figure C-1-a, the primary insulation layer shall be PFA(1) of fluorine resin and the secondary insulation layer shall be TPI(2) of polyimide resin.

Notes:
(1) PFA: PERFLUOROALCOXY
(2) TPI: THERMOPLASTIC POLY-IMIDE

C.3.3.2 Cables

a) The wires used for the cables shall be certified in conformance with this specification as specified in paragraph C.3.3.1. An individual wire or

strands of two or three wires shall be covered with a jacket of PFA of fluorine resin.

b) When a shield is required, the shield braids of nickel-plated annealed copper wires shall be provided as shown in Figure C-1-b.

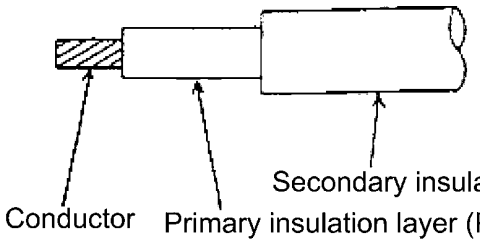

Figure C-1-a. Electric Wire

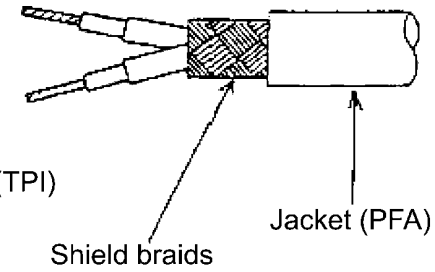

Figure C-1-b. Cable

C.3.4 Specification

The specifications of the wires and cables are specified with a working voltage and the maximum continuous operating temperature as shown in Table C-3.

Table C-3. Specification of Wires and Cables

Item	Specification
Working voltage	600V_{AC} (at 60Hz or 50Hz)
Maximum continuous operating temperature	200ºC

C.3.5 Externals, Construction and Weight of Wires

C.3.5.1 Externals

The wires shall have no visible defects when tested as specified in paragraph C.4.4.7.1.

C.3.5.2 Construction

a) Conductor

1) Concentric-lay stranding

The conductors of AWG 26 through 12 shall be concentric-lay conductors constructed as specified in Table C-4.

The lay of the individual strands in the outer layer of the concentrically stranded conductors of the finished wire shall be in the left hand direction.

The length of lay of the outer layer shall be between 8 and 16 times the maximum conductor diameter as specified in Table C-4.

2) Rope-lay stranding

The conductors of AWG 8 shall be rope-lay as specified in Table C-4 and below.

2.1) The length of lay of the outer layer of rope-lay stranded members forming the conductor shall be between 10 and 14 times the outside diameter of the completed conductor. The lay of the outside layer shall be either the left or right hand direction.

2.2) The length of lay of the wires composing the members of the rope-lay stranded conductors shall be not greater than 16 times the outside diameter of the member. Stranding of the individual members may be either concentric or bunch.

3) Diameter

The diameter shall be as specified in Table C-4.

Table C-4. Details of Conductors

AWG size	Stranding (No. of strands × AWG size of strands)	Outer diameter of stranded conductor			Maximum resistance of conductor (Ω/km at 20ºC)		Breaking strength of copper alloy conductor (min) N{kgf}
		Minimum (mm)	Maximum (mm)		Nickel-coated annealed copper	Nickel-coated high strength copper alloy	
			Nickel-coated annealed copper	Nickel-coated high strength copper alloy			
26	19x38	0.45	-	0.51	-	162	63.1{6.44}
24	19x36	0.58	-	0.64	-	98.8	99.6{10.16}
22	19x34	0.73	-	0.79	-	61.0	159.2{16.24}
20	19x32	0.94	1.00	-	32.1	-	-
18	19x30	1.16	1.25	-	20.0	-	-
16	19x29	1.32	1.40	-	15.6	-	-
14	19x27	1.65	1.76	-	9.84	-	-
12	37x28	2.08	2.27	-	6.49	-	-
8	133x29	4.01	4.30	-	2.28	-	-

b) Insulation

1) Minimum insulation wall thickness

The minimum insulation wall thickness shall satisfy the requirements specified in the detail specification when tested in accordance with C.4.4.7.2 b)1).

2) Concentricity

The primary insulation layer (PFA) and all insulation layers (PFA/TPI) shall satisfy the requirements specified in the detail specification when tested in accordance with C.4.4.7.2 b)2).

3) Finished diameter

When tested in accordance with C.4.4.7.2 b)3), the wires shall satisfy the requirements specified in the detail specification.

4) Color

When cables are tested in accordance with C.4.4.7.2 b)4), the wire colors shall be those indicated in the part number. The wire colors shall be that of the primary insulation layer and shall be one of the six colors (black, red, orange, green, blue or white) shown in Table C-1.

C.3.5.3 Weight

When cables are tested as specified in paragraph C.4.4.7.3, the weight of the completed cable shall be as specified in the detail specification.

C.3.6 Externals, Construction and Weight of Cables

Cables shall be tested for externals, construction, core marking, weight and workmanship. The cable cores shall be the wires that passed Group A inspection specified in Table C-11 and are certified in accordance with this appendix.

C.3.6.1 Externals

Cables shall be free from visible defects when inspected as specified in paragraph C.4.4.8.1.

C.3.6.2 Construction

a) Cabling of wires
The specified number of wires of which conductor size is indicated in the part number shall be stranded in left hand. The length of lay shall be between 8 and 16 times the outside diameter of the cable.
When the cables are cut, each wire shall keep the correct arrangement.
Cables shall satisfy the above requirements when inspected as specified in C.4.4.8.2 a). The wires forming the cables shall not be spliced inside the cable.

b) Shield
1) The shield shall be a braid structure without being loose nor deformed.
2) The braids shall be free of gaps or unwoven strands. There shall be no splices in the completed braid.
3) When cables are tested in accordance with C.4.4.8.2 b), the individual strand size, braiding angle and braid coverage shall satisfy the requirements specified in the detail specification.

c) Jacket
1) Minimum thickness
When cables are tested as specified in C.4.4.8.2 c)1), the minimum thickness of the jacket shall satisfy the requirements specified in the detail specification.
2) Thickness uniformity
When the cables are tested in accordance with C.4.4.8.2 c)2), the jacket thickness shall be uniform for at least 70% of the jacket area.

d) Finished diameter
When cables are tested in accordance with C.4.4.8.2 d), the diameter shall be as specified in the detail specification.

C.3.6.3 Cable Core Marking

The cable cores shall be identified by the color of the primary insulation layer. The color shall be as shown in Table C-5 when examined in accordance with paragraph C.4.4.8.3.

Table C-5. Identification Color of Cable Core

Number of core	Identification color		
	First core	Second core	Third core
1	White	-	-
2	White	Blue	-
3	White	Blue	Orange

C.3.6.4 Weight

When cables are tested as specified in paragraph C.4.4.8.4, the weight of cables shall be as specified in the detail specification.

