nationalgrid

Lockport-Batavia Line #112
Rebuild Project

Appendix U

QA/QC Plan

Lockport-Batavia 112 Line Rebuild

Project Materials Quality Control & Quality Assurance Plan

The following document details the methodology to be employed on the Lockport – Batavia 112 Line Rebuild Project to demonstrate that those materials required to safely construct the new facilities have been furnished in accordance with the appropriate industry and National Grid standards.

Reporting and Document Management

All reports associated with material quality review shall be made available to the internal project team via ProjectWise and to external stakeholders via the Project Specific SharePoint Site.

The Project Engineer shall be the point of contact between the vendor and National Grid. The Project Engineer or designee shall be responsible for the timely review and response to any technical or fabrication issues encountered.

Steel Pole Structures & Anchor Bolts

The steel pole supplier associated with the Project shall be regularly engaged in the fabrication of steel pole transmission structures, have a staff regularly engaged in the design and detailing of tubular steel poles, have a published Quality Manual detailing activities from raw material purchase to final inspection and coating to shipping, and employ AWS certified welding inspectors. It is the intention of this Project to utilize the steel pole supplier's personnel and procedures to ensure the rigorous enforcement of their own QA/QC procedures and any supplemental procedures necessary to ensure conformance with the Project requirements on all steel pole structures and anchor bolt clusters associated with the Project.

The steel pole vendor shall be required to submit the following details to demonstrate conformance with the Project specifications:

- A fabrication plan, including the number of facilities used for manufacturing and their geographical location
- A material plan, including the material type, source, and specification to be used for poles, base plates, and arms
- An inspection & testing plan that covers the details of testing and inspection including applicable weld standards, performance requirements, sampling frequency, and testing method for each component to demonstrate compliance with Project specifications
- Vendor's assembly, handling, storage and standard installation procedures inclusive of any procedure necessary to prevent arm damage prior to conductor and/or insulator installation due to wind induced vibration
- Fabrication drawings and anchor bolt cluster drawings

Oversight of the steel pole fabrication process will be conducted in a phased approach such that the project is clearly defined with the vendor's internal QA/QC procedures reviewed, supplemented, and accepted as applicable, followed by a detailed review of the Project specific submittals and preparation for fabrication activities. The final phase of oversight will be the periodic review and enforcement of the supplier's procedures in alignment with the Project specification.

The Construction Service Provider (CSP) or National Grid Construction Supervision shall perform a visual QA/QC inspection of all steel pole elements as they are delivered to the project marshalling yards to ensure no damage has occurred during shipment. To the extent that damage has occurred, the CSP shall identify such damage so that it can be repaired without adverse impact to Project schedule. The individual doing the visual inspection of steel poles and anchor bolt clusters shall have a minimum of ten years of experience in material management associated with transmission line construction. The steel pole vendor shall provide field services of representatives, equipment and materials to correct errors, discrepancies or omissions in the structures furnished for the Project.

Lastly, the steel pole vendor shall be required to submit calculations and fabrication drawings bearing the seal of a Professional Engineer licensed in the State of New York upon completion of shipment of all materials and calculations. The design of the steel pole structures shall be in accordance with ASCE 48 *Design of Steel Transmission Pole Structures* and all relevant Project specifications.

Concrete

Use of a concrete supplier shall be based on the selection of the CSP. The CSP shall be required to conform to Section 17 of SP.06.01.301 unless otherwise approved for specific justifiable reasons by the Project Engineer or Designee. All concrete mix designs shall be submitted to the Project Engineer following the award of the construction contract associated with the Project. Seven (7) day and 28-day break tests shall be required as part of the Project and shall be submitted for review to the Project Engineer. All concrete test samples shall be taken in accordance with ACI 336.1.

Reinforcing Steel

The procurement of reinforcing steel shall be the responsibility of the CSP with the exception of any anchor bolt clusters (see Steel Pole Structures & Anchor Bolts above). All reinforcing steel purchased in association with the Project shall conform to National Grid Document SP.06.01.402 “Reinforcing Steel”. Prior to installation, the reporting requirements set forth in Section 2.2 of SP.06.01.402 shall be met with documentation provided to the Project Engineer for review and acceptance prior to installation. National Grid Document SP.06.01.402 is included as Attachment 1 to this document.

Conductor

The following requirements have been imposed on the all conductor vendors and their designees associated with Project as part of the bid documents associated with conductor procurement.

All conductor associated with this bid package shall be subject to the review of conformance with industry standards and good practice prior to shipment to National Grid. The selected vendor shall provide the following minimum information to demonstrate compliance:

1. *Formal documentation of conformance with all applicable ASTM Standards referenced in SP.06.01.418.*
2. *Formal documentation that the finish of all wires furnished have a non-specular finish in accordance with ASTM 8979*
3. *Formal documentation of conformance with all packaging requirements associated with the project specific documents*

All documentation shall be provided to the Project Engineer a minimum of ten working days prior to shipment from the manufacturer for review. Shipment of materials shall not be made without confirmation from the Project Engineer or designee.

As part of this request for quote, vendors are to provide examples of the above referenced documentation for National Grid review.

National Grid specification SP.06.01.418 is provided as Attachment 2 to this document.

Shield Wire

The following requirements have been imposed on all shield wire vendors and their designees associated with the Project as part of the bid documents associated with shield wire procurement.

All shield wire associated with this bid package shall be subject to the review of conformance with industry standards and good practice prior to shipment to National Grid. The selected vendor shall provide the following minimum information to demonstrate compliance:

- *Formal documentation of conformance with all applicable ASTM standards.*

All documentation shall be provided to the Project Engineer a minimum of ten working days prior to shipment from the manufacturer for review. Shipment of materials shall not be made without confirmation from the Project Engineer or designee.

As part of this request for quote, vendors are to provide examples of the above referenced documentation for National Grid review.

