10-MWe Solar Thermal
Central Receiver Pilot Plant

SOLAR-FACILITIES DESIGN INTEGRATION

MASTER

**PLANT-SUPPORT SUBSYSTEM
PROCUREMENT DOCUMENTATION
(RADL ITEM 7-44D)**

September 1980

WORK PERFORMED UNDER CONTRACT
DE-AC03-79SF10499

STEARNS-ROGER ENGINEERING CORP
4500 CHERRY CREEK DRIVE
P.O. BOX 5888
DENVER, CO 80217

U.S. Department of Energy

Solar Energy

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Solar Facilities Design Integration**

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ACD3-79SF10499

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4500 CHERRY CREEK DRIVE
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**PREPARED FOR THE
U.S. DEPARTMENT OF ENERGY
SOLAR ENERGY
UNDER CONTRACT DE-AC-03-79SF10499**

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PREFACE

This document is provided by McDonnell Douglas Astronautics Company (MDAC) in accordance with Department of Energy Contract Number DE-AC03-79SF10499, Reports and Deliverables List (RADL), Item 7-44D. The information contained was provided by Stearns-Roger Engineering Corporation under MDAC Subcontract Number 78012035.

This document is a partial submittal of the PSS Long Lead Hardware Procurement Documentation. The procurement documentation contained herein (purchase specification and purchase orders) are for specific long lead materials provided as GFE for the Electrical and Instrumentation and Control (I&C) Equipment Construction Package 11. It includes the Power Control and Instrumentation Cable and the 480 Volt Load Center and Motor Control Centers for the Core Area.

For the complete list of GFE furnished to the Construction Package 11 construction contractor, see RADL 7-35 (DOE Drawing 40E700-8S).

Questions concerning this report should be directed to R. J. Perkins at (714) 896-3073.

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I SCOPE

This document contains the procurement documentation prepared by the SFDI (Stearns-Roger) for the long lead material required to be procured in support of the Electrical and Instrumentation and Control (I&C) Construction Package 11 for the 10 MWe Solar Pilot Plant being constructed at Daggett, California.

II PURCHASE SPECIFICATIONS

The purchase specifications included herein define the technical requirements for the specific long lead items to be procured. They represent the final specification as conformed for purchase. The hardware was grouped into two (2) categories for this procurement effort as follows:

- A. 480 Volt Load Center and 480 Volt Motor Control Centers;
identified as Specification S-R F235.1, DOE 40E700-19S, dated 11 July 1980 (For Purchase).
- B. Power, Control and Instrumentation Cable (Core Area);
identified as Specification S-R F010.3, DOE 40E700-21S,
dated 10 September 1980.

The detail technical specification for each of these procurement packages are included in Appendix I.

III PURCHASE ORDERS

The purchase orders issued by Stearns-Roger for each of the procurement packages noted in Section II are included herein to provide a detailed listing of each procurement. As noted in each purchase order, the material is planned for direct delivery to the jobsite, i.e., 10 MWe Solar Pilot Plant, Daggett, California. A copy of the purchase order for each package is included in Appendix II.

IV HARDWARE DELIVERY SCHEDULE

The need dates established for each of the various items of hardware is identified in the purchase specification and on the purchase orders. The SFDI has prepared and maintains a hardware delivery status log to track the subject hardware. This information is provided to STMPQ and Townsend & Bottum, Inc., on a regular basis in order to maintain a current status with respect to projected on-site deliveries.

V REFERENCES

The material identified herein was referenced in the Technical Specifications as prepared by the SFDI for the Electrical and I&C Construction Package 11, which is identified as follows:

- ° Technical Specification DOE 40E700-8S, under cover of SAN/0499-41, MDC G8179 (RADL Item 7-35), dated July 1980, as revised August 1980 to incorporate the I&C portion.

The above specification was included in the invitation for bid prepared by Townsend & Bottum, Inc., as follows:

- ° 10 MWe Solar Pilot Plant, Invitation for Bids, TB-FB-96-80-JC50008, Electrical and I&C distributed on 2 September 1980.

APPENDIX I
PURCHASE SPECIFICATIONS
FOR
ELECTRICAL AND I&C
CONSTRUCTION PACKAGE 11
LONG LEAD MATERIAL

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SPECIFICATION

S-R F010.3

D.O.E. NO. 40 E 700 - 215

May 23, 1980

(For Bids)

August 15, 1980

(For Purchase)

Rev. 1 September 10, 1980

for

**POWER, CONTROL
AND INSTRUMENTATION CABLE
(CORE AREA)**

for

10MW_e SOLAR PILOT PLANT

SOLAR - ONE

DAGGETT, CA.

Prepared by:

Stearns-Roger
ENGINEERING CORP.

PROJECT NO. C-21700

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REVISION NO. 1
TO
S-R F010.3
D.O.E. NO. 40 E 700-21S
FOR
POWER, CONTROL
AND INSTRUMENTATION CABLE
(CORE AREA)
FOR PURCHASE

1. Revision No. 1 is issued to conform this document to awardee's proposal and subsequent updating and/or negotiations.
2. Remove pages i, DS-1, DS-2, DS-3, DS-4, DS-5, DS-6, DS-9, DS-10, DS-13, and replace with corresponding pages and Appendix 1 attached hereto.

Changes are noted by Revision No. "1" in the right-hand margin opposite the items changed.

3. Remove cover and replace with cover marked Revision No. 1 attached hereto.
4. See purchase order for bid data.

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SPECIAL INSTRUCTIONS

An asterisk has been placed in the right-hand margins to denote changes made to the "For Bid" specification. The subject changes were made to conform this document to awardee's proposal and subsequent updating and/or negotiations.

All further changes to this "For Purchase" document shall be made by the issuance of a numbered revised copy.

See purchase order for bid data.

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DETAILED SPECIFICATION
FOR
POWER, CONTROL AND INSTRUMENTATION
CABLE

1. SCOPE

A. General

The materials to be furnished and delivered consist of insulated power, control and instrumentation cable as specified. The cable shall be provided as follows:

<u>Item</u>	<u>Description</u>	
1	One (1) lot of 5000-Volt Non-shielded Power Cable	1
2	One (1) lot of 600-Volt Power and Control Cable	
3	One (1) lot of Instrumentation, Thermocouple and Coaxial Cable	

The above cable will be installed by others primarily in the Core Area of the 10 MW_e Solar Pilot Plant near Daggett, California.

B. Definitions

Engineer: Shall mean Stearns-Roger Engineering Corporation

2. SUPPLEMENTS

The following supplements are included with and form a part of this Specification.

- A. Engineering Standard No. JF16.03.01, Specification for 600- and 1000-Volt Power and Control Cable, dated 4/25/78, 11 pages.
- B. Engineering Standard No. JF16.03.02, Specification for 600-Volt Instrumentation and Thermocouple Cable, dated 4/26/78, 12 pages.
- C. Engineering Standard No. JF16.03.03, Specification for Ethylene Propylene Rubber Insulated 5,000-, 8,000- and 15,000-Volt Shielded Power Cable, dated 4/11/78, 9 pages.
- D. Specification No. FJ50.50, Documentation, dated 11/3/76, 7 pages.
- E. Engineering Standard No. FJ60.60, Documentation Requirements, dated 7/16/79, 1 page.

3. MATERIALS TO BE FURNISHED

- A. The 5000-Volt non-shielded power cable (90°C) to be furnished shall be as follows:

1

<u>Description</u>	<u>Total Quantity, Feet</u>	<u>Minimum Reel Length, Feet</u>	*
1/C - No. 2/0 AWG	3000	1000	

- B. The 600-volt power cable (90°C) to be furnished shall be as follows:

<u>Description</u>	<u>Total Quantity, Feet</u>	<u>Minimum Reel Length, Feet</u>	*
1/C - No. 12 AWG	1000	500	*
2/C - No. 12 AWG	8000	1000	*
2/C - No. 10 AWG	1500	1500	*
3/C - No. 12 AWG	3500	1000	*
3/C - No. 10 AWG	2000	1000	*
3/C - No. 8 AWG	1000	1000	*
3/C - No. 6 AWG	1500	1500	*
3/C - No. 2 AWG	1200	1200	*
3/C - No. 1/0 AWG	1000	1000	*
3/C - 350 MCM	1500	1500	*
3/C - 500 MCM w/#1 AWG Gnd Conductor	1000	1000	*

- C. The 600-volt control cable (90°C) to be furnished shall be as follows:

<u>Description</u>	<u>Total Quantity, Feet</u>	<u>Minimum Reel Length, Feet</u>	*
3/C - No. 14 AWG	9000	1000	*
5/C - No. 14 AWG	4000	1000	*
7/C - No. 14 AWG	1500	1500	*
9/C - No. 14 AWG	1000	1000	*

- D. The 600-volt instrumentation cable (90°C) to be furnished shall be as follows:

<u>Description</u>	<u>Total Quantity, Feet</u>	<u>Minimum Reel Length, Feet</u>	*
One (1) twisted, shielded pair No. 16 AWG	24,000	1000	*

<u>Description</u>	<u>Total Quantity, Feet</u>	<u>Minimum Reel Length, Feet</u>	*
One (1) twisted, shielded triad No. 16 AWG	24,000	1000	*
Four (4) twisted, shielded pairs No. 16 AWG	3,500	1000	*
Four (4) twisted, shielded triads No. 16 AWG	4,000	1000	
Eight (8) twisted, shielded pairs No. 16 AWG	4,500	1000	*
Twelve (12) twisted, shielded pairs No. 16 AWG	4,000	1000	
Twenty (20) twisted, shielded pairs No. 16 AWG	3,000	1000	

- E. The 600-volt shielded thermocouple cable (90°C) to be furnished shall be as follows:

<u>Description</u>	<u>Total Quantity, Feet</u>	<u>Minimum Reel Length, Feet</u>	*
Twisted shielded pairs of chromel-alumel, Type KX, thermocouple extension wire:			
One (1) pair No. 16 AWG	3000	1500	* 1
Four (4) pairs No. 20 AWG	2000	1000	
Twenty (20) pairs No. 20 AWG	2000	1000	

- F. The coaxial cable to be furnished shall be as follows:

<u>Description</u>	<u>Total Quantity, Feet</u>	<u>Minimum Reel Length, Feet</u>	*
RG-11A/U	4000	1000	*
RG-22B/U	4500	1000	*

4. EQUIPMENT AND SERVICES FURNISHED BY OTHERS

All handling equipment and labor required to unload, install, connect, inspect and test the electrical cable in the field will be furnished by others.

5. OPERATING CONDITIONS

A. Environmental

The materials furnished shall be suitable for installation and shall provide satisfactory operation under the following environmental conditions:

- a. Plant elevation above mean sea level: 1950 feet (13.72 psia).
- b. Ambient temperature range: 9°F to 117°F.

B. Service Conditions

- a. The cable shall be capable of operating continuously without exceeding rated temperatures at rated current, and without deterioration of insulating, protecting and jacketing materials under the conditions specified.
- b. The cable will be installed in cable trays, in rigid steel conduit, or in PVC conduit.
- c. The cable will be exposed to varying degrees of ozone concentrations and dust.

6. DESIGN AND CONSTRUCTION

A. General

- a. All cable to be furnished hereunder shall have a design life of thirty (30) years. This requirement supersedes the design life requirement specified in the JF16.03.01, JF16.03.02 and JF16.03.03 Engineering Standards.
- b. All cables shall be suitable for circuits operating in wet or dry locations.
- c. Power and control cables shall be rated for 90°C normal conductor temperature, 130°C for emergency overload conditions and 250°C for short-circuit conditions.

B. 5000-Volt Non-shielded Power Cable (90°C)

The 5000-volt non-shielded power cable shall be fabricated, tested and delivered in accordance with the requirements of Appendix 1

and with the requirements of this Specification. The cable shall be non-shielded, stranded copper conductor with high temperature Kerite rubber insulation and neoprene or Hypalon jacket.

1
1

C. 600-Volt Power and Control Cable

The 600-volt power and control cable shall be fabricated, tested and delivered in accordance with the requirements of Engineering Standard No. JF16.03.01 and with the requirements of this Specification. The cables shall be stranded, tin-coated copper conductor with cross-linked polyethylene insulation and an overall neoprene or Hypalon jacket.

- a. Item 3.C.b.(2) of Stearns-Roger Engineering Standard JF16.03.01 changed to read as follows: *

High Voltage AC Test. Immediately after the insulation resistance test above, and while still immersed, the cable shall withstand, without failure, a 5 minute wet AC voltage test at the voltage specified in Table II.

- b. Item 3.C.c.(2) of Stearns-Roger Engineering Standard JF16.03.01 is deleted. *

- c. Item 3.C.c.(4) of Stearns-Roger Engineering Standard JF16.03.01 is changed to read as follows: *

Final High Voltage AC Test. After the insulation resistance test above, each conductor shall withstand without failure a 5 minute dry AC voltage withstand test at the voltage specified in Table II.