C.3.7 Performance of Wires

C.3.7.1 Impulse Dielectric Test

Wires shall not exhibit evidence of insulation breakdown when tested in accordance with paragraph C.4.4.9.1.

C.3.7.2 Conductor Strength

a) Annealed copper wire with nickel plating
Wires removed from the conductors shall exhibit elongation of a minimum of 10% for the wires of AWG 20 to 8 when tested as specified in C.4.4.9.2 a).

b) High strength copper alloy with nickel plating
The whole conductor removed from the wires shall exhibit elongation of a minimum of 6% for the wires of AWG 26 to 22 and a tensile breaking strength conforming to Table C-4 when tested as specified in C.4.4.9.2 b).

C.3.7.3 Conductor Resistance

The conductor resistance shall satisfy the values specified in Table C-4 when measured in accordance with paragraph C.4.4.9.3.

C.3.7.4 Insulation Resistance

The insulation resistance shall be a minimum of 1500MΩkm when measured as specified in paragraph C.4.4.9.4.

C.3.7.5 Shrinkage

The shrinkage in insulation length shall be a maximum of 3.18mm when wires are tested as specified in paragraph C.4.4.9.5.

C.3.7.6 Low Temperature (Cold Bend)

When wires are tested as specified in paragraph C.4.4.9.6, there shall be no evidence of cracks or insulation breakdown in the dielectric core material.

C.3.7.7 Thermal Shock Resistance

When shrinkage in the insulation length is measured in accordance with paragraph C.4.4.9.7, the differences between the initial value and the measured values at each cycle shall satisfy the requirements in the detail specification.

C.3.7.8 Wrap Test

The insulation shall be free from cracks when wires are tested as specified in paragraph C.4.4.9.8.

C.3.7.9 Life Cycle

Wires shall satisfy the following requirements when tested as specified in paragraph C.4.4.9.9.

a) Bend test: The insulation shall not exhibit cracks.
b) Voltage withstanding test: There shall be no insulation breakdown.

C.3.7.10 Immersion

When wires are tested as specified in paragraph C.4.4.9.10, the following requirements shall be satisfied.

a) Outer diameter: The increase in the wire diameter shall be a maximum of 5% of the initial value.
b) Bend test: The insulation shall not exhibit cracks.
c) Voltage withstanding test: The dielectric test shall not exhibit insulation breakdown.

C.3.7.11 Humidity Resistance

The insulation resistance shall be a minimum of 1500MΩkm when wires are tested as specified in paragraph C.4.4.9.11.

C.3.7.12 Surface Resistance

The surface resistance shall be a minimum of 10MΩcm when wires are tested as specified in paragraph C.4.4.9.12.

C.3.7.13 Removability of Insulation

Insulation shall be readily removable without damaging the conductors when wires are tested as specified in paragraph C.4.4.9.13.

C.3.7.14 Continuous Lengths

The continuous lengths shall satisfy the values defined in Table C-6 when measured as specified in paragraph C.4.4.9.14.

Table C-6. Minimum Continuous Wire Length

Wire length / Conductor size (AWG)	Minimum continuous length			
	Min. 150m	Min. 30m	Min. 15m	Min. 7.5m
26 to 20	50%	80%	100%	-
18 to 14	30%	80%	100%	-
12 to 10	-	50%	80%	100%
8	-	20%	50%	100%

C.3.7.15 Radiation Hardness

Wires shall satisfy the following requirements when tested as specified in paragraph C.4.4.9.15.

a) Wire surface: The wire surface shall be free from cracks.

b) Voltage withstanding test: There shall be no insulation breakdown.

C.3.7.16 Arc Tracking

Wires shall undergo the arc tracking test specified in paragraph C.4.4.9.16. When arc tracking occurs at the initial voltage application, second voltage application or both, the average distance of insulation damage(1) shall be a maximum of 13mm.

Note (1): The average distance of the insulation damage shall be measured from a conductor edge to the far end of the damaged area in the longitudinal direction.

C.3.7.17 Flammability

When wires are tested as specified in paragraph C.4.4.9.17, the distance the flame travels in the insulation shall be a maximum of 150mm. K-10 paper shall not burn as a result of incendiary drippings from the specimen.

C.3.7.18 Blocking

Adjacent turns or layers of the wire shall not stick to one another when wires are tested as specified in paragraph C.4.4.9.18.

C.3.7.19 Odor

When wires are tested as specified in paragraph C.4.4.9.19, the average assessment of the odor shall be less than 2.5.

C.3.7.20 Off-Gas

When wires are tested as specified in paragraph C.4.4.9.20, the total toxic hazard index of off-gas that is generated from the specimen shall be less than 0.5.

C.3.8 Performance of Cables

C.3.8.1 Continuity

When cables are tested as specified in paragraph C.4.4.10.1, all conductors forming the cables shall be continuous.

C.3.8.2 Voltage Withstanding

When cables are tested as specified in paragraph C.4.4.10.2, there shall be no insulation breakdown.

C.3.8.3 Low Temperature (Cold Bend)

When cables are tested as specified in paragraph C.4.4.10.3, the jacket shall exhibit no evidence of cracks.

C.3.8.4 Thermal Shock Resistance

When cables are tested as specified in paragraph C.4.4.10.4, there shall be no evidence of cracks in the jacket material.

C.3.8.5 Aging Resistance

When cables are tested as specified in paragraph C.4.4.10.5, there shall be no evidence of cracks in the jacket material.

C.3.8.6 Jacket Defect

When cables are tested as specified in paragraph C.4.4.10.6, there shall be no evidence of insulation breakdown in the jacket material.

C.3.8.7 Removability of Jacket

Insulation shall be readily removable without damaging the conductors when cables are tested as specified in paragraph C.4.4.10.7.

C.3.8.8 Continuous Lengths

Prior to delivery to the procurer, the continuous lengths shall be measured in accordance with paragraph C.4.4.10.8. Cables of the shipping lot shall consist of a minimum of 50% of cables longer than 150m, a maximum of 30% of cables between 30m and 150m, and a maximum of 20% of cables between 15m and 30m.

C.3.8.9 Radiation Hardness

When cables are tested as specified in paragraph C.4.4.10.9, the jacket surface shall not exhibit any evidence of cracks.

C.3.8.10 Upward Flame Propagation Test

When cables are tested as specified in paragraph C.4.4.10.10, the distance the flame travels in the jacket material shall be a maximum of 150mm. K-10 paper shall not burn as a result of incendiary drippings from the specimen.

C.3.8.11 Blocking

Adjacent turns or layers of the cable shall not stick to one another when tested as specified in paragraph C.4.4.10.11.

C.3.8.12 Odor

Cables shall satisfy the requirements in paragraph C.3.7.19 when tested as specified in paragraph C.4.4.10.12.