Fiber Optic Ground Wire (OPGW) & Hardware

The following requirements have been imposed on all OPGW vendors and their designees associated with the Project as part of the OPGW procurement.

All cable associated with this bid package shall be subject to the review of conformance with industry standards and good practice prior to shipment to National Grid. The selected vendor shall provide the following minimum information to demonstrate compliance:

1. *Formal documentation of conformance with all applicable standards referenced in SP.06.01.413*
2. *Formal documentation of conformance with all packaging requirements associated with the project specific documents*
3. *Proof of continuity of fiber on each reel prior to shipment*

All documentation shall be provided to the Project Engineer a minimum of ten working days prior to shipment from the manufacturer for review. Shipment of materials shall not be made without confirmation from the Project Engineer or designee.

As part of this request for quote, vendors are to provide examples of the above referenced documentation for National Grid review.

National Grid specification SP.06.01.413 is provided as Attachment 3 to this document.

Insulators

All disc insulators procured for the Project shall conform to National Grid document SP.06.01.420 “Porcelain and Toughened Glass Insulators” and all disc insulators supplied in association shall be toughened glass. Document SP.06.01.420 is supplied as Attachment 4 to this document.

All insulators furnished in association with the Project shall be sourced through the National Grid store room and be subject to the quality control and quality assurance procedures managed by the store room.

Transmission Line Hardware

The bulk of hardware furnished in association with the Project shall be sourced through a hardware distributor. Prior to shipping the material to National Grid, the chosen distributor will be responsible for quality control and quality assurance of the material received from the providing manufacturers. All material shall be in conformance with their applicable standards and reviewed for conformance upon delivery to the site.

Attachment 1
SP.06.01.402 - “Reinforcing Steel”

Reinforcing Steel

Table of Contents

1.0 GENERAL

1.1 SCOPE

The scope of work includes furnishing, fabrication and delivery of deformed reinforcing steel, tie wires and bar supports for concrete foundations.

1.2 DEFINITIONS

Certain terms and abbreviations used throughout this specification are defined as follows:

- ASTM - American Society for Testing and Materials.
- Supplier - Fabricator of reinforcing steel, tie wire & bar supports.

1.3 REFERENCES

References to industry standards are made throughout this specification. The following specifications and codes, in their latest revisions, are incorporated as part of this specification:

- ASTM A615, "Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement."
- ASTM A700, “Standard Guide for Packaging, Marking, And Loading Methods for Steel Products for Shipment.”

1.4 DRAWINGS & SUPPLEMENTAL SPECIFICATION

Drawings and supplemental specification furnished by National Grid provide fabrication details & additional requirement for the supply of reinforcing steel, tie wire & bar supports under this specification.

2.0 REINFORCING STEEL

2.1 Reinforcing steel shall be deformed bars for concrete reinforcement conforming to ASTM A615, Grade 60.

2.2 Certified mill test reports are required for each heat. Certificates of conformance to ASTM A615 requirements are also required upon request for each heat.

2.3 Reinforcing bar sizes and quantities shall be as indicated in the Drawings & Supplemental Specification. Welding of reinforcement is not allowed.

2.4 Steel shall be cut and bent in accordance with the Drawings such that field cutting or bending will not be required.

3.0 TIE WIRE

3.1 Tie wire shall be 16.5 gauge or heavier, black annealed, conforming to the standards established by the Concrete Reinforcing Steel Institute.

3.2 Tie wire quantity shall be as indicated in the Supplemental Specification.

4.0 BAR SUPPORTS

4.1 Bar supports shall be precast concrete blocks meeting the standards established by the Concrete Reinforcing Steel Institute. Blocks shall have a minimum compression strength of 6,000 psi.

5.0 PACKAGING AND MARKING

5.1 Marking shall be in accordance with ASTM A700 and the Supplier's standard practices.

5.2 Packaging shall be in accordance with ASTM A700 and the Supplier's standard practices.

Revision History

Version	Date	Revision	Author	Reviewer	Approver
1.0	03/07/06	Initial Issue			Mark Browne
2.0	10/08/10	Conductor periodic document review -Removed specifications for drawing creation and bar bundles, these services are not required	Jeremy Cote		Mark Browne
3.0	11/29/23	FY24 full cycle review. Included Section 1.2 Definitions, Section 1.3 References, & Section 1.4 Drawings, removed revision year of referenced ASTM standards & formatting edits.	Sophia Ma	GPS Committee	Nicole Nims, Fawad Amjad

Attachment 2
SP.06.01.428 – “Overhead Transmission Line Conductors”

Overhead Transmission Line Conductors

Table of Contents

1.0 General

1.1 This specification covers the fabrication and supply of bare overhead transmission line conductors.

1.2 Upon request by the Owner, the Manufacturer at its expense shall provide proof of conformance with any or all requirements of this specification.

1.3 Upon request by the Owner, the Manufacturer at its expense shall provide, a qualified on-site technical field representative to provide advice and guidance during conductor stringing, sagging, or clipping-in.

2.0 Definitions

2.1 Owner – National Grid

2.2 Manufacturer – the entity responsible for manufacturing and providing the conductor

3.0 References

3.1		ASTM B979 Aluminum Association Non-Specular Surface Finish on Bare Overhead Aluminum Conductors
3.2		ASTM B193 Standard Test Method for Resistivity of Electrical Conductor Materials
3.3		ASTM B230 Standard Specification for Aluminum 1350-H19 Wire for Electrical Purposes
3.4	ASTM B231	Standard Specification for Concentric-Lay-Stranded Aluminum 1350 Conductors
3.5	ASTM B232	Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Coated-Steel Reinforced (ACSR)
3.6	ASTM B398	Standard Specification for Aluminum-Alloy 6201-T81 Wire for Electrical Purposes
3.7	ASTM B399	Standard Specification for Concentric-Lay-Stranded Aluminum-Alloy 6201-T81 Conductors
3.8	ASTM B498	Standard Specification for Zinc-Coated (Galvanized) Steel Core Wire for Use in Overhead Electrical Conductors
3.9	ASTM B500	Standard Specification for Metallic Coated Stranded Steel Core for Use in Overhead Electrical Conductors
3.10	ASTM B524	Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Aluminum-Alloy Reinforced (ACAR, 1350/6201)
3.11	ASTM B557	Standard Test Methods for Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products