- d. Table II of Stearns-Roger Engineering Standard JF16.03.01 is changed to read as follows: *

600-Volt Cable

<u>Conductor Size</u>	<u>AC Test Voltage, kV</u>
16-18 AWG	2.5
14-9 AWG	4
8-2 AWG	5.5
1-4/0 AWG	7
225-500 MCM	8
525-1000 MCM	10

D. 600-Volt Instrumentation and Thermocouple Cable

The 600-volt instrumentation and thermocouple cable shall be fabricated, tested and delivered in accordance with the requirements of Engineering Standard No. JF16.03.02 and with the requirements of this Specification.

a. 600-Volt Instrumentation Cable

The 600-volt instrumentation cable shall be stranded, tin-coated copper conductor with cross-linked polyethylene insulation, with twisted shielded pairs or triads, shield-to-shield isolation between pairs or triads where applicable, and overall neoprene or Hypalon jacket.

b. 600-Volt Shielded Thermocouple Cable

The 600-volt shielded thermocouple cable shall be twisted, shielded pairs of chromel-alumel thermocouple extension wire, Type KX, Tefzel insulation, shield-to-shield isolation between pairs where applicable, and overall Tefzel jacket.

1
1

c. Exception to Engineering Standard JF16.03.02

(1) Paragraph 2.D.a. (2) on Page 4 of the Standard is changed to read as follows:

"(2) The conductors of each twisted pair of single-pair or multipair cables shall be identified by having one conductor colored white and the other conductor colored black. For multipair cable, one conductor of each pair shall bear a printed number to indicate the pair number in that cable, e.g., 1,2,3,4 for a four-pair cable."

(2) Paragraph 2.D.a. (3) on Page 4 of the Standard is changed to read as follows:

"(3) The conductors of each twisted triad of single-triad or multitriad cables shall be identified by having one conductor colored white, one conductor colored black and one conductor colored red. For multitriad cable, one conductor of each triad shall bear a printed number to indicate the triad number in that cable, e.g., 1,2,3,4 for a four-triad cable."

(3) Sections 2.B., 2.C., and 2.G. of the Standard are not pertinent to the 600-Volt Shielded Thermocouple Cable.

1

E. Coaxial Cable

The coaxial cable furnished shall be of standard design and construction, and shall be manufactured and tested in accordance with the latest applicable requirements of ASTM, ICEA, NEMA, NEC and UL Codes and Standards. The coaxial cable shall conform to the requirements of Federal Specification MIL-C-17.

7. PREPARATION FOR SHIPMENT

The following requirements shall take precedence over any conflicting requirements in the JF16.03.01, JF16.03.02, and JF16.03.03 Engineering Standards.

- A. All cable shall be packaged on reels in such a manner that the cable will be protected for shipment and for outdoor storage. Each end of the cable shall be protected with watertight seals and shall be secured to the reel.
- B. All reels shall have heavy-duty wood lagging consisting of closely spaced boards held in place by nailing and by not less than two (2) steel bands circumferentially secured. The required clearance and bedding shall be provided between the outer layer of the cable and the inner surface of the wood lagging to prevent damage to the cable from crushing by impact up to the impact limits of the lagging.
- C. The outside radius of the reel drum shall be not less than the bending radius recommended by the manufacturer.
- D. The diameter of the reel flange shall not exceed 80 inches, unless special permission is granted by the Engineer to allow larger reels required by the cable length or construction.
- E. Each cable reel shall be marked on both flange sides with noncorrosive metal plates securely attached to the reel and legibly stating the Contract or Purchase Order Number, reel number, length of cable on the reel, number and size of conductors, voltage rating, temperature rating, gross shipping weight and net weight of the cable. A shipping tag containing the same information shall be attached to the outer end of the cable.

8. DOCUMENTATION REQUIREMENTS

- A. Prior to fabrication or delivery to the jobsite of materials to be furnished under this Specification, the Seller shall submit to the Engineer, for review and comment, the drawings and descriptive data called for in this Specification. Drawings and data submittals shall be in accordance with Specification No. FJ50.50 and Engineering Standard No. FJ60.60, both attached.

- B. Item 2C of Engineering Standard No. FJ60.60 shall include cable installation and application data, terminating instructions, maximum allowable pulling tensions and side-wall pressures, and minimum allowable bending radii.

C. Certified Test Reports

Item 3C of Engineering Standard No. FJ60.60 shall include complete certified test reports for all qualification tests and production tests made.

9. GUARANTEES

- A. The Seller shall guarantee that the materials furnished conform to the requirements set forth herein and to the specified Codes and Standards, and that all required tests have been satisfactorily completed and passed.
- B. The Seller shall guarantee all physical and electrical properties tabulated in the Bid Data Section hereinafter.
- C. The foregoing shall not be construed in any way to limit or negate any other standard guarantee or portion thereof which may provide a more comprehensive guarantee than those required by this Specification.

10. SCHEDULE

Date of delivery at the jobsite shall be December 1, 1980.

*

BID DATA (CONTD)

(See Purchase Order)

NAME OF BIDDER _____

In addition to ther data and descriptive material furnished with the Bidder's Proposal, Bidder shall fill in all spaces of the following Bid Data Section. The specifically listed data is in no way intended to limit the data submitted, and the Bidder is invited to submit any additional information he believes necessary to complete the description of his offering:

1. GUARANTEED PHYSICAL AND ELECTRICAL PROPERTIES

		<u>Material Thicknesses</u>					
		<u>Weight (lbs/ 1,000 ft)</u>	<u>Overall Cable Dia. (Inches)</u>	<u>Minimum Bend Rad. (Inches)</u>	<u>Maximum Pulling Force (lbs)</u>	<u>Insulation (Mils)</u>	<u>Jacket (Mils)</u>
A. Weights, dimensions and physical properties							
a. 5000-volt non-shielded power cable (90°)							
1/C - No. 2/0 AWG		_____	_____	_____	_____	_____	_____
b. 600-volt power cable (90°)							
(1) 1/C - No. 12 AWG		_____	_____	_____	_____	_____	_____
(2) 2/C - No. 12 AWG		_____	_____	_____	_____	_____	_____
(3) 2/C - No. 10 AWG		_____	_____	_____	_____	_____	_____
(5) 3/C - No. 12 AWG		_____	_____	_____	_____	_____	_____
(6) 3/C - No. 10 AWG		_____	_____	_____	_____	_____	_____

BID DATA (CONTD)

(See Purchase Order)

NAME OF BIDDER

		<u>Material Thicknesses</u>				
		<u>Weight (lbs/ 1,000 ft)</u>	<u>Overall Cable Dia. (Inches)</u>	<u>Minimum Bend Rad. (Inches)</u>	<u>Maximum Pulling Force (lbs)</u>	<u>Insulation (Mils)</u> <u>Jacket (Mils)</u>
	(7) 3/C - No. 8 AWG					
	(8) 3/C - No. 6 AWG					
	(9) 3/C - No. 2 AWG					
	(10) 3/C - No. 1/0 AWG					
	(12) 3/C - 350 MCM					
	(13) 3/C - 500 MCM w/gnd. conductor					
c.	600-Volt control cable (90°)					
	(1) 3/C - No. 14 AWG					
	(2) 5/C - No. 14 AWG					
	(3) 7/C - No. 14 AWG					
	(4) 9/C - No. 14 AWG					
d.	600-Volt instrumentation cable (90°)					
	(1) One (1) twisted, shielded pair No. 16 AWE					

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BID DATA (CONTD)

(See Purchase Order)

NAME OF BIDDER

	<u>Weight (lbs/ 1,000 ft)</u>	<u>Overall Cable Dia. (Inches)</u>	<u>Minimum Bend Rad. (Inches)</u>	<u>Maximum Pulling Force (lbs)</u>	<u>Material Thicknesses</u>	
					<u>Insulation (Mils)</u>	<u>Jacket (Mils)</u>
(2) One (1) twisted, shielded triad No. 16 AWG						
(3) Four (4) twisted, shielded pairs No. 16 AWG						
(4) Four (4) twisted, shielded, triads No. 16 AWG						
(5) Eight (8) twisted, shielded pairs No. 16 AWG						
(6) Twelve (12) twisted shielded pairs No. 16 AWG						
(7) Twenty (20) twisted, shielded pairs						

C-21700
S-R F010.3

BID DATA (CONTD)

(See Purchase Order)

NAME OF BIDDER

e. 600-volt shielded
thermocouple cable
(90°C), twisted
shielded pairs -
Type KX, chromel-
alumel

(1) One (1) pair
No. 16 AWG

(2) Four (4) pair
No. 20 AWG

(3) Twenty (20) pair
No. 20 AWG

<u>Weight (lbs/ 1,000 ft)</u>	<u>Overall Cable Dia. (Inches)</u>	<u>Minimum Bend Rad. (Inches)</u>	<u>Maximum Pulling Force (lbs)</u>	<u>Material Thicknesses</u>		
				<u>Insulation (Mils)</u>	<u>Insulation Covering (Mils)</u>	<u>Jacket (Mils)</u>

BID DATA (CONTD)

(See Purchase Order)

NAME OF BIDDER _____

f. Coaxial cable

	<u>RG-11A/U</u>	<u>RG-22B/U</u>
(1) Weight, pounds per 1000 feet	_____	_____
(2) Overall cable diameter, inches	_____	_____
(3) Minimum bend radius, inches	_____	_____
(4) Maximum pulling force, pounds	_____	_____
(5) Material Thickness, mills		
(a) Insulation	_____	_____
(b) Jacket	_____	_____
(6) Insulation Material	_____	_____

B. Cable, insulation and jacket characteristics

a. 5000-volt non-shielded power cable

- (1) Manufacturer _____
- (2) Material description _____
- (3) Catalog description _____
- (4) Continuous temperature rating, °C _____
- (5) Emergency overload temperature rating,
°C/short circuit temperature
rating, °C _____ / _____

	<u>Insulation</u>	<u>Insulation Covering</u>	<u>Overall Jacket</u>
(6) Physical characteristics before aging	_____	_____	_____
(a) Tensile Strength, psi	_____	_____	_____
(b) Elongation at rupture, percent	_____	_____	_____

BID DATA (CONTD)

(See Purchase Order)

NAME OF BIDDER _____

	<u>Insulation</u>	<u>Insulation Covering</u>	<u>Overall Jacket</u>
(7) Physical characteristics after air oven aging of 168 hours at 150°C for insulation and 168 hours at 100°C for jacket			
(a) Tensile strength, percent retained	_____	_____	_____
(b) Elongation at Rupture, percent retained	_____	_____	_____
(8) Accelerated water absorp- tion (EM-60, 75°C)			
(a) Dielectric constant after 24 hours	_____		
(b) Increase in SIC from 1 to 14 days, percent	_____		
(c) Increase in SIC from 7 to 14 days, percent	_____		
(d) Stability factor after 14 days	_____		
(e) Dielectric constant after 52 weeks	_____		
(f) Stability factor after 52 weeks	_____		
(g) Insulation resistance constant (K) after 52 weeks	_____		
(9) Accelerated water absorp- tion (Gravimetric Method)			
Water absorption, mg per square inch	_____		
(10) Insulation resistance constant (K)	_____		

BID DATA (CONTD)

(See Purchase Order)

NAME OF BIDDER

	<u>Insulation</u>	<u>Insulation Covering</u>	<u>Overall Jacket</u>
(11) Cold bend, 24 hours at minus 25°C followed by wet voltage withstand test of 80 volts per mil. ac, (pass/fail)	_____	_____	_____
(12) Oxygen index	_____	_____	_____
(13) IEEE 383 flame test on: (Specify configuration)	_____	_____	_____
(a) Burn period following removal of flame, seconds	_____	_____	_____
(b) Propagation following removal of flame (Yes/No)	_____	_____	_____
(c) Length of burned cable, inches	_____	_____	_____
(d) Time to short circuit, seconds	_____	_____	_____
(14) Design life tests			
(a) Have proposed cables been subjected to elevated temperature testing to demonstrate 30 year life?			Yes/No _____
(b) Temperatures and test periods	<u>Temp °C</u>	<u>Duration, Wks.</u>	
Test 1	_____	_____	
Test 2	_____	_____	
Test 3	_____	_____	
Test 4	_____	_____	

BID DATA (CONTD)

(See Purchase Order)

NAME OF BIDDER _____

- (c) Description of pass/
fail criteria utilized,
e.g., voltage with-
stand, tensile
strength, etc. _____

- (d) Test report reference _____

b. 600-volt power cable

- (1) Manufacturer _____

- (2) Material description _____

- (3) Catalog description _____

- (4) Continuous temperature rating, °C _____

- (5) Emergency overload temperature rating,
°C/short circuit temperature
rating, °C _____ / _____

- (6) Physical characteristics
before aging

- (a) Tensile strength,
psi _____

- (b) Elongation at
rupture, percent _____

- (7) Physical characteristics
after air oven aging of
168 hours at 150°C for
insulation and 168 hours
at 100°C for jacket

- (a) Tensile strength,
percent retained _____

- (b) Elongation at rupture,
percent retained _____

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BID DATA (CONTD)

(See Purchase Order)

NAME OF BIDDER _____

	<u>Insulation</u>	<u>Insulation Covering</u>	<u>Overall Jacket</u>
(8) Accelerated water absorption (EM-60, 75°C)			
(a) Dielectric constant	_____		
(b) Increase in SIC from 1 to 14 days, percent	_____		
(c) Increase in SIC from 7 to 14 days, percent	_____		
(d) Stability factor after 14 days	_____		
(e) Dielectric constant after 52 weeks	_____		
(f) Stability factor after 52 weeks	_____		
(g) Insulation resistance constant (K) after 52 weeks	_____		
(9) Accelerated water absorption (Gravimetric Method)			
Water absorption, mg per square inch	_____		
(10) Insulation resistance constant (K)	_____		
(11) Cold bend, 24 hours at minus 25°C followed by wet voltage withstand test of 80 volts per mil ac, (pass/fail)	_____	_____	_____
(12) Oxygen index	_____	_____	_____
(13) IEEE 383 flame test on:			
(Specify configuration)		_____	
(a) Burn period following removal of flame, seconds		_____	

BID DATA (CONTD)

(See Purchase Order)

NAME OF BIDDER _____

(b) Propagation following
removal of flame (Yes/No) _____

(c) Length of burned cable, inches _____

(d) Time to short circuit, seconds _____

(14) Design life tests

(a) Have proposed cables been
subjected to elevated
temperature testing to
demonstrate 30 year life?