C.3.8.13 Off-Gas

Cables shall satisfy the requirements in paragraph C.3.7.20 when tested as specified in paragraph C.4.4.10.13.

C.4. Quality Assurance Provisions

C.4.1 In-Process Inspection

As an in-process inspection, wires and cables shall be subjected to the impulse dielectric test (100% inspection) in accordance with paragraph C.4.4.9.1.

C.4.2 Qualification Test

C.4.2.1 Samples

a) The wire samples shall be one from each size range specified in Table C-7. The manufacturer shall also submit a minimum of 3m of a plated strand used in manufacturing the sample.
b) One cable from each sample group specified in Table C-8 shall be prepared.

C.4.2.2 Production Records

The production records of the qualification test shall be as specified in paragraph 4.4.2.

C.4.2.3 Test Items and Number of Samples

The qualification test items and order of tests shall be as specified in Tables C-9 and C-10. However, the Group V and VI tests may be performed in the reversed order. The tests within the same group may be performed in any order except for the Group II. The Group I tests may be exempted when the manufacturer performs the tests at the most appropriate stages of production process or submits evidence to prove the product quality.

Table C-7. Qualification Coverage of Wires

Wire size range (AWG)
26 to 22
20 to 18
16 to 12
8

Table C-8. Qualification Coverage of Cables

Type	Qualification coverage		Representative sample	
	Number of core	Size (AWG)	Number of core	Size (AWG)
Without shield	2, 3	26 to 22	3	26
		20 to 16		20
With shield	1 to 3	26 to 22	3	26
		20 to 16		20

Table C-9. Qualification Tests for Wires

Group	Test item	Requirement paragraph	Test method paragraph
I	Conductor materials(1)	C.3.2.1	C.4.4.2
II	Impulse dielectric test	C.3.7.1	C.4.4.9.1
	Insulation resistance	C.3.7.4	C.4.4.9.4
III	Continuous lengths	C.3.7.14	C.4.4.9.14
IV	Dielectric core material	C.3.2.2.1	C.4.4.3
	Externals, construction and weight of wires	C.3.5	C.4.4.7
	Workmanship	3.5	
	Conductor strength	C.3.7.2	C.4.4.9.2
	Insulation resistance	C.3.7.4	C.4.4.9.4
	Removability of insulation	C.3.7.13	C.4.4.9.13
V	Shrinkage	C.3.7.5	C.4.4.9.5
	Low temperature (Cold bend)	C.3.7.6	C.4.4.9.6
	Thermal shock resistance	C.3.7.7	C.4.4.9.7
	Wrap test	C.3.7.8	C.4.4.9.8
	Life cycle	C.3.7.9	C.4.4.9.9
	Immersion	C.3.7.10	C.4.4.9.10
	Humidity resistance	C.3.7.11	C.4.4.9.11
	Surface resistance	C.3.7.12	C.4.4.9.12
	Blocking	C.3.7.18	C.4.4.9.18
VI	Outgassing	C.3.2.2.2	C.4.4.6
	Radiation hardness	C.3.7.15	C.4.4.9.15
	Arc tracking	C.3.7.16	C.4.4.9.16
	Flammability	C.3.7.17	C.4.4.9.17
	Odor	C.3.7.19	C.4.4.9.19
	Off-gas	C.3.7.20	C.4.4.9.20

Note: (1) The manufacturer shall submit a document that provides evidence that their products conform to the design specification.

Table C-10. Qualification Tests for Cables

Group	Test item	Requirement paragraph	Test method paragraph
I	Shield materials(1)	C.3.2.3	C.4.4.4
II	Continuity	C.3.8.1	C.4.4.10.1
	Voltage withstanding	C.3.8.2	C.4.4.10.2
	Jacket defect	C.3.8.6	C.4.4.10.6
III	Continuous lengths	C.3.8.8	C.4.4.10.8
IV	Jacket materials	C.3.2.4	C.4.4.5
	Externals, construction and weight of cables	C.3.6	C.4.4.8
	Workmanship	3.5 of NASDA-QTS-2120	
	Removability of jacket	C.3.8.7	C.4.4.10.7
V	Low temperature (Cold bend)	C.3.8.3	C.4.4.10.3
	Thermal shock resistance	C.3.8.4	C.4.4.10.4
	Aging resistance	C.3.8.5	C.4.4.10.5
	Blocking	C.3.8.11	C.4.4.10.11
VI	Outgassing	C.3.2.2.2	C.4.4.6
	Radiation hardness	C.3.8.9	C.4.4.10.9
	Upward flame propagation test	C.3.8.10	C.4.4.10.10
	Odor	C.3.8.12	C.4.4.10.12
	Off-gas	C.3.8.13	C.4.4.10.13

Note: (1) The manufacturer shall submit a document that provides evidence that their products conform to the design specification.

C.4.2.4 Criteria for Pass/Fail

Pass/fail criteria for the qualification test shall be as specified in paragraph 4.4.4.

C.4.2.5 Disposition after Test

The disposition of samples after the qualification test shall be in accordance with paragraph 4.4.5.

C.4.3 Quality Conformance Inspection

C.4.3.1 Quality Conformance Inspection (Group A)

C.4.3.1.1 Samples

The samples for Group A quality conformance inspection shall be as follows and as specified in paragraph 4.5.1.1.

C.4.3.1.2 Test Items and Number of Samples

The test items of the Group A inspection shall be as specified in Tables C-11 and C-12. Since Group A1 consists of tests which are not accomplished with the samples submitted for the test, the tests may be exempted when the manufacturer performed the tests in the most appropriate stage of the production process or submit an evidence to prove the cable or wire quality.

C.4.3.1.3 Order of Tests

The tests may be performed in any order except for Group A2 specified in Tables C-11 and C-12. These tests shall be performed in the order shown in each table.

C.4.3.1.4 Sampling Plan

The sampling method shall be a single sampling method in accordance with “Special Inspection Level S-2” and “AQL (Acceptable Quality Level) = 6.5%” of JIS Z 9015-1.
The product unit for determining lot size for sampling shall be one continuous length of the wire or cable submitted for inspection.

C.4.3.1.5 Number of Samples

The sample unit for Group A4 of Group A inspections (Tables C-11 and C-12) shall consist of a single piece of the finished wire or cable taken at random from the inspection lot and of sufficient length to permit all applicable inspections and tests. Unless otherwise specified, the length of the sample unit for Group A4 inspections shall be a minimum of 8m. One sample unit shall be taken from a single unit of product.

C.4.3.1.6 Criteria for Pass/Fail

Pass/fail criteria of Group A inspection shall be in accordance with paragraph 4.5.1.3.