3.12 ASTM B802 Standard Specification for Zinc-5% Aluminum-Mischmetal Alloy-Coated Steel Core Wire for Aluminum Conductors, Steel Reinforced (ACSR)

3.13 ASTM B856 Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Coated Steel Supported (ACSS)

3.14 ASTM B857 Standard Specification for Shaped Wire Compact Concentric-Lay-Stranded Aluminum Conductors, Coated-Steel Supported (ACSS/TW)

3.15 ASTM B941 Standard Specification for Heat Resistance Aluminum-Zirconium Allow Wire for Electrical Purposes

3.16 ASTM B987 / B987M-17e1 “Standard Specification for Carbon Fiber Thermoset Polymer Matrix Composite Core (CFC) for use in Overhead Electrical Conductors.

3.17 NEMA WC-26 Binational Wire and Cable Packaging Standard

4.0 Standards

4.1 Conductors shall meet the applicable requirements of the ASTM standards indicated in Table 1.

Table 1 ASTM Standards

Type	B193	B230	B231	B232	B398	B399	B498	B500	B524	B557	B802	B856	B857	B941	B987/M
AAC		X	X												
AAAC					X	X									
ACAR		X			X				X						
ACCC		X											X		X
ACSR		X		X			X	X			X				
ACSS											X	X			
ACSS/TW											X		X		
ACCR[1]	X									X				X	

5.0 Materials and Manufacturing Processes

5.1 The wires for conductors other than ACCR shall be either continuously cast or hot rolled. The reinforcing wires for ACSR shall be standard galvanized (Class A) steel unless otherwise specified. The galvanizing shall be done either by the hot-dipped or electro-magnetic process. Alternate coatings shall be subject to the approval of the Owner.

[1] ACCR shall comply with the proprietary specifications of 3M as contained in the Type Registration for this product.

5.2 Reinforcing steel core wire for ACSS shall be coated with Class A, Zinc-5% Aluminum-Mischmetal Alloy conforming to ASTM B802 suitable for continuous operating temperatures up to 250°C.

6.0 Fabrication

6.1 Conductor shall be stranded so as to minimize the tendency for the individual wires to fly apart when the conductor is cut in preparation for splicing for dead-ending. Forming processes for the conductor shall conform to the applicable ASTM specifications. Preforming of the aluminum wires is desirable, but not required by these Provisions.

6.2 Conductor stranding processes shall conform to the applicable ASTM or proprietary specifications according to Table 1.

6.3 Conductor shall be suitable for stringing and tensioning under the controlled-tension method, and free of any tendency to “birdcage” or have humped or popped strands.

7.0 Testing and Inspection

7.1 The Manufacturer shall maintain a quality control program in accordance with appropriate ASTM standards.

8.0 Finish

8.1 Conductors shall have non-specular surface finish in accordance with ASTM B979.

9.0 Packaging

9.1 Reels shall conform to NEMA WC-26.

9.2 The minimum drum diameter shall be 20 times the outside diameter of conductor.

9.3 Conductor shall be provided on the reel specific to the conductor type and size listed in Appendix A. For conductors not listed in Appendix A, the reel shall match as closely as possible to the most comparable conductor in Appendix A.

9.4 The length of conductor on each reel shall be the length listed in Appendix A. The length of conductor on a reel may not be less than the length required. For conductors not listed in Appendix A, the conductor length shall match as closely as possible to the most comparable conductor in Appendix A. The length may exceed the length required by no more than 100 feet or five percent whichever is less.

9.5 Reels and reel components shall be constructed of steel. Wood and wood components shall not be used.

9.6 Reels shall be Class 1 steel fluted reels meeting the requirements of Section 2.1.2 of NEMA WC-26, except that Class 2 Steel Fluted reels shall be used if needed to support the conductor weight and/or movement/transportation loads.

9.7 Reels shall use Level 4 protective coverings as defined in NEMA WC-26 Section 4. Packaging material shall be weather resistant solid fiberboard in accordance with Table 4-2 of NEMA WC-26.

9.8 No paper or other type of material shall be placed between the layers of the spooled conductor.

9.9 Arbor hole diameters shall meet the requirements of NEMA WC-26 Section 2. As a general rule, National Grid prefers and requests that reels with arbor holes at 5.25 inches in diameter be provided. The arbor hole shall be flush with the cross arms, and it shall not protrude beyond the edge of the cross arms. Additionally, the arbor hole shall be free of any tubing connecting the arbor holes from each flange.

9.10 All reels shall contain a minimum of 4 drive pin holes, 2 on each side of the reel opposing each other. The drive pin holes shall be located on the reel crossarms. The drive pin holes shall be flush with the arbor hole. The drive pin holes shall be 1.75 inches (+/- 0.25 inches) in diameter and shall be located on the reel at a minimum radius of 10 inches and maximum radius of 15 inches from the center of the arbor hole.