Yes/No

(b) Temperatures and
test periods

Temp °C

Duration, Wks.

Test 1

Test 2

Test 3

Test 4

(c) Description of pass/
fail criteria utilized,
e.g., voltage with-
stand, tensile
strength, etc.

(d) Test report reference _____

c. 600-volt control cable

(1) Manufacturer _____

(2) Material description _____

(3) Catalog description _____

(4) Continuous temperature rating, °C _____

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BID DATA (CONTD)

(See Purchase Order)

NAME OF BIDDER _____

- (5) Emergency overload temperature rating,
°C/short circuit temperature
rating, °C _____ / _____

	<u>Insulation</u>	<u>Insulation Covering</u>	<u>Overall Jacket</u>
(6) Physical characteristics before aging			
(a) Tensile strength, psi	_____	_____	_____
(b) Elongation at rupture, percent	_____	_____	_____
(7) Physical characteristics after air oven aging of 168 hours at 150°C for insulation and 168 hours at 100°C for jacket			
(a) Tensile strength, percent retained	_____	_____	_____
(b) Elongation at rupture, percent retained	_____	_____	_____
(8) Accelerated water absorp- tion (EM-60, 75°C)			
(a) Dielectric constant	_____		
(b) Increase in SIC from 1 to 14 days, percent	_____		
(c) Increase in SIC from 7 to 14 days, percent	_____		
(d) Stability factor after 14 days	_____		
(e) Dielectric constant after 52 weeks	_____		
(f) Stability factor after 52 weeks	_____		

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BID DATA (CONTD)

(See Purchase Order)

NAME OF BIDDER

	<u>Insulation</u>	<u>Insulation Covering</u>	<u>Overall Jacket</u>
(g) Insulation resistance constant (K) after 52 weeks	_____		
(9) Accelerated water absorption (Gravimetric Method)			
Water absorption, mg per square inch	_____		
(10) Insulation resistance constant (K)	_____		
(11) Cold bend, 24 hours at minus 25°C followed by wet voltage withstand test of 80 volts per mil ac, (pass/fail)	_____	_____	_____
(12) Oxygen index	_____	_____	_____
(13) IEEE 383 flame test on: (Specify configuration)		_____	
(a) Burn period following removal of flame, seconds		_____	
(b) Propagation following removal of flame (Yes/No)		_____	
(c) Length of burned cable, inches		_____	
(d) Time to short circuit, seconds		_____	
(14) Design life tests			
(a) Have proposed cables been subjected to elevated temperature testing to demonstrate 30 year life:		_____	Yes/No

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BID DATA (CONTD)

(See Purchase Order)

NAME OF BIDDER _____

(b) Temperatures and
test periods

Temp °C

Duration, Wks.

Test 1

Test 2

Test 3

Test 4

(c) Description of pass/
fail criteria utilized,
e.g., voltage with-
stand, tensile
strength, etc.

(d) Test report reference

d. 600-volt instrumentation cable

(1) Manufacturer

(2) Material description

(3) Catalog description

(4) Continuous temperature rating, °C

(5) Physical characteristics
before aging

Insulation

Insulation
Covering

Overall
Jacket

(a) Tensile strength,
psi

(b) Elongation at
rupture, percent

(6) Physical characteristics
after air oven aging of
168 hours at 150°C for
insulation and 168 hours
at 100°C for jacket

(a) Tensile strength,
percent retained

BID DATA (CONTD)

(See Purchase Order)

NAME OF BIDDER _____

	<u>Insulation</u>	<u>Insulation Covering</u>	<u>Overall Jacket</u>
(b) Elongation at rupture, percent retained	_____	_____	_____
(7) Accelerated water absorp- tion (EM-60, 75°C)			
(a) Dielectric constant	_____		
(b) Increase in SIC from 1 to 14 days, percent	_____		
(c) Increase in SIC from 7 to 14 days, percent	_____		
(d) Stability factor after 14 days	_____		
(e) Dielectric constant after 52 weeks	_____		
(f) Stability factor after 52 weeks	_____		
(g) Insulation resistance constant (K) after 52 weeks	_____		
(8) Accelerated water absorp- tion (Gravimetric Method)			
Water absorption, mg per square inch	_____		
(9) Insulation resistance constant (K)	_____		
(10) Cold bend, 24 hours at minus 25°C followed by wet voltage withstand test of 80 volts per mil ac, (pass/fail)	_____	_____	_____
(11) Oxygen index	_____	_____	_____
(12) IEEE 383 flame test on: (Specify configuration)		_____	
(a) Burn period following removal of flame, seconds		_____	

BID DATA (CONTD)

(See Purchase Order)

NAME OF BIDDER _____

(b) Propagation following
removal of flame (Yes/No) _____

(c) Length of burned cable, inches _____

(d) Time to short circuit, seconds _____

(13) Design life tests

(a) Have proposed cables been
subjected to elevated
temperature testing to
demonstrate 30 year life: _____

Yes/No

(b) Temperatures and
test periods

Temp °C

Duration, Wks.

Test 1

Test 2

Test 3

Test 4

(c) Description of pass/
fail criteria utilized,
e.g., voltage with-
stand, tensile
strength, etc. _____

(d) Test report reference _____

e. 600-volt shielded thermocouple cable

(1) Manufacturer _____

(2) Material description _____

(3) Catalog description _____

(4) Continuous temperature rating, °C _____

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BID DATA (CONTD)

(See Purchase Order)

NAME OF BIDDER _____

	<u>Insulation</u>	<u>Insulation Covering</u>	<u>Overall Jacket</u>
(5) Physical characteristics before aging			
(a) Tensile strength, psi	_____	_____	_____
(b) Elongation at rupture, percent	_____	_____	_____
(6) Physical characteristics after air oven aging of 168 hours at 150°C for insulation and 168 hours at 100°C for jacket			
(a) Tensile strength, percent retained	_____	_____	_____
(b) Elongation at rupture, percent retained	_____	_____	_____
(7) Accelerated water absorp- tion (EM-60, 75°C)			
(a) Dielectric constant	_____		
(b) Increase in SIC from 1 to 14 days, percent	_____		
(c) Increase in SIC from 7 to 14 days, percent	_____		
(d) Stability factor after 14 days	_____		
(e) Dielectric constant after 52 weeks	_____		
(f) Stability factor after 52 weeks	_____		
(g) Insulation resistance constant (K) after 52 weeks	_____		

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BID DATA (CONTD)

(See Purchase Order)

NAME OF BIDDER

	<u>Insulation</u>	<u>Insulation Covering</u>	<u>Overall Jacket</u>
(8) Accelerated water absorption (Gravimetric Method)			
Water absorption, mg per square inch	_____		
(9) Insulation resistance constant (K)	_____		
(10) Cold bend, 24 hours at minus 25°C followed by wet voltage withstand test of 80 volts per mil ac, (pass/fail)	_____	_____	_____
(11) Oxygen index	_____	_____	_____
(12) IEEE 383 flame test on: (Specify configuration)		_____	
(a) Burn period following removal of flame, seconds		_____	
(b) Propagation following removal of flame (Yes/No)		_____	
(c) Length of burned cable, inches		_____	
(d) Time to short circuit, seconds		_____	
(13) Design life tests			
(a) Have proposed cables been subjected to elevated temperature testing to demonstrate 30 year life:		_____	Yes/No
(b) Temperatures and test periods	<u>Temp °C</u>	<u>Duration, Wks.</u>	
Test 1	_____	_____	
Test 2	_____	_____	
Test 3	_____	_____	
Test 4	_____	_____	

BID DATA (CONTD)

(See Purchase Order)

NAME OF BIDDER _____

(c) Description of pass/
fail criteria utilized,
e.g., voltage with-
stand, tensile
strength, etc.

(d) Test report reference _____

f. Coaxial Cable

RG-11A/U

RG-22B/U

(1) Manufacturer

(2) Material description

(3) Catalog description

2. TESTS

List all factory tests, and their standard industry identification, that will be performed on the materials specified herein.

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DIVISION USAGE <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 10%;">MM</td> <td style="width: 10%;">P</td> <td style="width: 10%;">PP</td> <td style="width: 10%;">SH</td> <td style="width: 10%;">FI</td> <td style="width: 10%;">SP</td> </tr> <tr> <td></td> <td style="text-align: center;">X</td> <td></td> <td></td> <td></td> <td></td> </tr> </table>						MM	P	PP	SH	FI	SP		X					Stearns-Roger <small>INCORPORATED</small> ENGINEERING STANDARD		STANDARD NUMBER JF16.03.01
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	X																			
APPROVALS Des. Sect. <i>J. G. [Signature]</i> Sect. Supv. <i>[Signature]</i> Div. <i>[Signature]</i>						SPECIFICATION FOR 600- AND 1000-VOLT POWER AND CONTROL CABLE		PAGE <u>1</u> OF <u>11</u> ISSUED 4/25/78 REVISED												

1. GENERAL

A. This Specification describes the requirements for cross-linked polyethylene insulated cable and for ethylene propylene rubber insulated cable, both for use in power and control circuits operating in wet or dry locations. The cables shall have a continuous temperature rating of 90°C, an emergency overload temperature rating of 130°C for periods not to exceed 100 hours per year and a short-circuit temperature rating of 250°C. The cables shall provide satisfactory service under the above conditions when installed in trays, conduits or ducts, when used for direct earth burial or when used as suitably supported aerial cable. The cable shall have a design life of forty (40) years.

B. The cable to be furnished hereunder shall consist of the manufacturer's standard design and first line quality which meets or exceeds the requirements of this Specification.

C. All cable specified herein shall be manufactured and tested in accordance with the latest applicable parts of the following Codes and Standards unless specified otherwise herein or in the Specification to which this Engineering Standard is attached as a supplement.

- a. ASTM - American Society for Testing and Materials
- b. IEEE - Institute of Electrical and Electronic Engineers
- c. IPCEA- Insulated Power Cable Engineers Association
- d. UL - Underwriters' Laboratories, Inc.

D. All references to Tables are as contained herein unless specified otherwise.

2. DESIGN AND CONSTRUCTION

A. Conductors

The conductors shall be stranded soft annealed copper wire covered with a continuous tin coating. The tensile, electrical and coating properties shall be in accordance with ASTM B33. The stranding shall be Class B in accordance with ASTM B3, unless otherwise specified. The conductor resistance shall be in accordance with IPCEA S-19-81, Paragraph 2.6.

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2. DESIGN AND CONSTRUCTION (CONTD)

B. Conductor Insulation

a. Cross-Linked Polyethylene Insulated Cable

(1) Material

The conductor shall be insulated with a flame, heat, moisture and corona resisting cross-linked polyethylene compound. The insulation shall be free-stripping, shall conform to the applicable requirements of IPCEA S-66-524 and shall have electrical and physical characteristics in accordance with Table I.

(2) Thickness

The average insulation thickness shall not be less than specified in Table II. The minimum thickness at any one point shall not be less than 90 percent of the specified average thickness.

(3) Conductor Jacket (For Individual Conductors of Multiconductor Cable)

A conductor jacket is not required for cross-linked polyethylene insulated conductors.

b. Ethylene Propylene Rubber Insulated Cable - Type I

(1) Material

The conductors shall be insulated with a flame, heat, moisture and corona resisting ethylene propylene Type I elastomer compound. The insulation shall be free-stripping, shall conform to the applicable requirements of IPCEA S-68-516 and shall have electrical and physical characteristics in accordance with Table I.

(2) Thickness

The average insulation thickness shall not be less than specified in Table II. The minimum thickness at any one point shall not be less than 90 percent of the specified average thickness.

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2. DESIGN AND CONSTRUCTION (CONTD)

B. Conductor Insulation (Contd)

b. Ethylene Propylene Rubber Insulated Cable - Type I (Contd)

(3) Conductor Jacket (For Individual Conductors of Multiconductor Cable)

Individual conductors of multiconductor cable shall be jacketed with a flame retardant compound meeting the requirements listed in Table III. The jacket material shall be either a chlorosulphonated polyethylene compound meeting the requirements of Paragraph 4.4.9 of IPCEA S-68-516 or a colorable neoprene meeting the requirements of Paragraph 4.4.3 of IPCEA S-68-516. The jacket shall be securely bonded to the insulation and have a peel strength of not less than 4 pounds per inch width. The thickness of the conductor jacket shall not be less than the values shown in Table IV.

c. Ethylene Propylene Rubber Insulated Cable - Type II

(1) Material

The conductors shall be insulated with a flame, heat, moisture and corona resisting ethylene propylene Type II elastomer compound. The insulation shall be free-stripping, shall conform to the applicable requirements of IPCEA S-68-516 and shall have electrical and physical characteristics in accordance with Table I.