C.4.3.1.7 Disposition after Inspection

The disposition of samples subjected to Group A inspection shall be as follows and as specified in paragraph 4.5.1.4.

a) The section of wires or cables where an insulation breakdown occurs from the impulse dielectric test (Table C-11), continuity test, voltage withstanding test or jacket defect test (Table C-12) shall be cut out of the finished products. The wire or cable ends or portions not subjected to the tests shall also be removed.
b) If a sample fails to pass the insulation resistance test of Table C-11 or a test of Group A4, all products of the inspection lot shall not be shipped.

Table C-11. Quality Conformance Inspection (Group A) for Wires

Group	Inspection item	Requirement paragraph	Test method paragraph	Pass/fail criteria	
				Sample	Quantity of allowable defects
A1	Conductor materials(1)	C.3.2.1	C.4.4.2	1	0
A2	Impulse dielectric test	C.3.7.1	C.4.4.9.1	Entire length	0
	Insulation resistance	C.3.7.4	C.4.4.9.4	AQL=6.5%(2) (3)	
A3	Continuous lengths	C.3.7.14	C.4.4.9.14	Entire length	0
A4	Dielectric core materials	C.3.2.2	C.4.4.3	AQL=6.5%(2) (3) (4)	
	Externals, construction and weight of wires	C.3.5	C.4.4.7		
	Workmanship	3.5			
	Conductor strength	C.3.7.2	C.4.4.9.2		
	Conductor resistance	C.3.7.3	C.4.4.9.3		
	Removability of insulation	C.3.7.13	C.4.4.9.13		

Notes:

(1) The manufacturer shall submit a document that provides evidence that their products conform to the design specification.

(2) For the acceptable quality level (AQL), the inspection level S-2 of JIS Z 9015-1 shall be applied.

(3) The specimen shall be a wire randomly extracted from the lot that passed the impulse dielectric test. The length shall be a minimum of 8m.

(4) AQL shall not be applied to the workmanship of product inspection for the wires.

Table C-12. Quality Conformance Inspection (Group A) for Cables

Group	Inspection item	Requirement paragraph	Test method paragraph	Pass/fail criteria	
				Sample	Quantity of allowable defects
A1	Shield materials(3)	C.3.2.3	C.4.4.4	1	0
A2	Continuity	C.3.8.1	C.4.4.10.1	Entire length	0
	Voltage withstanding	C.3.8.2	C.4.4.10.2		
	Jacket defect	C.3.8.6	C.4.4.10.6		
A3	Continuous lengths	C.3.8.8	C.4.4.10.8		
A4	Jacket materials	C.3.2.4	C.4.4.5	AQL=6.5%(1) (2)	
	Externals, construction and weight of cables	C.3.6	C.4.4.8		
	Workmanship	3.5			
	Removability of jacket	C.3.8.7	C.4.4.10.7		

Notes:

(1) The manufacturers shall submit a document that provides evidence that their products conform to the design specification.

(2) For the acceptable quality level (AQL), the inspection level S-2 of JIS Z 9015-1 shall be applied.

(3) AQL shall not be applied to the workmanship of cables.

C.4.3.2 Quality Conformance Inspection (Group B)

C.4.3.2.1 Samples

Samples for Group B quality conformance inspection shall be as follows and as specified in paragraph 4.5.2.1. The sampling method shall be as specified in Table C-13 or C-14.

C.4.3.2.2 Test Items and Number of Samples

The test items and number of samples for Group B inspection shall be in accordance with Table C-13 or C-14.

Table C-13. Quality Conformance Inspection (Group B) for Wires

Group	Inspection item	Requirement paragraph	Test method paragraph	Pass/fail criteria	
				Sample	Quantity of allowable defects
B1	Shrinkage	C.3.7.5	C.4.4.9.5	1	0
	Low temperature (Cold bend)	C.3.7.6	C.4.4.9.6		
	Thermal shock resistance	C.3.7.7	C.4.4.9.7		
	Wrap test	C.3.7.8	C.4.4.9.8		
	Life cycle	C.3.7.9	C.4.4.9.9		
	Immersion	C.3.7.10	C.4.4.9.10		
	Humidity resistance	C.3.7.11	C.4.4.9.11		
	Surface resistance	C.3.7.12	C.4.4.9.12		
	Blocking	C.3.7.18	C.4.4.9.18		

Table C-14. Quality Conformance Inspection (Group B) for Cables

Group	Inspection item	Requirement paragraph	Test method paragraph	Pass/fail criteria	
				Sample	Quantity of allowable defects
B1	Low temperature (Cold bend)	C.3.8.3	C.4.4.10.3	1	0
	Thermal shock resistance	C.3.8.4	C.4.4.10.4		
	Aging resistance	C.3.8.5	C.4.4.10.5		
	Blocking	C.3.8.11	C.4.4.10.11		

C.4.3.2.3 Criteria for Pass/Fail

Pass/fail criteria for Group B inspection shall be in accordance with paragraph 4.5.2.3.

C.4.3.2.4 Disposition after Inspection

The disposition of samples subjected to Group B inspection shall be in accordance with paragraph 4.5.2.4.

C.4.4 Methods for Test and Inspection

C.4.4.1 Test Conditions

Unless otherwise specified, all measurements and tests shall be made at a temperature of 15°C to 35°C, a relative humidity of 45% to 75%, and an atmospheric pressure of 86kPa to 106kPa. If it is difficult to conduct tests and inspections under the above conditions, other conditions may be permitted, provided they do not give a questionable judgment on pass/fail.

C.4.4.2 Conductor Materials

The nickel coating of the conductor shall be tested as follows:

a) The thickness shall be tested in accordance with ASTM B 355.
b) The continuity shall be tested in accordance with ASTM B 355.
c) The adhesion shall be tested in accordance with ASTM B 355.
d) The adhesion against heat shall be tested as follows.
    1) Two 150mm specimens shall be cut from the sample of a nickel-coated strand. One specimen shall be wrapped over its own diameter for eight close turns. The second specimen shall remain in its straight form.
    2) Both specimens shall then be subjected to ten continuous cycles of temperature change. Each cycle of temperature change shall consist of 4 hours at 250±3ºC followed by 4 hours at room temperature.
    3) Upon completion of the thermal cycling, the straight specimen shall be wrapped over its own diameter for eight close turns in a manner identical to the first specimen. Both wrapped specimens shall then be tested for coating continuity in accordance with the procedure given in ASTM B 355.

C.4.4.3 Dielectric Core Materials

The samples of the primary insulation layer (PFA) and compound insulation layers (PFA/TPI) are prepared by removing the conductor carefully from the finished wire. The samples are subjected to the tensile strength tests and elongation tests of FED-STD-228, Method 3021 or 3031. The speed of pulling the samples, however, shall be 50±5mm/min.

C.4.4.4 Shield Materials

The samples of the shield braid material shall be subjected to the nickel plating test of paragraph C.4.4.2 and the elongation test for nickel plating of FED-STD-228, Method 3211.