9.11 The “tail” (final few inches of the spooled conductor) shall be well-secured to the reel.

9.12 Marking shall conform to NEMA WC-26 Section 5 and include the following additional information printed on a metal tag:

9.12.1 Project name

9.12.2 National Grid purchase order number

9.12.3 Conductor size, type and name

9.12.4 Length of conductor on reel

9.12.5 Gross, net and tare weight of reel

9.12.6 Manufacturer name

9.12.7 Date of manufacture and run number

9.12.8 Reel serial number

Appendix A – Reel Requirements for Various Conductor

Size		Type	Name	National Grid Conductor ID (SAP)	National Grid Conductor ID (Legacy)	Reel Designation (see Note 1)	Conductor Length on Reel (feet)
4/0	AWG	ACSR	Penguin	9316034	4035211	RM 40.24	5400
336.4	kcmil	ACSR	Oriole	9316036	4035207	RM 48.24	4100
336.4	kcmil	AAC	Tulip	9316037	4035204	RM 48.24	4000
336.4	kcmil	ACSR	Merlin	9315752	4035236	RM 48.24	3795
336.4	kcmil	ACSR	Linnet	9314933	4035223	RM 60.32	8205
394.5	kcmil	AAAC	Canton	9313276	5941537	RM 48.24	4500
465.4	kcmil	AAAC	Cairo	9301948	5106564	RM 48.24	3700
477	kcmil	AAC	Cosmos	9314655	0811125	RM 48.24	4245
477	kcmil	ACSR	Hawk	9302780	5941551	RM 48.24	5785
477	kcmil	ACSR	Pelican	9301947	5106565	RM 54.32	4800
605	kcmil	ACSR	Squab			RM 60.32	5100
628.7	kcmil	ACSR		9301946	5106568	RM 60.32	5200
636	kcmil	AAC	Orchid	9302815	5941609	RM 66.32	6200
636	kcmil	ACSR	Swift	9301945	5106569	RM 60.32	5200
636	kcmil	ACSR	Egret	9301944	5106570	RM 66.32	5300
795	kcmil	AAC	Arbutus	9302781	5941790	RM 66.32	4960
795	kcmil	ACSR	Condor	9302831	5941794	RM 72.36	5770
795	kcmil	ACSR	Tern	9301935	5106571	RM 72.36	6300
795	kcmil	ACSR	Mallard	9301934	5106572	RM 72.36	5500
795	kcmil	ACSR	Drake	9315757	4035224	RMT 90.45	10400
795	kcmil	ACSR	Coot	9315767	4035243	RM 66.32	5300
900	kcmil	AAC	Cockscomb	9302830	5941779	RM 72.36	6200
954	kcmil	ACSR	Rail	9313275	5941805	RM 72.36	5400
954	kcmil	ACSR	Cardinal	9387385	N/A	RMT 90.45	9600
1024.5	kcmil	ACAR		9387238	9387238	RMT 90.45	9700
1033.5	kcmil	ACSR	Ortolan	9387346	N/A	RMT 84.45	6000
1113	kcmil	AAC	Marigold	9302829	5941813	RM 78.36	4900
1113	kcmil	ACSR	Finch	9302828	5941814	RMT 96.60	13300
1192.5	kcmil	ACSR	Bunting	9315751	4035241	RMT 84.45	5100
1192.5	kcmil	ACSR	Grackle	9315750	4035242	RMT 84.45	5000
1351.5	kcmil	ACSR	Dipper	9315701	4016010	RMT 84.45	4400
1590	kcmil	AAC	Coreopsis	9302663	5949715	RMT 84.55	4800
1590	kcmil	ACSR	Falcon	9302827	5941913	RMT 96.60	12600
1703	kcmil	ACAR		9301932	5106573	RMT 96.71	9200
2156	kcmil	ACSR	Bluebird	9302826	5941920	RMT 108.85	9300
2167	kcmil	ACSR	Kiwi	9315769	4035245	RMT 96.71	6900
2335	kcmil	ACAR		9301931	5106574	RMT 96.71	6900
2839.8	kcmil	ACSR				RMT 96.71	5200

Note 1: The six or seven characters in the reel designation are interpreted as follows: The letters identify the reel type. The first two numbers represent the flange diameter of the reel in inches. The second two numbers represent the traverse of the reel in inches. Refer to NEMA WC-26 for further information.

Revision History

Version	Date	Revision	Author	Reviewer	Approver
1.0	2/22/2008	Original Issue	Mark Browne/Jeremy Cote		Mark Browne
1.1	04/30/2008	Changed requirement for conductor core wires to Class A galvanizing	Jeremy Cote		Mark Browne
1.2	07/07/2008	Revised ACSS and general specification	Jeremy Cote		Mark Browne
1.3	03/05/2009	Added requirement for returnable metal reels and heavy wood lagging	Jeremy Cote		Mark Browne
2.0	03/30/2010	Conducted document review per PR.06.01.003 and PR.06.01.016 -Removed section on standard conductors (not relevant to this specification) -Added standard packaging requirements -Added specifications for ACAR and AAAC	Jeremy Cote	Sara Migdal	Mark Browne
2.1	03/21/2011	Updated Table 1: ASTM Table and added non-specular specification Completed minor revisions to incorporate ACCR	Natasha Deschene Jeremy Cote		Mark Browne
2.2	11/15/2012	Updated Appendix A with new SAP ID numbers.	Phyllis Wall	Lisa Sasur	Mark Browne
3.0	02/08/2013	-Added requirement that reel must be steel -Added additional requirements for arbor holes and drive pin holes -Added section 8.6 (no paper between reels) and 8.9 (tail should be well secured) -Deleted section about F.O.B. delivery	Natasha Deschene		Mark Browne

3.1	03/03/2014	-Revised reel sizes to meet aluminum association reel code. -AA C7.69 Aluminum Association Non-Specular Surface Finish on Bare Overhead Aluminum Conductors superseded by ASTM B 979. - New item id's added for ASCR Ortolan, Cardinal and ACAR 1024.5 - Removed reference to MS2400	Natasha Deschene	Brian Reynolds	Mark Browne
3.2	07/07/2015	-Revised packaging section to clarify information should be "printed on a metal tag".	Natasha Deschene	Phyllis Wall	Mark Browne
3.3	05/24/2019	Added ACCC, update Table of Contents	Mark Browne		Natasha Deschene
3.4	01/08/2020	Corrected SAP and PS ID's for "Cardinal" and PS ID's for "Cosmos" and "Ortolan."	Brian Reynolds	Jeanne Marinelli	Nicole Maglione
3.5	04/12/2022	Added 5.25" diameter arbor hole to section 9.9 as National Grid preference. Clarified drive hole requirement in section 9.10	Brian Reynolds	Jeff Steiner, Jon Gonynor, Sophia Ma, Dilip Kommineni	Pauline Bassil