(2) Thickness

The average insulation thickness shall not be less than specified in Table II. The minimum thickness at any one point shall not be less than 90 percent of the specified average thickness.

(3) Conductor Jacket (For Individual Conductors of Multiconductor Cable)

A conductor jacket is not required for ethylene propylene rubber Type II insulated conductors.

C. Conductor Identification

Unless otherwise specified, the individual conductors of multiconductor control cable shall be identified in accordance with Method 1 of Part 5 of IPCEA S-19-81 by permanently indelible colors and tracers. The colors shall be nonfading and color stable.

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2. DESIGN AND CONSTRUCTION (CONTD)

D. Assembly of Multiconductor Cables

Multiconductor cables shall be assembled in accordance with Part 5 of IPCEA S-19-81 using nonhygroscopic, flame retardant fillers and binder tapes.

E. Shielding

When shielding is specified, the shielding shall be in accordance with one of the following methods as specified in the Specification to which this Engineering Standard is attached.

- a. Shielding shall consist of an aluminized-polyester tape not less than two (2) mils thick applied with an overlap of not less than 25 percent and with a stranded tin-coated copper drain wire not less than No. 18 AWG. The drain wire shall be in continuous contact with the aluminum side of tape.
- b. Shielding shall consist of a spirally-wound, tinned-copper tape not less than five (5) mils thick applied with an overlap of not less than 25 percent.
- c. Shielding shall consist of a five (5) mils thick longitudinal corrugated copper shield applied with an overlap of not less than 25 percent.

F. Overall Cable Jacket

- a. Each single conductor cable and each multiconductor cable assembly shall have an overall jacket. Unless otherwise specified, the overall jacket shall be black.
- b. The jacket shall be either a flame-resistant chlorosulphonated polyethylene compound meeting the requirements of Table III and of Paragraph 4.4.12 of IPCEA S-68-516 or a flame-resistant neoprene compound meeting the requirements of Table III and of Paragraph 4.4.3 of IPCEA S-68-516.
- c. The average thickness of the cable jacket shall not be less than the thickness specified in Table IV.

G. Cable Identification

- a. Each cable shall be identified by a printed marking in a contrasting indelible color applied to the outer surface of the cable jacket at intervals of not less than 24 inches.

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<div style="display: flex; justify-content: space-between; align-items: center;"> <div style="width: 25%;"> <div style="font-weight: bold; font-size: small;">APPROVALS</div> <div style="font-size: x-small;"> Des. Sect. <i>J.B.R.</i> Sect. Supv. <i>J.S. Kelly</i> Div. <i>W.D.</i> </div> </div> <div style="width: 50%; text-align: center;"> <div style="font-weight: bold; font-size: small;">SPECIFICATION FOR</div> <div style="font-weight: bold; font-size: small;">500- AND 1000-VOLT POWER AND CONTROL CABLE (CONTD)</div> </div> <div style="width: 20%; text-align: right;"> <div style="font-weight: bold; font-size: small;">PAGE <u> </u> OF <u>11</u></div> <div style="font-size: x-small;"> ISSUED 4/25/78 REVISED </div> </div> </div>																		

2. DESIGN AND CONSTRUCTION (CONTD)

G. Cable Identification (Contd)

b. The printed marking shall include the following information:

- (1) Manufacturer
- (2) Number and size of conductors
- (3) Shield (if applicable)
- (4) Conductor material
- (5) Voltage rating
- (6) Temperature rating
- (7) Insulation/jacket material
- (8) Year of manufacture
- (9) Sequential footage

H. Performance Characteristics

a. Single Conductor Cable and Individual Conductors of Multiconductor Cable

Samples of single conductor cable and samples of the individual conductors of multiconductor cable shall be subjected to and pass a vertical flame test per UL FR-1.

b. Completed Single and/or Multiconductor Cables

- (1) Samples of completed cables shall be subjected to the IEEE 383 ribbon burner flame test with failure detection circuitry connected and energized at 120 volts to ground. The tests shall demonstrate that the length of flame damage does not exceed 36 inches, the time for all flames to extinguish does not exceed 180 seconds, the minimum time to short-circuit exceeds 7 minutes and the cable does not exhibit any dripping or flowing of materials.
- (2) Samples of completed cables shall be subjected to and pass a twenty-four (24) hour cold bend test at minus 25°C over an 8x mandrel followed by a wet voltage withstand test of 80 volts ac per mil.
- (3) Samples of completed cable shall be tested at elevated temperatures to demonstrate an extrapolated design life of 40 years continuous operation at 90°C.

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3. TEST REQUIREMENTS

A. General

Unless otherwise specified, test methods shall be in accordance with IPCEA S-66-524 for cross-linked polyethylene insulated cable and with S-68-516 for ethylene propylene rubber insulated cable.

B. Qualification Tests

Qualification tests shall be performed to verify compliance with the electrical and physical requirements specified in Table I, Table III and Paragraph 2.H. above. These tests shall be performed on samples from cable purchased under the Specification to which this Engineering Standard is attached. The number and length of samples to be taken shall be based on the quantity of cable purchased in accordance with Tables 6-1, 6-2 and 6-3 of IPCEA S-19-81. The number of specimens to be prepared and tested shall be in accordance with Table 6-4 of IPCEA S-19-81 except that the specified flame tests and long term aging tests are required to be performed only once.

C. Production Tests

- a. Production tests shall be performed on each complete length of cable.
- b. On single conductor cables, the production tests shall consist of the following:

(1) Insulation Resistance Test

After not less than six hours immersion in water and while still immersed, and insulation resistance test shall be made on each cable. The insulation resistance constant (K) shall not be less than 20,000 when corrected to 60°F.

(2) High Voltage DC Test

Immediately after the insulation resistance test above, and while still immersed, the cable shall withstand, without failure, a 5-minute dc test at the voltage specified in Table II.

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3. TEST REQUIREMENTS (CONTD)

C. Production Tests (Contd)

b. Continued

(3) Conductor Resistance Test

The dc resistance shall be measured on each conductor and shall be in accordance with IPCEA S-19-81, Paragraph 2.6.

c. On multiconductor cables, the production tests shall consist of the following:

(1) Preliminary Insulation Resistance Test

Prior to the assembly of the cable and after not less than six hours immersion in water, an insulation resistance test shall be made on each conductor. The insulation resistance constant (K) shall not be less than 20,000 when corrected to 60°F.

(2) Preliminary High Voltage DC Test

Immediately after the preliminary insulation resistance test and while still immersed, each conductor shall withstand without failure a 5-minute dc test at the voltage specified in Table II.

(3) Final Insulation Resistance Test

After assembly of the cable is completed, a dry insulation test shall be performed on each conductor. The insulation resistance constant (K) shall not be less than 20,000 when corrected to 60°F.

(4) Final High Voltage DC Test

Immediately after the insulation resistance test above, each conductor shall withstand without failure a 5-minute dc test at the voltage specified in Table II.

(5) Conductor Resistance Test

The dc resistance shall be measured for each conductor and shall be in accordance with IPCEA S-19-81, Paragraph 2.6.

D. Certified Test Reports

Copies of complete certified test reports shall be furnished for all qualification tests and production tests made, unless otherwise specified.

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4. INSPECTION AND ACCEPTANCE

Where required for acceptance, inspection by the Buyer shall be carried out at the manufacturer's plant and under supervision of the Buyer's representative.

5. PACKAGING

A. Cable Reels

- a. All cable shall be packaged on reels in such a manner that the cable will be protected for shipment and for outdoor storage. Each end of the cable shall be protected with watertight seals and shall be secured to the reel.
- b. All reels shall have heavy-duty wood lagging consisting of closely spaced boards held in place by nailing and by not less than two (2) steel bands circumferentially secured. The required clearance and bedding shall be provided between the outer layer of the cable and the inner surface of the wood lagging to prevent damage to the cable from crushing by impact up to the impact limits of the lagging.
- c. The minimum drum diameter of the reel shall be in accordance with Appendix M of IPCEA S-6th 516.
- d. The diameter of the reel flange shall not exceed 72 inches, unless special permission is granted by the Buyer.

B. Cable Reel Identification

Each cable reel shall be marked on both flange sides with noncorrosive metal plates or labels securely attached to the reel and legibly stating the Buyer's Contract or Purchase Order number, reel number, length of cable on the reel, number and size of conductors, voltage rating, temperature rating, gross shipping weight and net weight of the cable. A shipping tag containing the same information shall be attached to the outer end of the cable.

6. GUARANTEES

- A. The Seller shall guarantee that the materials furnished conform to the requirements set forth herein and to the specified Codes and Standards, and that all specified tests have been satisfactorily completed and passed.
- B. The Seller shall guarantee all physical and electrical properties tabulated in the Bid Data of the Specification to which this Engineering Standard is attached.
- C. The foregoing shall not be construed in anyway to limit or negate any other standard guarantee or portion thereof which may provide a more comprehensive guarantee than those required by this Specification.

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TABLE I		INSULATION PROPERTIES	
		Cross-Linked Polyethylene	Ethylene Propylene Rubber
			Type I Type II
A. Physical characteristics before aging:			
a. Minimum tensile strength, psi	1800	700	1200
b. Minimum elongation at rupture, percent	300	250	150
B. Physical characteristics after air oven aging of 7 days at 150°C:			
a. Minimum tensile strength percent of unaged value	90	85	85
b. Minimum elongation at rupture, percent of unaged value	90	85	85
C. Accelerated water absorption, electrical method (EM-60) at 75°C:			
a. Dielectric constant after 24 hours, maximum	4.0	4.0	4.0
b. Increase in capacitance from 1 to 14 days, percent, maximum	3.0	3.5	3.5
c. Increase in capacitance from 7 to 14 days, percent, maximum	1.5	1.5	1.5
d. Dielectric constant after 52 weeks, maximum	5.5	5.0	5.0
e. Stability factor after 14 days, maximum	0.5	1.0	1.0
f. Stability factor after 52 weeks, maximum	0.75	1.2	1.2
g. Insulation resistance constant (K) after 52 weeks, minimum	5000	4000	4000
D. Accelerated water absorption, Gravimetric Method:			
Absorption, mg per square inch, maximum	10	8.0	8.0
E. Insulation resistance constant (K) at 60°F:			
Not less than	40,000	20,000	20,000
F. Cold bend per IPCEA, 24 hours at minus 25°C (Mandrel diameter 8x), withstand, ac volts/mil			
	80	80	80
G. Oxygen index per ASTM D2863, minimum			
	27	21	27

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TABLE II
INSULATION THICKNESS AND
TEST VOLTAGES

Conductor Size	600-Volt Cable		1000-Volt Cable	
	Insulation Thickness, mils	DC Test Voltage, kv	Insulation Thickness, mils	DC Test Voltage, kv
16 - 18 AWG	25	9	45	16.5
14 - 9 AWG	30	10.5	45	16.5
8- 2 AWG	45	16.5	55	21
1- 4/0 AWG	55	21	65	24
225 - 500 MCM	65	24	75	28.5
525 - 1000 MCM	80	30	90	34.5

TABLE III
JACKET PROPERTIES - CHLOROSULPHONATED
POLYETHYLENE AND NEOPRENE

	Chlorosulphonated Polyethylene	Neoprene
A. Physical characteristics before aging		
a. Minimum tensile strength, psi	1800	1800
b. Minimum elongation at rupture, percent	300	300
B. Physical characteristics after air oven aging at 100 °C for 168 hours:		
a. Minimum tensile strength, percent of unaged value	85	75
b. Minimum elongation at rupture, percent of unaged value	65	50
C. Physical characteristics after oil immersion aging at 121°C for 18 hours:		
a. Minimum tensile strength, percent of unaged value	60	60
b. Minimum elongation at rupture, percent of unaged value	60	60

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TABLE III
JACKET PROPERTIES - CHLOROSULPHONATED
POLYETHYLENE AND NEOPRENE (CONTD)

	Chlorosulphonated Polyethylene	Neoprene
D. Set, maximum percent	30	30
E. Tear strength, lb/inch, minimum	20	20
F. Cold bend per IPCEA, 24 hours at minus 25°C	No cracks	No cracks
G. Oxygen index:		
a. Before aging, minimum	30	30
b. After air oven aging at 150°C for 168 hours, minimum	30	30

TABLE IV
JACKET THICKNESS

Conductor or Cable Diameter, * Inches	For Multiconductor Cable		
	For Single Conductor Cable, Inches	Individual Conductor Jacket, EPR Type I Insulated, Inches	Overall Cable Jacket, Inches
0 - 0.250	0.015	0.015	0.045
0.251 - 0.425	0.030	0.025	0.045
0.426 - 0.700	0.045	0.030	0.060
0.701 - 1.500	0.065	0.050	0.080
1.501 - 2.500	0.095	0.080	0.110
2.501 and larger	0.125	--	0.140

* Including binder tapes and shield, if applicable.

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1. GENERAL

- A. This Specification describes the requirements for cross-linked polyethylene insulated cable and ethylene propylene rubber insulated cable, both for use in instrumentation and thermocouple circuits operating in wet or dry locations. The cables shall have a continuous temperature rating of 90°C. The cables shall provide satisfactory service under the above conditions when installed in trays, conduits or ducts or when used for direct earth burial. The cable shall have a design life of forty (40) years.
- B. The cable to be furnished hereunder shall consist of the manufacturer's standard design and first-line quality which meets or exceeds the requirements of this Specification.
- C. All cable specified herein shall be manufactured and tested in accordance with the latest applicable parts of the following Codes and Standards unless specified otherwise herein or in the Specification to which this Engineering Standard is attached as a supplement.
 - a. ANSI - American National Standards Institute
 - b. ASTM - American Society for Testing and Materials
 - c. IEEE - Institute of Electrical and Electronics Engineers
 - d. IPCEA - Insulated Power Cable Engineers Association
 - e. UL - Underwriters' Laboratories, Incorporated
- D. All references to Tables are as contained herein unless specified otherwise.