C.4.4.5 Jacket Materials

The samples of the jacket shall be removed carefully from the finished cables and subjected to the test of paragraph C.4.4.3.

C.4.4.6 Outgassing

The dielectric core and jacket materials are tested for outgassing as specified in ASTM E 595. The results shall be computed according to the mass allocation method.

The samples for outgassing measurements shall be prepared as follows.

a) Samples shall consist of 3mm to 4mm square pieces of the compound dielectric core, from which the conductor has been removed, or the jacket covering which is ripped off of the sample cables.
b) The sample weight shall be a minimum of 3 grams for each type of the wire or cable.
c) The samples shall not be touched with bare hands during handling. In addition, the cutter blade shall be kept free of contamination.

d) The samples shall be stored in a clean container until the time of measurement.

C.4.4.7 Externals, Construction and Weight of Wires

C.4.4.7.1 Externals

The sample surface shall be inspected visually.

C.4.4.7.2 Construction

a) Conductor
The dimensions shall be measured with a micrometer caliper or any other instrument of equal accuracy.

b) Dielectric core

1) Minimum insulation wall thickness
The minimum insulation wall thickness shall be measured at the thinnest points on a cross section of the wire. Thickness measurements of the entire insulation wall shall be made at 10x magnification or higher.

2) Concentricity
The concentricity of the primary insulation layer and the finished wire shall be tested in accordance with 2.1) or 2.2) shown below, as applicable.
All measurements of the insulation wall thickness shall be made on a cross section of the wires at 10x magnification or higher. The insulation wall thickness measurement shall be the shortest distance between the outermost rim of the primary insulation or of the finished wire, as applicable, and the outer rim of the outermost strand of the conductor.

2.1) Concentric lay stranding conductor
The thinnest measurement (T_{min}) and the thickest measurement (T_{max}) of the insulation shall be made on the identical cross section of the primary insulation layer or the finished wire. The concentricity (%) shall be computed using the following formula:

$$\text{Concentricity (\%)} = \frac{T_{min}}{T_{max}} \times 100$$

2.2) Rope-lay stranding conductor
The thickness shall be measured at four points at spacing approximately 90° apart in the cross section of the primary insulation or the finished wire. The first measurement shall be made at the thinnest points. The average value of these four measurements shall be an average thickness of the insulation. The concentricity (%) shall be computed with the following formula using the average thickness (T_{avg}) and the thinnest measurement (T_{min}) obtained at the first measurement:

$$\text{Concentricity (\%)} = \frac{T_{min}}{T_{ave}} \times 100$$

3) Finished diameter: The measurements shall be made with a micrometer caliper or any other instrument of equal accuracy.
4) Color: The color of the primary insulation layer shall be visually examined.

C.4.4.7.3 Weight

The weight of each wire shall be determined by Procedure I or II below.

a) Procedure I
The length, being 5m or longer, and the weight of a specimen shall be accurately measured and the resultant measurements converted to kilograms per 1km.

b) Procedure II
The net weight of the finished wire on each reel or spool shall be obtained by subtracting the tare weight of the reel or spool from the gross weight of the reel or spool and the wire thereon. The net weight of the wire on each reel or spool shall be divided by the exactly determined length of wire on that reel or spool and the resultant figure converted to kilograms per 1km. When wood or other moisture absorbent materials are used for reel or spool construction, weight determinations shall be made under substantially the same relative humidity conditions.

C.4.4.8 Externals, Construction and Weight of Cables

C.4.4.8.1 Externals

The specimen surface shall be inspected visually.

C.4.4.8.2 Construction

a) Wire cable
The wire cable shall be measured using a visual measuring tool of sufficient precision.

b) Shield
The shield shall be measured using a visual measuring tool of sufficient precision. The braid angle and percent coverage shall be determined in accordance with the following formulas.

$$\text{Braid angle: } \alpha = \mathrm{Tan}^{-1}\left(\frac{\pi(D + 2d)}{P}\right)(^\circ)$$

$$\text{Percent coverage: } K = 100(2F - F^2)\ (\%)$$

Where, $F = ECd/2P \sin\alpha$

F: Fill factor (area ratio covered by a group of unidirectional carriers)
P: Braiding pitch (mm)
E: Number of ends (wire strands) per carrier
C: Number of carriers (number of groups of a braid wire)
d: Diameter of an individual strand of the shield (mm)

D: Outside diameter of cable under the shield (mm)
For a cable without a filler, D = Gb
Where, G: Cable coefficient (Table C-15)
b: Wire diameter (mm)

Table C-15. Coefficient of Cable

Number of core	Coefficient
1	1.00
2	1.54
3	1.95

c) Jacket

1) Minimum jacket wall thickness
The minimum jacket wall thickness shall be measured at the thinnest points on a cross section of the wire. Thickness measurements of the jacket wall shall be made at 10x magnification or higher.

2) Thickness uniformity
The thinnest thickness (T_{min}) and the thickest thickness (T_{max}) of the jacket wall shall be measured on an identical cross section of a cable using a magnifier. The thickness uniformity shall be calculated using the following formula:

Thickness uniformity (%) = $\frac{T_{min}}{T_{max}} \times 100$

d) Finished diameter
The measurements shall be made using a micrometer caliper or any other instrument of equal accuracy.

C.4.4.8.3 Marking of Cable Core

The specimen shall be inspected visually.

C.4.4.8.4 Weight

A section of the cable shall be weighed in accordance with paragraph C.4.4.7.3.

C.4.4.9 Performance of Wires

C.4.4.9.1 Impulse Dielectric Test

C.4.4.9.1.1 Test Equipment

The electrode head through which the wire is passed in the impulse dielectric test shall be of a suitable bead chain construction such that the electrode will give intimate metallic contact with practically all of the wire insulation surface. The characteristics of the test impulse and of the equipment auxiliary to the electrode head shall be as follows.

a) Test impulse
The waveform of the voltage supplied to the electrode head shall consist of a negative pulse, the peak magnitude as specified for the wire under

test, followed by a damped oscillation. Unless otherwise specified in the detail specification, the peak impulse voltage for a wire of this specification shall be 8.0kV. The rise time of the negative impulse wave front from zero magnitude to 90% of the specified peak voltage shall be a maximum of 75μs.
The peak value of the first positive overshoot and each of the subsequent damped oscillations shall be smaller than the initial negative pulse. The time during which each pulse and accompanying damped oscillation (positive and negative) remains at an absolute potential of 80% or greater of the specified peak voltage shall be 20 to 100μs. The pulse repetition rate shall be 200Hz to 250Hz.

b) Capacitive tolerance
The tolerance of the equipment to change in capacitive load shall be such that the peak output voltage shall not be reduced by more than 12% in the event of an increase of capacitive load, between electrode and ground, from an initial load of 12.5pF to 25pF per 25.4mm of electrode length.

c) Instrument voltmeter
There shall be a peak reading voltmeter connected to the electrode head to continually measure the potential of the electrode. The voltmeter shall show full deflection at a potential not exceeding 15kV and shall have a minimum accuracy of ±4% at the specified test impulse potential.

d) Failure detection circuit
There shall be a failure detection circuit to give either a visible or audible indication of insulation failure, to automatically deenergize the electrode head, and to stop progress of the wire through the electrode. The detecting circuit shall be sufficiently sensitive to indicate a fault at 75% of the specified test voltage when the electrode is grounded through a 20kΩ resistor and shall be capable of detecting a fault which lasts for a duration of only one impulse.