Attachment 3
SP.06.01.413 – “Optical Ground Wire (OPGW) Fiberoptic Cable”

Optical Ground Wire (OPGW) Fiberoptic Cable

Table of Contents

1.0 General

1.1 This specification outlines the technical (optical, electrical, and mechanical) requirements for the design, manufacture, performance testing, packaging, and shipping of composite overhead ground wire with optical fibers, commonly known as OPGW. The OPGW serves the dual function of an overhead ground wire and a telecommunications path.

1.2 The technical requirements of this specification are intended to ensure proper lightning protection and fault current carrying capacity, and long-term optical fiber integrity and optical transmission quality.

1.3 General dimensions for the OPGW shall be determined by the Manufacturer, subject to meeting the requirements of these specifications.

2.0 Specifications

2.1 All OPGW strand data, test reports, charts and specifications referencing dimensional, mechanical, and electrical specifications, are to be published to include US customary units *(English)*.

2.2 All fiber optical data, test reports, charts and specifications referencing dimensional and optical specifications are to be published using the usual and customary units of measurement.

2.3 Except as otherwise specified in this specification, requirements for the individual metallic wires, aluminum/stainless tube/rod, and completed OPGW shall be generally in accordance with the latest edition/revision of the following specifications:

ASTM B483	Specification for Aluminum and Aluminum-Alloy Drawn Tube and Drawn pipe for General Purpose Applications
ASTM B415	Specification for Hard-Drawn Aluminum-Clad Steel Wire
ASTM B398	Standard Specification for Aluminum-Alloy 6201-T81 Wire and 6201-T83 Wire for Electrical Purposes
ASTM B399	Standard Specification for Concentric-Lay-Stranded Aluminum Alloy 6201-T81 Conductors
ASTM B416	Standard Specification for Concentric-Lay-Stranded Aluminum-Clad Steel Conductors
ASTM A632	Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing (Small-Diameter) for General Service
EIA-359-A	Standard Colors for Color Identification and Coding
TIA/EIA-598-C	Optical Fiber Cable Color Coding

IEEE 1138-2021 IEEE Standard for Testing and Performance for Optical Ground Wire (OPGW) for Use on Electric Utility Power Lines

3.0 Stranded Metallic Wire

3.1 The stranded metallic (aluminum clad steel and or aluminum alloy) wires may be assembled in one or more layers, comprised of one or more types of metallic wires in each layer. The outer layer shall be left hand lay unless otherwise specified. The direction of lay shall be reversed in successive layers.

3.2 The preferred length of lay for the various layers of wires is 13 1/2 times the outside diameter of the layer. In no case, however, shall the lay be less than 10 times nor more than 16 times this diameter.

3.3 The wires shall be so stranded that when the completed OPGW is cut, the individual wires can be readily regrouped and held in place with one hand.

3.4 The rated breaking strength of the completed OPGW shall not exceed 90 percent of the sum of the rated breaking strengths of the individual wires. The strength of the fiber optic unit shall not be included in the rated breaking strength.

4.0 Central Fiber Optic Unit

4.1 The fiber optic unit shall be designed to house the optical fibers to protect them from damage due to crushing, bending, twisting, tensile stress and moisture. When combined with the stranded metallic wires, the fiber optic unit and metallic wires shall protect the optical fibers from degradation due to vibration and galloping, wind and ice loading, wide variations in temperature, lightning and fault currents, and environmental effects that produce hydrogen.

4.2 The fiber optic unit shall include the optical fibers, aluminum tubes or stainless steel tubes, a filling compound and one or more central strength members.

4.2.1 Aluminum Tube, Stainless Steel Tube

a. When an aluminum or stainless steel tube is used as part of the fiber optic unit, the tube shall be an extruded seamless or welded seam tube.

4.2.2 Filling Compound

a. The spaces between the individual optical fibers, and the optical fibers and the tubes shall be filled with a suitable filling compound to inhibit any moisture ingress from outside and migration of water

within the fiber optic unit. The filling compound used shall be compatible with the other components of the fiber optic unit. It shall absorb, and or inhibit the generation of hydrogen within the fiber optic unit.

4.2.3 Central Strength Member

a. One or more non-metallic central strength members may be included in the fiber optic unit to limit the stress on the optical fibers.

5.0 Optical Fibers

5.1 Optical fibers shall be single mode, Corning® SMF-28e+®LL or approved equal in the quantities specified in the Material Package.

5.2 Optical fibers shall meet the current Corning® SMF-28e+®LL specifications. The manufacturer shall report any discrepancies to the OWNER.

6.0 Buffer Tubes

6.1 The individual coated optical fibers shall be placed in one or more buffer tubes to provide protection from physical damage during fabrication, installation, and use of the completed OPGW. A loose buffer tube construction shall be utilized.

7.0 Color Coding

7.1 The coating on the individual fibers and the buffer tubes shall be color coded using a method that will produce a coloring that will remain discernible throughout the design life of the OPGW. The color-coding shall be in accordance with EIA-359A and TIA/EIA-598-C or the latest applicable version of these Standards.

8.0 National Grid Standard OPGW Cable

8.1 National Grid has standardized on 3 OPGW cables of nominal diameters 3/8”, 7/16” and ½”. Manufactures must meet the minimum requirements of the cable characteristics as shown in Appendix 1, or minimum requirements as applicable such as fault current, UTS, etc. and are asked that all OPGW cable designs meet these criteria whenever possible. When cable designs shown in Appendix 1 cannot meet the requirements of a specific transmission line installation, the manufacturer must notify the OWNER in advance and seek approval prior to bid award and manufacturing.