2. DESIGN AND CONSTRUCTION

A. Conductors

a. Instrumentation Cable

The instrumentation cable conductors shall be stranded soft annealed copper wire covered with a continuous tin coating. The tensile, electrical and coating properties shall be in accordance with ASTM B33. The stranding shall be Class B in accordance with ASTM B8, unless otherwise specified. The conductor resistance shall be in accordance with IPCEA S-19-81, Paragraph 2.6.

b. Thermocouple Cable

The thermocouple cable conductors shall be solid soft annealed wire in accordance with ANSI C96.1. The type of wire and limits of error shall be in accordance with Table I. Standard limits of error shall be furnished unless otherwise specified. The nominal loop resistance shall be in accordance with Table II.

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2. DESIGN AND CONSTRUCTION (CONTD)

B. Conductor Insulation

a. Cross-linked Polyethylene Insulated Cable

(1) Material

The conductor shall be insulated with a flame, heat, moisture and corona resisting cross-linked polyethylene compound. The insulation shall be free-stripping, shall conform to the applicable requirements of IPCEA S-66-524 and shall have electrical and physical characteristics in accordance with Table III.

(2) Thickness

The average insulation thickness shall not be less than 25 mils. The minimum thickness at any one point shall not be less than 90 percent of the specified average thickness.

(3) Conductor Jacket (For individual conductors of multiconductor cable)

A conductor jacket is not required for cross-linked polyethylene insulated conductors.

b. Ethylene Propylene Rubber Insulated Cable - Type I

(1) Material

The conductors shall be insulated with a flame, heat, moisture and corona resisting ethylene propylene Type I elastomer compound. The insulation shall be free-stripping, shall conform to the applicable requirements of IPCEA S-68-516 and shall have electrical and physical characteristics in accordance with Table III.

(2) Thickness

The average insulation thickness shall not be less than 20 mils. The minimum thickness at any one point shall not be less than 90 percent of the specified average thickness.

(3) Conductor Jacket (For individual conductors of multiconductor cable)

Individual conductors of multiconductor cable shall be jacketed with a flame retardant compound meeting the requirements listed in Table

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2. DESIGN AND CONSTRUCTION (CONTD)

B. Conductor Insulation (Contd)

b. Ethylene Propylene Rubber Insulated Cable - Type I (Contd)

- (3) IV. The jacket material shall be either a chlorosulphonated polyethylene compound meeting the requirements of Paragraph 4.4.9 of IPCEA S-68-516 or a colorable neoprene meeting the requirements of Paragraph 4.4.3 of IPCEA S-68-516. The jacket shall be securely bonded to the insulation and have a peel strength of not less than 4 pounds per inch width. The thickness of the conductor jacket shall not be less than 10 mils.

C. Ethylene Propylene Rubber Insulated Cable - Type II

(1) Material

The conductors shall be insulated with a flame, heat, moisture and corona resisting ethylene propylene Type II elastomer compound. The insulation shall be free-stripping, shall conform to the applicable requirements of IPCEA S-68-516 and shall have electrical and physical characteristics in accordance with Table III.

(2) Thickness

The average insulation thickness shall not be less than 25 mils. The minimum thickness at any one point shall not be less than 90 percent of the specified average thickness.

(3) Conductor Jacket (For individual conductors of multiconductor cable)

A conductor jacket is not required for ethylene propylene rubber Type II insulated conductors.

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2. DESIGN AND CONSTRUCTION (CONTD)

D. Conductor Identification

a. Instrumentation Cable

- (1) The conductors of concentric lay ups shall be identified in accordance with Method 1 of Part 5 of IPCEA S-19-81.
- (2) The conductors of single twisted pair cables shall have one (1) white and one (1) black conductor. The conductors of multipair twisted cables shall be identified by having one (1) conductor of each pair colored white and the other conductor colored in accordance with the sequence given in Table 5-2 of IPCEA S-19-81, omitting the white color.
- (3) The conductors of single twisted triads shall have one (1) white, one (1) red, and one (1) black conductor.

b. Thermocouple Cable

The conductors of thermocouple cable shall be identified in accordance with ANSI C96.1.

- c. All identification shall be by permanently indelible colors and tracers. The colors shall be nonfading and color stable.

E. Pair and Triad Assembly

a. Length of Lay

The individual conductors of each instrumentation and thermocouple cable pair and of each instrumentation cable triad shall be twisted together with a length of lay in accordance with Table VI.

b. Shielding (If applicable)

- (1) Each cable pair and triad shall be shielded with an aluminized-polyester tape not less than 2 mils thick applied with an overlap of not less than 25 percent and a stranded tin-coated copper drain wire sized in accordance with Table VI. The drain wire shall be in continuous contact with the aluminum side of the shielding tape.
- (2) When low voltage shield-to-shield isolation between pairs or triads is specified, a one (1) mil thick polyester tape shall be applied over each subassembly with an overlap of not less than 25 percent.

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2. DESIGN AND CONSTRUCTION (CONTD)

F. Cable Assembly

- a. The required number of single conductors, pairs or triads shall be assembled in accordance with IPCEA S-19-81, Part 5, using nonhygroscopic, flame-retardant fillers.
- b. When an overall shield is specified, it shall be in accordance with Paragraph 2.E.b. above, except that for thermocouple cables the aluminum side of the shielding tape and the drain wire shall be on the outside.
- c. The assembly shall then be covered with helically applied flame-retardant fillers and binder tapes. These tapes shall be located directly under the cable jacket.

G. Overall Cable Jacket

- a. Each cable assembly shall have an overall jacket. Unless otherwise specified, the overall jacket shall be black.
- b. The jacket shall be either a flame-resistant chlorosulfonated polyethylene compound in accordance with Table IV and Paragraph 4.4.12 of IPCEA S-68-516 or a flame-resistant neoprene compound in accordance with Table IV and Paragraph 4.4.3 of IPCEA S-68-516.
- c. The average thickness of the cable jacket shall not be less than the thickness specified in Table V.

H. Cable Identification

- a. Each cable shall be identified by a printed marking in a contrasting indelible color applied to the outer surface of the cable jacket at intervals of not less than 24 inches.
- b. The printed marking shall include the following information:
 - (1) Manufacturer
 - (2) Number and size of conductors
 - (3) Shield (if applicable)
 - (4) Conductor material
 - (5) Voltage rating
 - (6) Temperature rating
 - (7) Insulation/jacket material
 - (8) Year of manufacture
 - (9) Sequential footage

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2. DESIGN AND CONSTRUCTION (CONTD)

I. Performance Characteristics

a. Individual Conductors

Samples of the individual conductors shall be subjected to and pass a vertical flame test in accordance with UL FR-1.

b. Completed Cables

- (1) Samples of completed cables shall be subjected to the IEEE 383 Ribbon Burner Flame Test with failure detection circuitry connected and energized at 120 volts to ground. The tests shall demonstrate that the length of flame damage does not exceed 36 inches, the time for all flames to extinguish does not exceed 180 seconds, the minimum time to short-circuit exceeds 7 minutes and the cable does not exhibit any dripping or flowing of materials.
- (2) Samples of completed cables shall be subjected to and pass a twenty-four (24) hour cold bend test at minus 25°C over an 8x mandrel followed by a wet voltage withstand test of 80 volts per mil ac.
- (3) Samples of completed cable shall be tested at elevated temperatures to demonstrate an extrapolated design life of 40 years continuous operation at 90°C.

3. TEST REQUIREMENTS

A. General

Unless otherwise specified, test methods shall be in accordance with IPCEA S-19-81, IPCEA S-66-524 or IPCEA S-68-516, as applicable.

B. Qualification Tests

Qualification tests shall be performed to verify compliance with the electrical and physical requirements specified in Table III, Table IV and Paragraph 2.H. above. These tests shall be performed on samples from cable purchased under the Specification to which this Engineering Standard is attached. The number and length of samples to be taken shall be based on the quantity of cable purchased in accordance with Tables 6-1, 6-2 and 6-3 of IPCEA S-19-81. The number of specimens to be prepared and tested shall be in accordance with Table 6-4 of IPCEA S-19-81 except that the specified flame tests and long term aging tests are required to be performed only once.

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3. TEST REQUIREMENTS (CONTD)

C. Production Tests

The following production tests shall be performed on each length of cable:

a. Preliminary Insulation Resistance Test

Prior to the assembly of the cable and after not less than six (6) hours immersion in water, an insulation resistance test shall be made on each conductor. The insulation resistance constant (K) shall not be less than 20,000 when corrected to 60°F.

b. Preliminary High Voltage DC Test

Immediately after the preliminary insulation resistance test and while still immersed, each conductor shall withstand without failure a 5 minute test at 7.5 kV dc.

c. Final Insulation Resistance Test

After assembly of the cable is completed, a dry insulation test shall be performed on each conductor. The insulation resistance constant (K) shall not be less than 20,000 when corrected to 60°F.

d. Final High Voltage DC Test

Immediately after the insulation resistance test above, each conductor shall withstand without failure a 5-minute test at 7.5 kV dc.

e. Conductor Resistance Test

The dc resistance shall be measured for each conductor and shall be in accordance with applicable requirements.

D. Certified Test Reports

Copies of complete certified test reports shall be furnished for all qualification tests and production tests made, unless otherwise specified.

4. INSPECTION AND ACCEPTANCE

Where required for acceptance, inspection by the Buyer shall be carried out at the manufacturer's plant and under supervision of the Buyer's representative.

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5. PACKAGING

A. Cable Reels

- a. All cable shall be packaged on reels in such a manner that the cable will be protected for shipment and for outdoor storage. Each end of the cable shall be protected with watertight seals and shall be secured to the reel.
- b. All reels shall have heavy-duty wood lagging consisting of closely spaced boards held in place by nailing and by not less than two (2) steel bands circumferentially secured. The required clearance and bedding shall be provided between the outer layer of the cable and the inner surface of the wood lagging to prevent damage to the cable from crushing by impact up to the impact limits of the lagging.
- c. The minimum drum diameter of the reel shall be in accordance with Appendix M of S-68-516.
- d. The diameter of the reel flange shall not exceed 72 inches, unless special permission is granted by the Buyer.

B. Cable Reel Identification

Each cable reel shall be marked on both flange sides with noncorrosive metal plates or labels securely attached to the reel and legibly stating the Buyer's contract or Purchase Order Number, reel number, length of cable on the reel, number and size of conductors, voltage rating, temperature rating, gross shipping weight and net weight of the cable. A shipping tag containing the same information shall be attached to the outer end of the cable.

6. GUARANTEES

- A. The Seller shall guarantee that the materials furnished conform to the requirements set forth herein and to the specified Codes and Standards, and that all specified tests have been satisfactorily completed and passed.
- B. The Seller shall guarantee all physical and electrical properties tabulated in the Bid Data of the Specification to which this Engineering Standard is attached.
- C. The foregoing shall not be construed in anyway to limit or negate any other standard guarantee or portion thereof which may provide a more comprehensive guarantee than those required by this Specification.

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TABLE I

TYPE AND LIMITS OF ERROR FOR THERMOCOUPLE EXTENTION WIRES

Extension Wire Types	Material	Polarity	Temperature Range, °F	Limits of Error, °F*	
				Standard	Special
EX	Chromel Constantan	+ -	0 to 400	± 3	
KX	Chromel Alumel	+ -	0 to 400	± 4	± 2
JX	Iron Constantan	+ -	0 to 400	± 4	
TX	Copper Constantan	+ -	-75 to 200	± 1-1/2	± 3/4

*The limits of error of thermocouples and extension wires are based on a Reference Junction temperature of 32°Fahrenheit.

TABLE II

NOMINAL LOOP RESISTANCE

Type	Loop Resistance - Ohms per (Double) Foot*		
	16 AWG	18 AWG	20 AWG
EX	0.279	0.444	0.705
JX	0.141	0.225	0.358
KX	0.233	0.372	0.590
TX	0.118	0.188	0.299

*Nominal - plus or minus 10 percent tolerance.