C.4.4.9.1.2 Calibration of Equipment

The instrument voltmeter shall be calibrated by comparison with an external standard voltmeter capable of detecting the peak potential at the electrode head. In performing the calibration, the standard voltmeter shall be connected to one of the electrode beads directly or through a calibrated attenuator circuit. The impulse generator shall be energized and the voltage control of the impulse generator shall be adjusted until the reading on the standard voltmeter is the specified potential. At this point, the reading on the instrument voltmeter shall be observed and recorded. This calibration shall be repeated for each peak potential at which the equipment is intended to operate. An alternative procedure is to use a calibrated oscilloscope connected to the electrode through a suitable attenuator. The peak magnitude of the negative pulse can then be read directly from the waveform display.

C.4.4.9.1.3 Procedure

The finished wire shall be threaded through the electrode head and the conductor shall be grounded at one or both ends. The electrode shall be energized to the specified peak potential and, after final adjustment of the voltage with the wire in the electrode head, the wire shall be passed from the pay-off spool through the electrode and onto the take-up spool. The speed of passage of the wire through the electrode shall be such that the wire is subjected to between 3 and 100 pulses at any given point. At the point where any dielectric failure occurs, it shall be cut out or marked for later removal including at least 5cm of the wire on each side of the failure. Dielectric failures, untested portions of the wire, or portions which have been exposed to fewer or more than the specified number of pulses shall be removed subsequent to the test.

C.4.4.9.2 Conductor Strength

a) Nickel-plated oxygen-free copper wire
Elongation tests of oxygen-free copper conductors shall be performed with an individual conductor strand extracted from the finished wire in accordance with Method 3211 of FED-STD-228, except that the elongation at break shall be determined by means of a recording chart on the testing machine rather than by measuring the specimen after the break.

b) Nickel-plated high strength copper alloy wire
Elongation and tensile strength tests of high strength alloy conductors shall be performed in accordance with Method 3211 of FED-STD-228. The exception to this is that the tensile strength shall be reported as the tensile breaking strength of the conductor and the elongation at break of the first strand of the whole conductor shall be determined by means of a recording chart on the testing machine rather than by measuring the conductor specimen after the first strand breaks. The tests shall be performed with the whole conductor removed from the finished wire. Conductor elongation shall be measured when the first strand of the conductor breaks. The total tensile force, measured by the testing machine at the time the strand breaks, shall be regarded as the breaking strength of the conductor. The values obtained with the whole conductor shall be considered in determining the conformity of high strength alloy conductor to the elongation and tensile strength requirements of this specification.

C.4.4.9.3 Conductor Resistance

The DC resistance of the conductor shall be measured in accordance with Method 6021 of FED-STD-228 except that the wire shall be tested dry without immersion.

C.4.4.9.4 Insulation Resistance

The uninsulated ends of a wire specimen of a minimum length of 8m shall be connected to a positive DC terminal and the specimen shall be immersed within 15cm of its ends in a water bath, at 25±5ºC, containing 0.5 to 1.0% of an anionic

wetting agent. The specimen shall remain immersed longer than 4 hours after which a voltage between 250 and 500V shall be applied between the conductor and the water bath which serves as the second electrode. The insulation resistance shall be determined after one minute of electrification at this potential, and shall be expressed as megohms·km by the following calculation.

$$\text{Insulation resistance (M}\Omega\text{km)} = \frac{\text{Total specimen resistance (M}\Omega\text{) x Immersed length (m)}}{1000}$$

The specimen may be tested on the reel or removed from the reel provided the length of the specimen can be determined.

C.4.4.9.5 Shrinkage

A 30cm finished wire specimen shall be cut so that the insulation and conductor are flush at both ends. The specimen shall be maintained at 230±2ºC for 6 hours in an air oven. At the end of this period, the specimen shall be removed from the oven and allowed to return to room temperature. Shrinkage of the insulation shall then be measured at the point of the greatest distance insulation has receded from either end of the conductor. The measurement obtained showing the greater shrinkage shall be considered the shrinkage of the specimen.

C.4.4.9.6 Low Temperature (Cold Bend)

One end of a wire specimen approximately 1m in length shall be secured to a rotatable mandrel in a cold chamber and the other end to the load weight specified in the detail specification. The diameter of the mandrel shall be as specified in the detail specification. Provision shall be made for rotating the mandrel by means of a handle or a control located outside the chamber. The wire specimen and the mandrel shall be conditioned at -65±2ºC for 4 hours. At the end of this period, the specimen shall be wrapped helically for its entire length or for 20 turns whichever is the less around the mandrel without opening the chamber. The bending shall be accomplished at a uniform rate of 2rpm±1rpm. At the completion of this test, the specimen shall be removed from the cold box and from the mandrel without straightening. The specimen shall be examined for cracks in the insulation. The insulation shall then be removed for a distance of approximately 25cm from each end of the specimen and the specimen shall be subjected to the wet dielectric test specified in paragraph C.4.4.9.9 b) with the bent portion submerged.

C.4.4.9.7 Thermal Shock Resistance

A 1.5m wire specimen shall be prepared by carefully removing 25mm of insulation from each end of the wire. The exposed length of the conductor at each end of the specimen shall be measured to the nearest 1/100mm. The specimen shall be formed into a loose coil at a minimum of 30cm in diameter and shall be laid on a wire screen for handling throughout the test. The specimen shall be placed in a preheated air circulating oven at 200±2ºC for 30 minutes. The specimen shall

then be removed from the oven and, within two minutes, placed in a chamber which has been precooled to -55±2ºC. It shall be exposed to this temperature for 30 minutes, after which it shall be removed and allowed a minimum of 30 minutes to return to room temperature, 20 to 25ºC. At the conclusion of this cycle, the distance from the end of each layer of insulation to the end of the conductor shall be measured to the nearest 1/100mm. This thermal shock cycle and the measurements shall be repeated for three additional cycles for a total of four cycles.

C.4.4.9.8 Wrap Test

A 305mm long specimen shall be bent at the middle at a radius larger than that of the specimen and one side of the specimen shall be wrapped over the other side for four tight turns. The ends of the test piece are not to be secured and unwinding of the wires is allowed. The specimen shall be placed in a preheated air oven at 250±2ºC for two hours. The specimen shall then be visually inspected for cracks.