9.0 Access to Manufacturer Plant

9.1 The Manufacturer shall provide the OWNER or the OWNER's representatives with reasonable access, without charge, to the Manufacturer's facilities to allow them to witness the tests required by this specification and to verify that the materials to be furnished in accordance with this specification comply with all of the requirements of the specification.

10.0 Testing

10.1 All OPGW cable furnished in accordance with this specification shall pass the required tests as outlined in Section 6 of IEEE Standard 1138-2009 or the latest applicable version of this Standard. The tests shall be conducted in accordance with the test procedures outlined in the Standard.

11.0 Test Reports

11.1 If the proposed OPGW design has not been previously tested to demonstrate the capability of the cable, the Manufacturer shall perform qualification testing as outlined in IEEE Standard 1138-2009 or the latest applicable version of this Standard and furnish the OWNER or OWNER'S representative with the test results at least 1 week prior to the shipment of the OPGW.

11.2 The Manufacturer shall perform routine testing as outlined in IEEE Standard 1138-2009 or the latest applicable version of this Standard. A copy of the test results for (both completed OPGW and optical fibers) shall be furnished to the OWNER or OWNER'S representative at least 1 week prior to the shipment of the OPGW.

11.3 One copy of the certified results of all qualification and routine tests (both completed OPGW and optical fibers) shall be maintained by the Manufacturer for a minimum of two years after the shipment date of the OPGW.

12.0 Factory Testing

12.1 Prior to shipment from the factory, each of the fibers on the reels shall be tested with an Optical Time Domain Reflectometer (OTDR). A certified test report shall be furnished to National Grid in paper and electronic form showing the OTDR trace and the attenuation on a per fiber basis. The factory acceptance test report shall include the following data:

- Purchaser's name
- Test date
- Cable serial number
- Reel number

- Length of the ordered cable per reel
- Length of the shipped cable per reel
- Total number of fibers
- Number of tubes
- Number of fibers per tube
- Short description of cable construction
- Attenuation of each fiber in dB/km at wavelengths of 1310 nm and 1550 nm. Each fiber shall be identified by fiber color and tube color if applicable and by fiber number.

13.0 Field Acceptance Testing

13.1 Upon receipt of the OPGW, the OWNER or OWNER's representative reserves the right to perform acceptance tests to verify the optical characteristics of the optical fibers and to determine if the optical fibers have been damaged during shipment. This testing shall be done prior to the reels being transported to another location and shall be performed within 60 days of original receipt. The results of the acceptance tests and the Manufacturer's certified test results will be compared. If one or more fibers fail to meet the requirements of this specification, the reel shall be rejected by the OWNER or OWNER's representative and be returned, freight collect, to the Manufacturer for replacement.

14.0 Packaging Requirements

14.1 The OPGW shall be tightly and uniformly wound onto reel(s) in layers. "Basket weave" or other winding methods that do not result in neatly wound layers are not acceptable. Reel lengths shall be as determined and called out as "SPECIFIED CUT-LENGTHS". A tolerance of plus 2 percent and minus 0 percent shall be maintained for "SPECIFIED CUT-LENGTHS".

14.2 No paper or other type of material shall be placed between the layers of the OPGW except 3/8" OPGW. For 3/8" OPGW, a divider sheet shall be between each layer with no exceptions to avoid layers binding during installation.

14.3 Reels shall be steel, conforming to ANSI/AA 53-1981 or equal or steel. Unless specified otherwise, the Manufacturer will determine the size and type reel that will withstand normal shipping, handling, storage, and stringing operations without damage to the OPGW. All reels for this project shall be of the same size and type. All reels shall have 5.25" arbor holes.

14.4 The drum and inside flanges shall be such that damage will not occur to the OPGW during shipping, handling, storage, and stringing. This may be provided for by a layer of suitable material that is water resistant and will not absorb

moisture. The outer layer of the OPGW shall be protected by a water-resistant wrapping placed over the exposed surface to prevent dirt and gritty material from coming in contact with the OPGW during shipment and storage.

14.5 Reels shall have wooden lagging attached to the flanges. Wood lagging should be similar to a Grade 3, cured and dressed, 2 x 4 Southern Pine lumber as defined by Sections 260 and 263 of the Southern Pine Inspection Bureau for Southern Pine Boards. Lagging shall be attached to reels in such that individual lagging strips will remain in place during normal shipment, handling and storage.

14.6 Reel numbers shall be painted in a clear and legible manner in two locations on the outside of each flange and on two opposite locations on the lagging.

14.7 Each reel shall be tagged with two shipping tags. One tag shall be attached to the outside of one of the reel flanges and the second tag shall be attached to the inside of the reel flange. Tags shall be weather resistant. Information such as the Manufacturer's name, OPGW size and number of fibers, order number, reel number, ordered and shipped lengths, and gross, tare and net weight shall appear legibly on the tags. The tags should clearly indicate OPGW in the description.

14.8 The outer end of the OPGW shall be fastened to the inner surface of the reel flange a minimum of 1” below the wood lagging. The cable end shall be securely fastened to prevent the cable from becoming loose during shipment. A minimum of 12’ of the inner end of the OPGW shall be accessible for connection to optical measuring equipment without removing wood lagging or the outer layer of protection. This length of cable shall be securely fastened and protected during shipment.

14.9 A seal shall be applied to each end of the OPGW to prevent the entrance of moisture into the optical fibers or the escape of filling compound during shipment and storage. Two extra seals shall be shipped with each reel and should be accessible without removing lagging.

14.10 The Manufacturer shall furnish at the time of shipment, a certified record of final quality control measured values for each fiber on each reel. This certification shall be attached to the outside flange of the reel in a weatherproof package.