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TABLE III
INSULATION PROPERTIES

	CROSS-LINKED POLYETHYLENE	ETHYLENE PROPYLENE RUBBER
A. Physical characteristics before aging:		
1. Minimum tensile strength, psi	1800	Type I 700 Type II 1200
2. Minimum elongation at rupture, percent	300	250 150
B. Physical characteristics after air oven aging of 7 days at 150°C:		
1. Minimum tensile strength, percent of unaged value	90	85 85
2. Minimum elongation at rupture, percent of unaged value	90	85 85
C. Accelerated water absorption, electrical method (EM-60) at 75°C:		
1. Dielectric constant after 24 hours, maximum	4.0	4.0 4.0
2. Increase in capacitance from 1 to 14 days, percent, maximum	3.0	3.5 3.5
3. Increase in capacitance from 7 to 14 days, percent, maximum	1.5	1.5 1.5
4. Dielectric constant after 52 weeks, maximum	5.5	5.0 5.0
5. Stability factor after 14 days, maximum	0.5	1.0 1.0
6. Stability factor after 52 weeks, maximum	0.75	1.2 1.2
7. Insulation resistance constant (K) after 52 weeks, minimum	5000	4000 4000
D. Accelerated water absorption, Gravimetric Method:		
Absorption, mg per square inch, maximum	10	8.0 8.0
E. Insulation resistance constant (K) at 60°F:		
not less than	40,000	20,000 20,000
F. Cold bend in accordance with IPCEA, 24 hours at minus 25°C (Mandrel diameter 8x), withstand, volts ac per mil	80	80 80
G. Oxygen index in accordance with ASTM D2863, minimum	27	21 27

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TABLE IV

JACKET PROPERTIES - CHLOROSULPHONATED
POLYETHYLENE AND NEOPRENE

A. Physical characteristics before aging:	Chlorosulphonated Polyethylene	Neoprene
1. Minimum tensile strength, psi	1800	1800
2. Minimum elongation at rupture, percent	300	300
B. Physical characteristics after air oven aging at 100°C for 168 hours:		
1. Minimum tensile strength, percent of unaged value	85	75
2. Minimum elongation at rupture, percent of unaged value	65	50
C. Physical characteristics after oil immersion aging at 121°C for 18 hours:		
1. Minimum tensile strength, percent of unaged value	60	60
2. Minimum elongation at rupture, percent of unaged value	60	60
D. Set, maximum percent	30	30
E. Tear strength, pounds per inch, minimum	20	20
F. Cold bend in accordance with IPCEA, 24 hours at minus 25°C	No cracks	No cracks
G. Oxygen index:		
1. Before aging, minimum	30	30
2. After air oven aging at 150°C for 168 hours, minimum	30	30

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TABLE V

JACKET THICKNESS

Conductor or Cable Diameter,* Inches	For Multiconductor Cables	
	Individual Conductor Jacket, EPR Type I Insulated, Inches	Overall Cable Jacket, Inches
0 to 0.250	0.015	0.045
0.251 to 0.425	0.030	0.045
0.426 to 0.700	0.045	0.060
0.701 to 1.500	0.065	0.080
1.501 to 2.500	0.095	0.110
2.501 and larger	0.125	0.140

*Including binder tapes and shield, if applicable.

TABLE VI

NOMINAL LENGTH OF LAY AND DRAIN WIRE SIZES

Conductor Size, AWG	Length of Lay, Inches			Drain Wire Sizes	
	Instrumentation Cable		Thermocouple Cable	Component Shield Drain	Overall Shield Drain
	Pairs	Triads	Pairs	AWG	AWG
20	2.0	2.0	2.5	20	18
18	2.0	2.25	2.75	20	18
16	2.0	2.5	3.0	18	16

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1. GENERAL

- A. This Specification describes the basic requirements for single conductor shielded power cable insulated with ethylene propylene rubber (EPR) and jacketed with neoprene or hypalon. The cable shall have a continuous temperature rating of 90°C, an emergency overload temperature rating of 130°C and a short-circuit temperature rating of 250°C. The cable shall be suitable for continuous operation in wet or dry locations and for installation in trays, conduits or ducts, for direct earth burial, or for use as aerial cable when suitably supported. The cable shall have a design life of forty (40) years.
- B. The cable to be furnished hereunder shall consist of the manufacturer's standard design and first line quality which meets or exceeds the requirements of this Specification.
- C. All cable specified herein shall be manufactured and tested in accordance with the latest applicable parts of the following Codes and Standards unless specified otherwise herein or in the Specification to which this Engineering Standard is attached as a supplement.
- a. AEIC - Association of Edison Illuminating Companies
 - b. ASTM - American Society for Testing and Materials
 - c. IEEE - Institute of Electrical and Electronic Engineers
 - d. IPCEA - Insulated Power Cable Engineers Association

2. DESIGN AND CONSTRUCTION

A. Conductors

The conductors shall be copper; Class B concentric or compact stranded in accordance with ASTM B8. The individual strands shall be soft or annealed copper wire with tensile and electrical properties in accordance with IPCEA S-68-516, Part 2.

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2. DESIGN AND CONSTRUCTION (CONTD)

B. Conductor Shielding

The conductor shall have an extruded semiconducting shielding material in accordance with Paragraph 2.4. of IPCEA S-68-516 except that the average thickness of the shield shall be 15 mils and the minimum thickness shall be 12 mils. The semiconducting conductor shield shall be free-stripping from the conductor.

C. Insulation

a. Type

The conductors shall be insulated with a heat, moisture, and corona resisting ethylene propylene type elastomer compound.

b. Thickness

- (1) The average wall thickness of insulation on conductors shall be equal to or greater than the thickness specified in the table below for each wire size and voltage rating:

Rated Cable Voltage (in kV)	Conductor Size	Insulation Thickness (mils)	
		100 Percent Insulation Level	133 Percent Insulation Level
5	No. 8 AWG to 1250 MCM	90	110
5	Above 1250 MCM	115	140
8	No. 6 AWG to 1250 MCM	115	150
8	Above 1250 MCM	140	170
15	No. 2 AWG to 1250 MCM	175	220
15	Above 1250 MCM	190	220

- (2) The minimum thickness of insulation at any point shall be not less than 90 percent of the specified average thickness.

c. Other Requirements

- (1) Conductor insulation shall meet or exceed the electrical and physical requirements of Table I herein, IPCEA S-68-516 and Paragraph A.3. of AEIC No. 6-75.
- (2) The conductor insulation shall be inseparably bonded to the semiconducting conductor shield.

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2. DESIGN AND CONSTRUCTION (CONTD)

D. Insulation Shielding

a. Extruded Semiconducting Material

The shielding over the insulation shall consist of an extruded semiconducting compound with a volume resistivity not in excess of 50,000 ohms per centimeter when tested in accordance with Paragraph 6.24.3 of IPCEA S-68-516. The thickness of the extruded semiconducting shield shall be in accordance with Table D1 of AEIC No. 6-75. Peel strength of the extruded shield from insulation shall be between 4 and 25 pounds per 0.5 inch width when tested in accordance with AEIC No. 6-75. The compound shall have a minimum elongation of 100 percent after an air oven test at 121°C for 168 hours and a brittleness temperature not warmer than minus 30°C. The words "Semiconducting Material - Remove When Splicing or Terminating" shall be clearly printed on the semiconducting material at close, regular intervals.

b. Identification

All cable shall be identified with a serial marker tape. The tape shall be placed over the extruded semiconducting material and under the copper shield tape. As a minimum, the information on the marker tape shall include the manufacturer and the year of manufacture number repeated at one foot intervals.

c. Metallic Shield Tape

The metallic shield tape shall consist of helically wrapped copper tape with a minimum thickness of 5.0 mils. The copper shield tape shall otherwise conform to Paragraphs 4.1.1. and 4.1.1.2. of IPCEA S-68-516.

E. Jacket

a. Type

The jacket shall be a high quality, heat, flame and radiation resistant compound. The jacket shall have good abrasion resistance and toughness, and shall be resistant to contaminants and solutions normally contained in duct installation. The jacket shall be either heavy duty black neoprene in accordance with Table II herein and with Paragraph 4.4.3 of IPCEA S-68-516, or heavy duty chlorosulfonated

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2. DESIGN AND CONSTRUCTION (CONTD)

polyethylene (Hypalon) in accordance with Table II and with Paragraph 4.4.9 of IPCEA S-68-516.

b. Thickness

The jacket thickness shall be in accordance with Table 4-3 of IPCEA S-68-516.

c. Identification

Cable jackets shall be durably marked with the manufacturer's name, generic name of insulation, size of conductor, conductor material, rated voltage, year of manufacture and sequential footage. This identification shall be repeated at regular intervals not exceeding 24 inches.

3. TEST REQUIREMENTS

A. General

Test methods shall be in accordance with IPCEA S-68-516, IEEE 383-1974 and AEIC No. 6-75.

B. Qualification Tests

a. Qualification tests shall be performed for each cable design to show compliance with the electrical and physical requirements of Paragraph 8. of AEIC No. 6-75, Items C.d. and C.f. of Table I herein, and to show compliance with the flame test specified in b. below.

b. Samples of completed cables shall be submitted to the IEEE 383 ribbon burner flame test with failure detection circuitry connected and energized at 120 volts to ground. The tests shall demonstrate that the length of flame damage does not exceed 36 inches, the time for all flames to extinguish does not exceed 180 seconds, the minimum time to short-circuit does not exceed 7 minutes and the cable does not exhibit any dripping or flowing of materials. The test shall be conducted three (3) times to show reproducibility when using different samples of cable.

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3. TEST REQUIREMENTS (CONTO)

C. Production Sampling Tests

Production sampling tests shall be performed to verify compliance with the electrical and physical requirements specified in Table I and Table II and in Paragraph E. of AEIC No. 6-75. These tests shall be performed on samples from cable purchased under the Specification to which this Engineering Standard is attached as a supplement. The number and length of samples to be taken shall be based on the quantity of cable purchased in accordance with Tables 6-1, 6-4 and 6-5 of IPCEA S-68-516. The number of specimens to be prepared and tested shall be in accordance with Paragraph 6.52 of IPCEA S-68-516.

D. Production Tests

Each length of completed cable shall be subjected to and shall pass the following tests.

a. Partial Discharge Extinction Level Test

The cable shall be subjected to the Partial Discharge Extinction Level Test as described in Part 6 of IPCEA S-68-516 and test results shall be in accordance with Paragraph 3.6.2.3 of IPCEA S-68-516. In addition, the cable shall comply with Table F1 of AEIC No. 6-75 for Apparent Discharge Characteristic.

b. Alternating Current Voltage Test

The cable shall be subjected to the Alternating Current Voltage Test as described in Paragraph 6.27.2 of IPCEA S-68-516 and test results shall be in accordance with Table 3-1 of IPCEA S-68-516.

c. Insulation Resistance Test

The cable shall be subjected to the Insulation Resistance Test as described in Paragraph 6.28 of IPCEA S-68-516. The cable shall show an insulation resistance of not less than that corresponding to a constant of 20,000 megohms per 1000 feet at 15.6°C (60°F) as required by Paragraph 3.6.2.2 of IPCEA S-68-516.

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3. TEST REQUIREMENTS (CONTD)

d. Direct Current Voltage Test

The cable shall be subjected to the Direct Current Voltage Test as described in Paragraph 6.27.3 of IPCEA S-68-516 and test results shall be in accordance with Table 3-1 of IPCEA S-68-516.

E. Certified Test Reports

Copies of complete certified test reports shall be furnished for qualification and production unless otherwise specified.

4. INSPECTION AND ACCEPTANCE

Where required for acceptance, inspection by the Buyer shall be carried out at the manufacturer's plant and under supervision of the Buyer's representative.

5. PACKAGING

A. Cable Reels

- All cable shall be placed on reels in such a manner that it will be protected adequately during shipment. Each end of the cable shall be firmly secured to the reel and shall be taped or otherwise sealed to prevent the entrance of moisture.
- All reels shall be full 2 x 4 inch wood lagged held in place by not less than two (2) steel bands. Adequate bedding shall be provided between the outer layer of the cable and the inner surface of the wood lagging to prevent damage to the cable.
- The outside radius of the reel drum shall be not less than the bending radius recommended by the manufacturer for installation of the cable.
- The diameter of the reel flange shall not exceed 80 inches, unless special permission is granted by the Buyer to allow larger reels required by the cable length or construction.

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5. PACKAGING (CONTD)

B. Cable Reel Identification

Each cable reel shall be marked with a non-corrosive metal plate or label securely attached to the reel and plainly stating the Buyer's Contract or Purchase Order number, reel number, length of cable on the reel, number and size of conductors, voltage rating, temperature rating, gross shipping weight and net weight of the cable. A shipping tag containing the same information shall be attached to the outer end of the cable.

6. GUARANTEES

- A. The Seller shall guarantee that the materials furnished conform to the requirements set forth herein and to the specified Codes and Standards, and that all specified tests have been satisfactorily completed and passed.
- B. The Seller shall guarantee all physical and electrical properties tabulated in the Bid Data Section of the Specification to which this Engineering Standard is attached.
- C. The foregoing shall not be construed in any way to limit or negate any other standard guarantee or portion thereof which may provide a more comprehensive guarantee than those required by this Specification.