C.4.4.9.9 Life Cycle

The insulation shall be removed for a distance of 25mm from each end of an approximate 600mm sample of the finished wire. The central portion of the specimen shall then be bent over a horizontally placed mandrel of a diameter specified in the detail specification. Each end of the conductor shall be loaded with the weight specified in the detail specification. This prepared specimen on the mandrel shall be placed in an air-circulating oven and maintained at 230±2ºC for 500 hours. At the completion of the oven exposure, the specimen shall be cooled to a temperature between 20 and 25ºC, within a period of 1 hour. When cooled, the wire shall be freed from tension, removed from the mandrel, and straightened. The specimen shall then be subjected to the following tests in the order shown.

a) Bend test
   In a temperature maintained between 0 and 25ºC, one end of the specimen shall be secured to the mandrel and the other end to the load weight specified in the detail specification. The mandrel shall be rotated until the full length of the specimen is wrapped around the mandrel and is under the specified tension with adjoining coils in contact. The mandrel shall then be rotated in the reverse direction until the full length of the wire which was outside during the first wrapping is now next to the mandrel. This procedure shall be repeated until two bends in each direction have been made in the wire. The outer surface of the wire shall then be observed with 10x magnification for cracks in the insulation.
b) Wet dielectric test
   The uninsulated ends of the specimen shall be attached to an electric lead. The specimen shall be immersed in a 5%, by weight, solution of sodium chloride in water between 20 and 25ºC, except that the uninsulated ends and about 40mm of the insulated wire at each end of the specimen shall protrude above the surface of the solution. After immersion for 5 hours, a voltage of

2500V at a frequency of 50Hz or 60Hz shall be applied between the conductor and an electrode in contact with the liquid.

C.4.4.9.10 Immersion

The wire specimens of sufficient length to perform the subsequent tests shall be accurately gauged to determine their initial diameter and shall then be immersed within an approximate 150mm of their ends in each of the following fluids (using a separate specimen for each fluid) for the periods of time and at the temperatures specified.

a) Lubricating oil, aircraft turbine engine, synthetic base (MIL-PRF-23699): 7 hours at 175±2ºC.
b) Hydraulic fluid, petroleum base, aircraft, missile and ordnance (MIL-H-5606): 20 hours each at 48 to 50ºC and 20 to 25ºC.
c) Isopropyl alcohol (JIS K 1522): 20 hours at 20 to 25ºC.
d) Turbine fuel, aviation, grade JP-4 (MIL-DTL-5624): 20 hours at 20 to 25ºC.

During immersion, the bend radius of the wire shall be greater than fourteen times the maximum specified diameter of the wire under test. Upon removal from the liquids, the specimen shall remain at room temperature for 1 hour. The diameter shall be gauged accurately and compared to the initial diameter. Insulation pieces of 25mm in length shall be removed from each end of the specimen which is an approximate 600mm in length and shall be subjected to the bend test (C.4.4.9.9 a)) and the dielectric test (C.4.5.9.9 b)).

C.4.4.9.11 Humidity Resistance

An approximately 16m specimen of the wire shall be placed in a test chamber and the temperature and relative humidity raised to 70±2ºC and 95±5% respectively over a 2-hour period and maintained there for a period of 6 hours. At the end of the 6-hour period, the heat shall be turned off. During the following 16-hour period, the temperature shall drop to 38ºC or lower. At the end of the 16-hour period, heat shall again be supplied for a 2-hour period to stabilize at 70±2ºC. This cycle (2 hours heating, 6 hours at high temperature and humidity, 16 hours cooling) shall be repeated fifteen times for a total of 360 hours. At the end of the fifteenth cycle, about 15mm center section of the specimen shall be immersed in a 5%, by weight, solution of sodium chloride in water at room temperature. The insulation resistance of the specimen shall be measured with the outer surface of the specimen grounded, through an electrode in the electrolyte, and with a potential of 250 to 500V DC applied to the conductor of the specimen. The measurement shall be made after 1 minute of electrification at this potential. The insulation resistance shall be converted to megohms per 1km by the calculation shown in paragraph C.4.4.9.4.

C.4.4.9.12 Surface Resistance

The surface resistance of the finished wire shall be measured in accordance with Method 6041of FED-STD-228. All specimens, after having been provided with the required electrodes prior to testing, shall be cleaned by the procedure

described in the test method. The specimens shall be placed in the test chamber with the ends being at least 25mm from any test chamber wall.

C.4.4.9.13 Removability of Insulation

About 15mm of insulation material shall be removed by a mechanical wire stripping device, if applicable. The conductor shall be visually inspected for damage.

C.4.4.9.14 Continuous Lengths

The continuous length is determined by measuring the length between cuts, where the impulse dielectric test (paragraph C.4.4.9.1) was not properly executed or the insulation was found defective.

C.4.4.9.15 Radiation Hardness

An approximate 1m long specimen shall be exposed to gamma rays (cobalt 60) at the rate of 0.5 to $1x10^4$ Gy per hour until the total dose amounts reaching to $1x10^4$ Gy in the ambient condition. The wire surface shall then be visually inspected. Next, one end of the specimen is affixed to the mandrel leaving a minimum of 15cm from the end. With a load applied to the other end, the mandrel shall be rotated and the specimen shall be tightly wound on the mandrel for ten turns. The mandrel diameter and load shall be as specified in the detail specification. The specimen wound on the mandrel shall be removed without unwinding the coil, and is subjected to the wet dielectric test (C.4.4.9.9 b)).

C.4.4.9.16 Arc Tracking

The arc tracking test shall be conducted in accordance with Test 18 of CR-99122.

C.4.4.9.17 Flammability

The flammability test shall be conducted in accordance with Test 4 of CR-99122.

C.4.4.9.18 Blocking

One end of the finished wire shall be affixed to a metal spool of the barrel diameter specified for the applicable wire size in the detail specification. The wire shall then be wound helically on the spool for at least three turns, with the succeeding turns in close contact with one another. The winding shall continue until there are at least three closely-wound layers of such helical turns on the spool. The tension for winding shall be the load specified in the detail specification. The free end of the wire shall then be affixed to the spool to prevent unwinding or loosening of the turns or layers. The spool and wire shall be placed in an air oven at 200±2ºC for 24 hours. At the end of the 24-hour period, the spool and wire shall be removed from the oven and allowed to cool to room temperature. After cooling, the wire shall be examined for evidence of adhesion (blocking) of adjacent turns or layers as the wire is manually unwound.

C.4.4.9.19 Odor

The odor test shall be performed with 40g of the covering material from the finished wire in accordance with Test 6 of CR-99122.

C.4.4.9.20 Off-Gas

The off-gas test shall be performed with 40g of the covering material from the finished wire in accordance with Test 7 of CR-99122. The coefficient of the material rating of MAPTIS shall be an A rating (Wu=4536).