14.11 Each reel shall be marked on the outside flange to indicate the direction the reel should be rolled during shipment in order to prevent loosening of the cable on the reel.

15.0 Shipping and Delivery Requirements

15.1 The cost of shipping shall be included in the price of the OPGW.

15.2 The OWNER or OWNER's representative shall be responsible for off-loading the OPGW at the designated yard.

15.3 The Manufacturer shall notify the OWNER or OWNER's representative of the delivery date at least seventy-two (72) hours prior to the delivery. The OWNER or OWNER's representative shall off-load the OPGW within 24 hours (excluding Saturdays, Sundays, and U.S. Federal Holidays).

16.0 OPGW Accessories

16.1 The Manufacturer shall provide the following OPGW accessory recommendations including manufacturer and manufacturer's part number, for each of the approved hardware vendors. Examples are listed below.

16.1.1 Deadend Assemblies
16.1.2 Running Angle Assemblies
16.1.3 Suspension Assemblies
16.1.4 Down lead Cushions (For wood poles)
16.1.5 Down lead Cushions (For lattice steel substation frame)
16.1.6 Splice Case, Bullet Resistant Cover, Coil bracket and Accessories
16.1.7 Dampers
16.1.8 Anti-Rotation Device for Wire Stringing
16.1.9 Come-Alongs for Wire Stringing

16.2 The approved cable hardware suppliers are: Preformed Line Products and AFL. Other suppliers of hardware may be considered upon OWNER'S review and approval.

17.0 Installation Assistance

17.1 If deemed necessary, and requested by OWNER or OWNER's representative, the Manufacturer shall provide a field engineer or equivalent representative qualified to provide technical instruction, observation, and evaluation of the required installation practice of the OPGW and/or provide instructions for splicing. The Manufacturer shall provide an "On Site Daily Price", which is to include all costs associated with the on-site visit (travel, lodging, meals, etc.).

17.2 Installation of the OPGW shall be the responsibility of the OWNER.

17.3 In the event the OPGW cannot be installed per the Manufacturer's installation procedures, or installation requires additional splicing or handling, as a result of

the Manufacturing process, the Manufacturer shall be responsible for all cost associated with replacing the OPGW or remedying the installation problems.

18.0 Installation Procedures

18.1 The Manufacturer shall provide detailed procedures for installation and splicing of the OPGW. The procedures shall include specified pulling hardware and handling requirements, installation tension limits, etc. These procedures shall be included in the Manufacturer's bid proposal.

18.2 The Manufacturer shall provide specific recommendations regarding the block sizes and construction techniques.

19.0 Sag and Tension Information

19.1 The Manufacturer shall provide the stress-strain coefficients and any other data required by the Alcoa SAG10 program and by Power Line System's PLS-CADD program for the proposed OPGW. In addition, the OPGW shall be designed and manufactured to provide for the load cases identified in the Material Package.

The cable shall be designed such that the axial strain on any fiber is zero.

19.2 In general, the cable shall match the sag-tension characteristics shown in the Material Package.

20.0 Fault Current

20.1 The cable shall be designed to meet the minimum allowable fault current capacity specified in the Material Package.

21.0 Composite Fiber Optic Ground Wire Physical and Electrical Characteristics

21.1 The Manufacturer shall provide information on all the physical characteristics listed in Attachment for the OPGW proposed. At a minimum the OPGW cable shall conform to the requirements listed in the technical requirements section of the Material Package.

22.0 Damper Recommendations

22.1 Following award of the cable, the final design tensions and span lengths shall be provided to the successful bidder. The successful bidder shall be responsible for the specification of damper hardware, as well as the description of the installation requirements.

22.2 Vibration dampers, if required, shall be of the Spiral type, unless the Manufacturer's engineering analysis indicates other vibration control measures are required.

Appendix 1 – National Grid Standard OPGW Characteristics

Nominal Size	**3/8"**	**7/16"**	**1/2"**
National Grid SAP ID	9392508	N/A	9392536
Anti-Rotational Device Required? Yes or No	Yes	No	No
Fiber qty.	48	48	48
Fiber type	Single Mode G.652D	Single Mode G.652D	Single Mode G.652D
Overall OD - in.	0.358	0.472	0.506
Cross Section Area - sq. in.	0.065	0.112	0.136
Fiber Manufacturer	Corning	Corning	Corning
Wires			
Center - Type	SS Tube	Al Clad Steel	Al Clad Steel
Center - Size in.	0.1417	0.0945	0.103
Direction of outer lay	Left Hand	Left Hand	Left Hand
(UTS)RBS lbs.	11712	14,905	18,953
Design Tension lbs.	5191	8,344	10,197
Approximate Weight lbs/mi	1,040	1,484	1,769
Short Circuit Rating kA^2*sec	11	36	50
SC Ambient Temp ^0F	104	104	104
SC duration - 1 sec kA	3	6	7.0711
SC Temp Final ^0F	392	392	392
Max String Tension lbs.	1,840	2,240	2,840
Operating Temperature (°F)	-40 to 185		
Min Bending Radius Cable, in			
Static (no load)	6	7	8
Dynamic (under tension)	8	10	11
Min Bull Wheel Dia in.	25	33	36
Min Sheave Dia in.	16" single up to 20° and double to 60° 20" single up to 45° and double to 90°	16" single up to 20° and double to 60° 20" single up to 45° and double to 90°	16" single up to 20° and double to 60° 20" single up to 45° and double to 90°