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TABLE I

INSULATION PROPERTIES
ETHYLENE PROPYLENE RUBBER

- A. Physical characteristics before aging:
 - a. Minimum tensile strength, psi 700
 - b. Minimum elongation at rupture, percent 250
- B. Physical characteristics after air oven aging of 7 days at 150°C:
 - a. Minimum tensile strength, percent of unaged value 85
 - b. Minimum elongation at rupture, percent of unaged value 85
- C. Accelerated water absorption, electrical method (EM-60) at 75°C:
 - a. Dielectric constant after 24 hours, maximum 4.0
 - b. Increase in capacitance from 1 to 14 days, maximum 3.5
 - c. Increase in capacitance from 7 to 14 days, maximum 1.5
 - d. Dielectric constant after 52 weeks, maximum 5.0
 - e. Stability factor after 14 days, maximum 1.0
 - f. Stability factor after 52 weeks, maximum 1.2
 - g. Insulation resistance constant (K) after 52 weeks, minimum 4,000
- D. Accelerated water absorption, Gravimetric Method:
 - Absorption, mg per square inch, maximum 8.0
- E. Insulation resistance constant at 60°F:
 - K not less than 20,000
- F. Cold bend per IPCEA, 1 hour. at minus 40°C No cracks
- G. Oxygen index per ASTM D2863, minimum 21

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TABLE II
JACKET PROPERTIES-CHLOROSULFONATED
POLYETHYLENE AND NEOPRENE

	Chlorosulfonated Polyethylene	Neoprene
Physical characteristics before aging:		
a. Minimum tensile strength, psi	1800	1800
b. Minimum elongation at rupture, percent	300	300
Physical characteristics after air oven aging at 100°C for 168 hours:		
a. Minimum tensile strength, percent of unaged value	35	75
b. Minimum elongation at rupture, percent of unaged value	65	50
Physical characteristics after oil immersion aging at 121°C for 18 Hours:		
a. Minimum tensile strength, percent of unaged value	60	60
b. Minimum elongation at rupture, percent of unaged value	60	60
Set, maximum percent	30	30
Tear Strength, lb/inch, minimum	20	20
Cold bend per IPCEA, 1 hour at minus 40°C	No cracks	No cracks
Oxygen index		
a. Before aging, minimum	30	30
b. After air oven aging at 150°C for 168 hours; minimum	30	30

Project No. C-21700

Spec. No. FJ50.50

November 3, 1976

SPECIFICATION

NO. FJ50.50

FOR

DOCUMENTATION

FOR

10MW_e SOLAR PILOT PLANT
SOLAR - ONE
DAGGETT, CA.

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STEARNS-ROGER ENGINEERING CORP.
DENVER, COLORADO

PROJECT NO. C-21700

Project No. C-21700Spec. No. FJ50.50DOCUMENTATION1. SCOPE

- A. This Specification outlines the requirements for, and the procedures associated with, the preparation and exchange of documentation for the work, equipment and/or materials specified in the Contract or Specification to which this Specification is a supplement.
- B. This Specification supplements requirements in Engineering Standard No. FJ60.60.
- C. This Specification also supplements requirements, where specified, in Paragraph DOCUMENTATION of the Contract or Specification to which this Specification is a supplement.
- D. This Specification and supplementary references specified in the foregoing paragraphs cover minimum requirements for documentation and are not intended to limit the amount of additional documentation which may be required for the engineering coordination, use or maintenance of the work, equipment and/or materials being furnished. Such additional documentation shall be provided by Seller or Contractor.
- E. All references to "Seller" herein shall apply to Seller or Contractor. All references to "Buyer" herein shall apply to the Buyer or the Owner. All references to "Engineer" herein shall apply to Stearns-Roger Incorporated.

2. TYPE, QUANTITIES AND QUALITY OF COPIES

The type and quantities of copies for required documentation are specified on Engineering Standard No. FJ60.60. Quality requirements shall be as follows:

A. Reproducible Drawings

All reproducible drawings submitted to Engineer shall be furnished on ozalid vellum, auto-positive vellum or Mylar, black line on vellum, or other Engineer-approved medium, each to be suitable for legible reproduction by the diazo copy process. Reproducible drawings shall be rolled, not folded, and enclosed in mailing tubes when mailed to Engineer or otherwise handled.

B. Prints

Where designated by the word "Prints" on Engineering Standard No. FJ60.60, it shall be understood to mean suitable "blueprint print/copy," "blueprint," or other Engineer-accepted reproduction of an original Seller-prepared tracing or sepia.

Project No. C-21700Spec. No. FJ50.50**2. TYPE, QUANTITIES AND QUALITY OF COPIES (CONTD)****C. Other Documentation**

Where designated by the word "Copies" on Engineering Standard No. FJ60.60, applicable documentation shall be submitted on legible, black on white, 8-1/2-inch by 11-inch pages.

3. DOCUMENTATION BY SELLER**A. General**

a. Required types of documentation are specified on Engineering Standard No. FJ60.60. Where this Standard does not fully describe individual categories of documentation that are required, such detailed categories are specified in Paragraph DOCUMENTATION of the Contract or Specification to which this Specification is a supplement.

b. Where equipment for Units 1 and 2 is identical, or where equipment is common to Units 1 and 2, one (1) set of documentation shall be furnished. If equipment is identical, Seller shall certify, on each document, that it is applicable to both Units 1 and 2. Where equipment is neither identical for nor common to Units 1 and 2, two (2) complete, individual sets of documentation shall be furnished, appropriately identified.

c. The title block of each drawing shall denote the applicability of the drawing either to "Unit 1," "Unit 2" or "Units 1 and 2." Other documentation submitted by Seller shall carry similar identification.

d. The following information shall be included in each drawing:

- (1) Buyer's Name.
- (2) Engineer's Project Number.
- (3) Plant or station name.
- (4) Unit number (if applicable).
- (5) Buyer's Purchase Order Number.

Other documentation submitted by Seller shall carry similar identification.

e. Unless specifically approved by the Engineer, "typical" or "similar" documentation is not acceptable for review.

Project No. C-21700Spec. No. FJ50.50**3. DOCUMENTATION BY SELLER (CONTD)****A. General (Contd)**

- f. "Standard Hardware Items" are defined as standard commercial items, such as air and hydraulic cylinders and operating valves, gear reducers, small motors, instruments, etc. For such items, review drawings are not required. Certified sheets showing exact mounting dimensions, overall dimensions, cross-sectional arrangement, parts nomenclature and material designation shall be submitted. Details of parts shall be furnished when requested by Buyer.
- g. Within 30 days after written notice of award, Seller shall submit a complete Definitive Drawing List, by drawing and title, of all drawings that will be submitted to Engineer. On this list, each drawing shall be identified by its appropriate category as defined in Items 1 or 2 on Engineering Standard No. FJ60.60, and as supplemented in Paragraph DOCUMENTATION of the Contract or Specification. Any drawing that does not fall under these predefined categories shall be identified on the list as "Miscellaneous." This list shall include proposed submittal dates for each drawing. This drawing list and schedule, together with any subsequent modifications, shall be subject to Engineer's review and comments.

B. Progress Reports

Seller shall furnish Engineer monthly progress reports and schedule status reports. These reports and schedules shall cover the complete status and progress of engineering, documentation, fabrication, materials, labor and shipment.

C. Review and Comment

- a. Entries in the column "WEEKS AFTER AWARD" on Engineering Standard No. FJ60.60 designate maximum time spans for Seller's submittal of documentation for review after the date of Buyer's written notification of award, whether such notification be in the form of a Purchase Order, a Letter of Intent or similar written authorization.
- b. All documentation to be certified and submitted by Seller for interface coordination shall show sufficient details of design so that the Engineer may proceed with his overall project design where interrelated with Seller's design.
- c. All documentation submitted in the correct and complete form to Engineer for his review and comment will be processed and a copy sent to Seller within 2 weeks after receipt of Seller's submittal. If more than 2 weeks review time is necessary, Engineer will advise Seller in writing as to his review schedule for such data. Seller shall then advise Engineer in writing what effect the extended review schedule has on the scheduled delivery of Seller's materials and equipment.

Project No. C-21700
Spec. No. FJ50.503. DOCUMENTATION BY SELLER (CONTD)C. Review and Comment (Contd)

- d. Drawings and data will be returned to Seller marked either "REVIEWED/NO COMMENTS," "REVIEWED/SEE COMMENTS" or "REVISE PER COMMENTS AND RESUBMIT FOR REVIEW."
- e. When the documentation is returned marked "REVIEWED/NO COMMENTS" or "REVIEWED/SEE COMMENTS," final certified submittals incorporating the noted changes shall be furnished, unless otherwise authorized by Engineer in writing, within 3 weeks from the time of receipt of copy by Seller or at least 3 weeks before the scheduled delivery of Seller's work, whichever is earlier. Where Engineering Standard No. FJ60.60 stipulates that drawing review is required before release for fabrication, "REVIEW/SEE COMMENTS" shall constitute such release.
- f. When the documentation is returned marked "REVISE PER COMMENTS AND RESUBMIT FOR REVIEW," the documentation with the noted revisions incorporated shall be resubmitted for review and comment within 3 weeks from the time of receipt of copy by Seller. The review and comment and final submittal schedule shall be as specified in Sub-paragraphs 3.C.c. and 3.C.e. above.
- g. The documentation submittal schedules shall be adhered to by Seller, unless otherwise authorized by Engineer in writing. In any case, final submittals shall be furnished at least 3 weeks before the scheduled delivery of Seller's work.
- h. When reviewed information is subsequently revised by Seller, or is subsequently found to be deficient because of Seller's error or omission, additional Seller submittals shall be made to Engineer as developed. Any Engineer's design changes and any changes in equipment or construction by others which are required to make such subsequent revisions an integral part of the overall project shall be made at Seller's expense.
- i. Fabrication or shipment shall be at Seller's risk, whether or not Engineer has reviewed Seller's drawings as specified on Engineering Standard No. FJ60.60.
- j. Seller will be notified of review by a stamped copy of Stearns-Roger Form 02.145 or TRMSR05A stating "Supplier: As to all Drawings/Data listed on this transmittal: PROCEED TO FABRICATE." All Seller drawings which are submitted as final shall be stamped "Final." Where specified on Engineering Standard No. FJ60.60, final drawings shall be certified for construction.
- k. Neither review of, nor comment or revision on drawings by Engineer relieves Seller or Contractor from compliance with Specifications or with all other requirements of Purchase Order or Contract, nor shall the procedures outlined herein be cause for delay of equipment deliveries, except as otherwise specified herein.

Project No. C-21700Spec. No. FJ50.503. DOCUMENTATION BY SELLER (CONTD)C. Review and Comment (Contd)

1. Notations made during the review of drawings shall not be construed to authorize contractual changes in price or delivery of equipment or materials furnished by Seller. If the scope of work has been changed as a result of such notations, Seller shall request a change in Purchase Order price and/or delivery date(s). Seller shall make the request in writing to Engineer before proceeding with the work.

D. Operation and Maintenance Manualsa. General

- (1) Seller shall furnish Operation and Maintenance Manuals which shall be complete for all equipment and systems furnished by Seller and by Seller's suppliers. Any differences between equipment supplied for Unit 1 and Unit 2 with regard to operation and maintenance shall be clearly defined in these Manuals.
- (2) Manuals shall be forwarded four (4) weeks prior to complete delivery of equipment in accordance with Engineering Standard No. FJ60.60.
- (3) If the publication of a subassembly manufacturer does not contain a complete operation, maintenance and parts breakdown meeting the intent of this Specification, then it shall be the responsibility of Seller to include such information in the Operation and Maintenance Manual.
- (4) All necessary precautions and warnings relative to the safety of life and equipment shall be included.

b. Operation

As a minimum, the Operation Section of the Manual shall contain the following:

- (1) Starting instructions, including, as applicable, instructions for initial startup, normal starting, starting after overhaul and startup after emergency trip.
- (2) Operating instructions, including trouble-shooting procedures.
- (3) Shutdown instructions, for both normal and emergency shutdown.
- (4) Design data for all equipment and systems, specifying horsepower, kilowatts, voltage, amperage, pressure, temperature, revolutions per minute, flow, etc.

Project No. C-21700Spec. No. FJ50.503. DOCUMENTATION BY SELLER (CONTD)D. Operation and Maintenance Manuals (Contd)c. Maintenance

As a minimum, the Maintenance Section of the Manual shall contain the following:

- (1) Disassembling and reassembling instructions.
- (2) Preventive maintenance and lubrication information.
- (3) Description and identification of special maintenance tools.
- (4) Settings, clearance and adjustment data.

d. Parts Breakdown

The Parts Breakdown Section of the Manual shall contain:

- (1) A list of replacement parts, including drawings and data for all equipment assemblies and subassemblies. The material shall cover all information required for ordering replacement parts such as part name, part number, equipment serial number, supplier, address and normal delivery time.
- (2) Complete instructions for procuring replacement parts. Recommended forms for tabulating replacement part information and instructions for returning material to the factory shall also be included. Special storage, handling or packaging procedures required for any particular parts shall be noted.

E. Bills of Material

Detailed Bills of Material are required to facilitate identification by constructors of the items received. Shipment, therefore, shall be preceded by submittal of Bills of Material in accordance with Engineering Standard No. FJ60.60, Item 4 C.

4. DRAWINGS BY ENGINEER

- A. For applicable equipment, prints of drawings prepared by Engineer for use by others in constructing foundations, building components and major piping and wiring requiring coordination with the work associated herewith will be furnished to Seller for review as soon as possible after Engineer's receipt from Seller of the certified equipment drawings and design information necessary for their preparation.
- B. Where material, locations, etc., are marked HOLD on Engineer's Drawings, that material, location, etc., shall not be detailed or fabricated by Seller until the HOLD is removed by Engineer.

Project No. C-21700
Spec. No. FJ50.50**4. DRAWINGS BY ENGINEER (CONTD)**

- C. Within 30 calendar days after the date of transmittal to Seller, Seller shall return to Engineer two (2) copies of each of these drawings marked to indicate Seller's review thereof either without change, or with any corrections or necessary changes clearly marked thereon in red or other contrasting color.
- D. After making such corrections or changes as shown on the review copies returned by Seller, Engineer will release these drawings for construction. Subsequent changes or corrections to foundations, building components, wiring or piping fabricated or installed in accordance with drawings corresponding to the review copies approved by the Seller, such changes having been necessitated by Seller-initiated modifications, shall be done in a manner satisfactory to Buyer and at Seller's expense.