C.4.4.10 Performance of Cables

C.4.4.10.1 Continuity

The continuity of each wire of all cables wound on a reel or made into a bundle shall be tested by a tester or any other appropriate indicator.

C.4.4.10.2 Voltage Withstanding

The entire length of the finished cable specimen shall be tested in accordance with Method 6111 of FED-STD-228 except that the specimen shall be tested dry, not be immersed in water. 1500V at a frequency of 50Hz or 60Hz shall be applied between an individual strand of the conductor and other strands as whole, or a shield. The test voltage shall be applied for a period of 15 to 30 seconds.

C.4.4.10.3 Low Temperature (Cold Bend)

One end of an approximately 1m long specimen taken from the finished cable shall be secured to a rotatable mandrel in a cold chamber and the other end to the load weight. The load shall be sufficient to keep the wires perpendicular to the mandrel. The diameter of the mandrel shall be as specified in Table C-16. Provision shall be made for rotating the mandrel by means of a handle or a control located outside the chamber. The specimen of wire and the mandrel shall be conditioned at -65±2ºC for 4 hours. At the end of this period, the specimen shall be helically wrapped, for its entire length around the mandrel without opening the chamber. The bending shall be accomplished at a uniform rate of 2rpm±1rpm. At the completion of this test, the specimen shall be removed from the cold box and from the mandrel without straightening. The specimen shall be visually examined for cracks in the jacket surface.

Table C-16. Diameter of Test Mandrel

D: Cable diameter (mm)	Mandrel diameter (±3%) (mm)
D≤3.18	76.2
3.18<D≤6.35	152.4

C.4.4.10.4 Thermal Shock Resistance

One end of a wire specimen taken from the finished cable shall be secured to a mandrel of the diameter specified in Table C-17. The specimen shall be wrapped

tightly for a minimum of 6 turns. The specimen shall be placed in a preheated air circulating oven at 230±2ºC for 4 hours. At the end of the 4-hour period, the specimen shall be removed from the oven and cooled at room temperature. The jacket surface shall then be visually inspected for cracks.

Table C-17. Diameter of Test Mandrel

D: Cable diameter (mm)	Mandrel diameter (± 3%) (mm)
D≤2.11	19.05
2.11<D≤2.82	25.40
2.82<D≤3.53	31.75
3.53<D≤4.93	44.45
4.93<D≤6.35	57.15

C.4.4.10.5 Aging Resistance

A specimen taken from the finished cable shall be placed in a preheated air circulating oven at 230±2ºC for 96 hours. At the end of this period, the specimen shall be removed from the oven and wound around the mandrel of the diameter specified in Table C-17 for at least 1 turn at room temperature. The bending shall be accomplished at a uniform rate of 15rpm±3rpm. The jacket surface shall then be visually inspected for cracks.

C.4.4.10.6 Jacket Defect

For wires with a shield, the whole length of the specimen shall be passed through an applicable spark tester. The electrode of the spark tester shall be in contact with the jacket surface and 1500V_{AC} shall be applied between the electrode and the shield.
The length of the electrode and the speed of the cable to pass through the electrode shall be adjusted such that the voltage shall be applied to the jacket for minimum 0.2 seconds.

C.4.4.10.7 Removability of Jacket

A cut shall be made around the jacket's circumference at the point 100mm from a cable end. The cable shall be bent at the cut and the jacket shall be separated. Then, the jacket with the length of 100mm shall be pulled by hand or a grip jig to remove the jacket from the cable.

C.4.4.10.8 Continuous Lengths

Prior to the delivery to the purchaser, the length of each cable consisting of a shipping lot shall be inspected for their conformance to the requirements of paragraph C.3.8.8.

C.4.4.10.9 Radiation Hardness

An approximate 1m long specimen taken from a finished cable shall be exposed to gamma rays (cobalt 60) at the rate of 0.5 to 1x10^4Gy per hour until the total

dose amounts reaching to $1x10^4$Gy in the ambient condition. One end of the specimen is affixed to the mandrel of the diameter specified in Table C-16. With a load applied to the other end, the mandrel shall be rotated and the entire length of the specimen shall be tightly wound on the mandrel. The load shall be sufficient to keep the cables perpendicular to the mandrel. The surface of the specimen jacket shall then be visually inspected.

C.4.4.10.10 Upward Flame Propagation Test

The upward flame propagation test shall be conducted in accordance with Test 1 of CR-99122 except that the test specimen shall be a 30cm long completed cable and it shall be fixed to the center of the test stage.

C.4.4.10.11 Blocking

Blocking shall be tested as specified in paragraph C.4.4.9.18, and the following conditions shall apply.

a) The cable shall be wound with a sufficient load to keep the cable perpendicular to the reel.
b) Before testing, the cable shall be placed in a preheated air oven at 200±2ºC for six hours.

C.4.4.10.12 Odor

The odor test shall be conducted as specified in paragraph C.4.4.9.19.

C.4.4.10.13 Off-Gas

The off-gas test shall be conducted as specified in paragraph C.4.4.9.20.

C.4.5 Product Identification

Unless otherwise specified in the detail specification, the following items shall be marked on the tag or reel for the wires and on the jacket surface for the cables.

a) Part number in the detail specification
b) Name or abbreviation code of the QML manufacturer

The marking on the cable surface shall be in black and at intervals of 230mm to 480mm. All printed characters shall be legible.

C.4.6 Long-Term Storage

When wires or cables have been stored for a long term, the wires shall be subjected to the impulse dielectric test (paragraph C.4.4.9.1) and the cables shall be subjected to the jacket defect test (paragraph C.4.4.10.6).

C.5. Preparation for Delivery

Preparation for delivery shall be as follows and as specified in Section 5.

C.5.1 Reels

The wires or cables shall be shipped wound on reels that have appropriate diameters for each wire or cable size. For the wires, the reel diameters shall be the values

specified in Table C-18 or 75mm, whichever is larger. The cables shall be wound on reels with a diameter that is a minimum of 30 times the cable diameter.

Table C-18. Barrel Diameters of Reels

Wire size (AWG)	Minimum diameter of barrel (As times minimum diameter of finished wire)
26 to 14	50 times
12 to 10	40 times
8	30 times

C.5.2 Winding Requirements

Unless otherwise specified in the purchase order, there are no restrictions for the number of windings on a reel or the number of cables as long as the inspection lots satisfy the requirements of continuous length specified in paragraph C.3.7.14 and paragraph C.3.8.8.

C.5.3 Marking on Packaging

The package marking shall be in accordance with the requirements specified in paragraph 5 of JAXA-QTS-2000. In addition, each continuous length of the wire or cable wound on the reel shall be indicated on the tag or the reel surface in accordance with paragraph C.3.7.14 and paragraph C.3.8.8 herein.

C.6. Notes

Notes shall be in accordance with Section 6.