Revision History

Version	Date	Revision	Author	Reviewer	Approver
1.1	10/30/2009	Completed various improvements and clarifications Added requirement for sag-tension data compatible with PLS-CADD Adding various shipping requirements	Joe Drouin	Jeremy Cote	Mark Browne
1.2	03/02/2015	- Updated according to latest specifications - Added factory testing section - Added requirement that no paper or other type of materials shall be placed between the layers of the OPGW	Nicole Maglione	Mike Lac, Rima Crepeau, Ross Kennedy, Ken Dawe	Mark Browne
1.3	03/22/2019	-Updated section 13.3 to remove wooden reels and specify that steel reels are required -Added note that 5.25” arbor holes are required on reels	Hilary Rotatori	Nicole Maglione, Scott Stanczewski, Don Stamer, Brian Reynolds	Natasha Deschene
1.4	07/25/2019	-Updated section 5.0 to specify single mode fibers instead of mix of single mode and LEAF	Nicole Maglione	Scott Stanczewski, Don Stamer	Natasha Deschene
1.5	04/08/2022	Revised section 13.1 to clarify winding requirements.	Brian Reynolds	Jon Gonynor, Jeff Steiner, Sophia Ma	Pauline Bassil
2.0	08/24/2022	Inserted section 8 and Appendix 1 to include National Grid standard OPGW cables.	Brian Reynolds	Dilip Kommineni	GPS Log Committee
3.0	11/15/2023	Added Operating Temperature, and updated the date of IEEE 1138 to 2021	Brett Gervais	GPS Log Committee	Mary Foster, Jeff Steiner
4.0	08/09/2024	Added divider that is needed for 3/8” OPGW to avoid layers	Brett Gervais	Jim Winn	GPS Log Committee

binding during installation

Attachment 4
SP.06.01.420 – “Porcelain and Toughened Glass Insulators”

Porcelain and Toughened Glass Insulators

Table of Contents

Insulators shall comply with the ANSI/NEMA C29.2 B-2013 standards, in addition to the governing requirements listed below:

1.0 General Requirements

1.1 Insulators shall be one of three ball-and-socket type classes with given strength ratings listed in Table 1.

Table 1

ANSI CLASS	COMBINED MECHANICAL & ELECTRICAL	TENSION PROOF	NOMINAL DIAMETER	SAP ID	Description
52-3-H	20,000 lbs	10,000 lbs	10-3/4 in	9311689	Gray Porcelain
				9311629	Brown Porcelain
				9392059	Toughened Glass
				9392507	Toughened Glass-Fog
52-5-H	30,000 lbs	15,000 lbs	10-3/4 in	9311544	Gray Porcelain
				9311710	Brown Porcelain
				9389305	Toughened Glass
52-8-H	40,000 lbs	20,000 lbs	11-3/4 in	9394137	Toughened Glass
52-11	50,000 lbs	25,000 lbs	13 in	9394135	Toughened Glass DC Class CSDC-3 (HVDC only). Note: the mechanical ratings and ball & socket dimensions for this insulator fully comply with ANSI 52-11.

1.2 The shell of the insulator shall be made up of wet-process porcelain or of toughened glass. The decision of which material to use shall be at the discretion of National Grid. Wet-process porcelain insulators shall be of grey or brown color. The color shall be determined by National Grid. If gray is required, it shall be in accordance to ANSI Z55.1. Toughened glass insulators shall be of clear glass color unless otherwise specified by National Grid. In order to avoid the risk of cement growth, the cement type used to secure insulator pins to the cap shall be aluminous based with

a content of approximately 30% Al2O3. Portland based cements are not acceptable. To ensure adequate strength, aluminous cement shall be hot cured in water at 70°C.

1.3 The shell diameter dimension "B", as shown in Table 3 and Figure 1 of ANSI/NEMA 29.2 B-2013, shall have nominal values shown in Table 1.

1.4 Insulator units shall be packed and marked in crates. The design of crates shall prevent direct insulator pin impact and disc damage during transportation and on-site handling. The 30,000 lbs (52-5-H) insulators shall be marked at the cap with a yellow band. Each box or container shall be marked with the number of insulators contained in it, the ANSI class number or description of the contents, and the manufacturer's name. Each crate shall contain 6 insulator units.

2.0 Conflict

2.1 If any conflict exists between the "General Requirements" provided in Section 1.0 of this specification and ANSI/NEMA C29.2 B-2013, the "General Requirements" section shall govern.

3.0 Forms and Records

3.1 The supplier shall meet the requirements of PR.06.01.020 Type Registration.

4.0 References

4.1 References to standards are made within this specification. The following specifications and codes in their latest revisions are incorporated as part of this specification. Additional standards are referenced within these standards.

- ANSI/NEMA C29.1-2018 American National Standard for Test Methods for Electrical Power Insulator
- ANSI/NEMA C29.2 B-2013 Wet Process Porcelain and Toughened Glass - Transmission Suspension Type
- PR.06.01.020 Type Registration

Revision History

Version	Date	Revision	Author	Reviewer	Approver
1.0	03/25/2010	Initial Issue	Natasha Deschene	Jeremy Cote	Mark Browne
2.0	03/31/2011	Combine specification for Glass and Porcelain insulators; Revised specification to comply with ANSI C29.2 and additional general requirements	Natasha Deschene	Mike Lac, Rima Crepeau, Ross Kennedy, Ken Dawe	Mark Browne
2.1	07/30/2019	Footer correction and footer revision	Brian M Reynolds	Tim Hayden	Nicole Maglione
3.0	06/25/2020	Updated ANSI specifications to latest revision. Added requirement for toughened glass insulator cement to be aluminous based and hot cured.	Brian M Reynolds	Pauline Bassil, Scott Stanczewski, Joshua Lasher	Nicole Maglione (Nims)
4.0	05/26/2022	- Updated Table 1 by adding new columns for nominal diameter, SAP ID's and description. - Updated Table 1 by adding a new row for 40,000 lbs insulator. - Removed Table 2 which had nominal diameter information as it now added to Table 1. - Updated color marking information in section 1.4 to differentiate 20,000 lbs & 30,000 lbs insulators.	Dilip Kommineni	GPS Review Committee	Pauline Bassil