5. TRANSMITTALS

When transmitting documentation, Seller shall:

- A. Prepare original and four (4) copies of transmittal letters to accompany each submittal of documentation. Drawing transmittal letters shall identify the purpose of the transmittal (drawings for review, revised drawings, final drawings), the piece of equipment or material involved, and shall list the drawing numbers with applicable revision numbers or dates.
- B. Identify each letter and parcel with Buyer's Project Name, Engineer's Project Number, Purchase Order Number and Seller's Shop Order Number, and transmit it by air mail or first class mail. Each parcel shall contain an enclosed copy of the transmittal letter.
- C. Stamp each document to be submitted with reproduction date and purpose of the transmittal, e.g., "For Review," "Revised," "Final," etc.

6. SPECIAL CONSIDERATIONS

- A. It is understood that upon delivery of Seller's documentation without any restrictive notations concerning such work, they shall become Buyer's property and may be used in any manner desired for obtaining replacements, repairs and spare parts.
- B. Seller's final invoice will not be paid by Buyer until all materials and/or equipment governed hereunder have been received complete at the delivery point, and final certified submittals of all specified documentation have been received by Engineer.

DIVISION USAGE							Stearns-Roger <small>INCORPORATED</small>				STANDARD NUMBER		
MM	P	PP	SH	FI	SP		ENGINEERING STANDARD				FJ 60.60		
APPROVALS Des. Sec. <i>[Signature]</i> Sect. Supv. <i>[Signature]</i> Div. <i>[Signature]</i>							DOCUMENTATION REQUIREMENTS				C-21700		
							PROJECT: SOLAR ONE CONTRACT/REQUISITION NUMBER: F010.3 TITLE: POWER, CONTROL AND INSTRUMENTATION CABLE (CORE AREA)				ISSUED 7/16/79		
											REVISED		
TYPE OF DOCUMENTATION							TYPE OF COPIES	FOR REVIEW		FINAL		REVIEW	CTFY.
								NO. OF COPIES	WEEKS AFTER AWARD*	NO. OF COPIES	"X" IF REQ'D	REQ'D BEFORE FAB.**	FINAL ISSUE ***
1-ENGINEERING DRAWINGS							Repro-ducibles						
A-Outline, General Arrangement and Principal Dimensions							Prints						
B-Cross Sections													
C-Foundation Requirements, including Loadings & Anchoring Locations													
D-Physical Locations of Piping and/or Wiring Terminals													
E-Control Diagrams													
F-Electrical Schematic Diagrams													
G-Wiring Diagrams, Including Internal External and Interconnecting													
H-Standard Hardware Items													
2-ERECTION OR INSTALLATION INFO.							Repro-ducibles						
A-Shop Fabrication Drawings							Prints						
B-Erection or Installation Drawings													
C-Erection or Install. Instructions							Copies	8	6-8	8	X		X
3-SPECIAL DOCUMENTATION													
A-Performance Data, including Curves							Copies						
B-Design Calculations							Copies						
C-Test Reports							Copies			8	X		X
D-Code Papers and Certificates							Copies						
E-Shop Fab. and/or Welding Proced.							Copies						
F-Shop Fabrication Reports							Copies						
G-Welder's Qualification Reports							Copies						
H-Operating Certificates							Copies						
4-MISCELLANEOUS													
A-Operation and Maintenance Manuals							Manuals						
B-Recommended Spare Parts List for 1 Year's Operation, with Unit Prices							Copies						
C-Bills of Material							Copies			8	X#		X
D-Definitive Drawing List							Copies						
*-Entries in the column "WEEKS AFTER AWARD" designate which types of review documentation are required. Blank spaces in this column denote that review documentation is not required. **-"X" in this column means drawing review req'd. before fabric. release. ***-"X" in this column means final issue must be certified for construction.											Except where otherwise specified, send all Documentation to: Stearns-Roger Engineering Corp. P.O. Box 5888 Denver, Colorado 80217 Attn: Mr. R.K. Brushel		
#-At least 2 weeks before each shipment, detailed Bills of Material shall be sent to the plant site, C/O Stearns-Roger Resident Engineer, with 3 copies to Stearns-Roger Denver Office. This form supplements requirements, where specified, in Paragraph DOCUMENTATION in the Specification and in Specification FJ50.50.													

APPENDIX 1

SPECIFICATION FOR 5000 VOLT NON-SHIELDED POWER CABLE

1. GENERAL

- A. This Specification describes the basic requirements for single conductor non-shielded 5000 volt power cable insulated with high temperature Kerite rubber (EPR) and jacketed with neoprene or Hypalon. The cable shall have a continuous temperature rating of 90°C, an emergency overload temperature rating of 130°C and short-circuit temperature rating of 250°C. The cable shall be suitable for continuous operation in wet or dry locations and for installation in trays, conduits or ducts, for direct earth burial, or for use as aerial cable when suitably supported. The cable shall have a design life of forty (40) years.
- B. The cable to be furnished hereunder shall consist of the manufacturer's standard design and first line quality which meets or exceeds the requirements of this Specification.
- C. All cable specified herein shall be manufactured and tested in accordance with the latest applicable parts of the following Codes and Standards unless specified otherwise herein or in the Specification to which this Engineering Standard is attached as a supplement.
 - a. AEIC - Association of Edison Illuminating Companies
 - b. ASTM - American Society for Testing and Materials
 - c. IEEE - Institute of Electrical and Electronic Engineers
 - d. IPCEA - Insulated Power Cable Engineers Association

2. DESIGN AND CONSTRUCTION

A. Conductors

The conductors shall be copper; Class B concentric or compact stranded in accordance with ASTM B8. The individual strands shall be soft or annealed copper wire with tensile and electrical properties in accordance with IPCEA S-68-516, Part 2.

B. Conductor Shielding

The conductor shall have an extruded permashield energy suppression material with an average thickness of 15 mils and a minimum thickness of 12 mils. The energy suppression water shall be free-stripping from the conductor.

C. Insulation

a. Type

The conductors shall be insulated with a heat, moisture, and corona resisting ethylene propylene type elastomer compound.

b. Thickness

- (1) The average wall thickness of insulation on conductors shall be equal to or greater than the thickness specified in the table below for each wire size and voltage rating:

<u>Rated Cable Voltage (in kV)</u>	<u>Conductor Size</u>	<u>Insulation Thickness (mils)</u>
5	2/0 AWG	125

- (2) The minimum thickness of insulation at any point shall be not less than 90 percent of the specified average thickness.

c. Other Requirements

Conductor insulation shall meet or exceed the electrical and physical requirements of Table I herein, IPCEA S-68-516 and Paragraph A.3. of AEIC No. 6-75.

D. Jacket

a. Type

The jacket shall be a high quality, heat, flame and radiation resistant compound. The jacket shall have good abrasion resistance and toughness, and shall be resistant to contaminants and solutions normally contained in duct installation. The jacket shall be either heavy duty black neoprene in accordance with Table II herein and with Paragraph 4.4.3 of IPCEA S-68-516, or heavy duty chlorosulfonated polyethylene (Hypalon) in accordance with Table II and with Paragraph 4.4.9 of IPCEA S-68-516.

b. Thickness

The jacket thickness shall be 95 mils.

c. Identification

Cable jackets shall be durably marked with the manufacturer's name, generic name of insulation, size of conductor, conductor material, rated voltage, and year of manufacture. This identification shall be repeated at regular intervals not exceeding 24 inches.

3. TEST REQUIREMENTS

A. General

Test methods shall be in accordance with IPCEA S-68-516, IEEE 383-1974 and AEIC No. 6-75.

B. Qualification Tests

a. Qualification tests shall be performed for the cable to show compliance with the following requirements.

1. Ubend plate discharge which shows no dielectric failure with the insulation and/or insulation and jacket exposed to a continuous stress equal to 200 volts per mil of insulation thickness for a minimum of 100 hours.

2. High temperature Kerite insulation withstands 121°C and remains flexible to meet the 75 percent of unaged elongation for more than 16,000 hours.

3. The HTNS jacket remains flexible following continuous exposure to a temperature of 131°C for more than 2000 hours.

b. Samples of completed cables shall be submitted to the IEEE 383 ribbon burner flame test with failure detection circuitry connected and energized at 120 volts to ground. The tests shall demonstrate that the length of flame damage does not exceed 36 inches, the time for all flames to extinguish does not exceed 180 seconds, the minimum time to short-circuit does not exceed 7 minutes, and the cable does not exhibit any dripping or flowing of materials. The test shall be conducted three (3) times to show reproducibility when using different samples of cable, both aged and unaged.

C. Production Sampling Tests

Production sampling tests shall be performed to verify compliance with the electrical and physical requirements specified in Table I

and Table II and in Paragraph E. of AEIC No. 6-75. These tests shall be performed on samples from cable purchased under the Specification to which this Engineering Standard is attached as a supplement. The number and length of samples to be taken shall be based on the quantity of cable purchased in accordance with Tables 6-1, 6-4 and 6-5 of IPCEA S-68-516. The number of specimens to be prepared and tested shall be in accordance with Paragraph 6.52 of IPCEA S-68-516.

D. Production Tests

Each length of completed cable shall be subjected to and shall pass the following tests.

a. Conductor Tests

The conductor supplier shall furnish certificates of conformance indicating that all conductors have been tested in accordance with ASTM B8, B33, B189, B230, and B231 as applicable. These certificates shall be available for review and audit at the manufacturer's plant.

b. Insulation Tests

(1) Preliminary Tank Test

Each individual insulated length of conductor, after extrusion and prior to any further processing, shall be immersed in a water tank for a minimum period of twenty-four hours. At the end of sixteen hours (minimum), while immersed, each length of insulated conductor shall pass a DC voltage withstand test, applied for five minutes at the test voltage specified in Section e, Table A.

At the end of the twenty-four hour immersion (minimum, while still immersed, each length of insulated conductor shall pass an AC voltage withstand test, applied for five minutes at the test voltage specified in Section e, Table A. Following the five-minute AC voltage test, the one-minute insulation resistance (R) of each length of insulated conductor shall be measured and corrected to 15.6°C (60°F) and 1000 ft. This resistance shall be not less than the value of R as calculated from the following formulas.

$$R = K \log_{10} D/d \text{ in megohms-kilofoot}$$

$$K = 21,000 \text{ megohms-kilofoot}$$

$$D = \text{Diameter over insulation}$$

$$d = \text{Conductor diameter}$$

(2) Intermediate Tank Test

Each individual jacketed length of conductor shall be immersed in a water tank for a minimum period of sixteen hours. At the end of the sixteen hours (minimum), each length of jacketed conductor shall pass an AC and DC voltage withstand test applied for five minutes at the test voltage specified in Section e, Table B.

(3) Final Test on Shipping Reel

Each length of completed multiconductor, triplexed, or paralleled cable shall pass an AC voltage withstand test, applied for one minute, using a center tapped ground transformer, at the test voltages specified in Section e, Table B. Following the one-minute AC test, the one-minute insulation resistance (R) of each insulated conductor of these completed cables shall be measured and corrected to 15.6° (60°F) and 1000 feet. The corrected values of insulation resistance shall not be less than 60% of the value of R specified in Paragraph 2a.

c. Dimensional Verification

- a) Each length of insulated conductor shall be examined to verify that the conductor is the correct size.
- b) Each length of insulated conductor shall be measured to verify that the insulation wall thickness is of the correct dimension.
- c) Each length of completed cable shall be measured to verify that the jacket wall thickness is of the correct dimension.

d. Conductor Resistance

The DC resistance of each conductor of each length of completed cable shall be measured and recorded.

e. Voltage Withstand Test Values (Kilovolts)

Conductor Sizes	Table A Preliminary Test Voltage		Table B Intermediate and Final Test Voltage	
	AC	DC	AC	DC
8 - 1 AWG	26.0	52.0	26.0	52.0
1/0 - 4/0 AWG	26.0	52.0	26.0	52.0
250 - 500 kemil	26.0	52.0	26.0	52.0
600 - 1000 kemil	30.0	60.0	30.0	60.0
1100 - 2000 kemil	35.0	70.0	35.0	70.0

E. Certified Test Reports

Copies of complete certified test reports shall be furnished for paragraphs 3.D.b. and 3.D.d. above. The data related to paragraphs 3.D.a. and 3.D.c. above shall be available for review and audit at the manufacturer's plant.

4. INSPECTION AND ACCEPTANCE

Where required for acceptance, inspection by the Buyer shall be carried out at the manufacturer's plant and under supervision of the Buyer's representative.

5. PACKAGING

A. Cable reels

- a. All cable shall be placed on reels in such a manner that it will be protected adequately during shipment. Each end of the cable shall be firmly secured to the reel and shall be taped or otherwise sealed to prevent the entrance of moisture.
- b. All reels shall use tech wood lagging held in place by not less than two (2) steel bands. Adequate bedding shall be provided between the outer layer of the cable and the inner surface of the wood lagging to prevent damage to the cable.
- c. The outside radius of the reel drum shall be not less than the bending radius recommended by the manufacturer for installation of the cable.
- d. The diameter of the reel flange shall not exceed 80 inches, unless special permission is granted by the Buyer to allow larger reels required by the cable length or construction.

B. Cable Reel Identification

Each cable reel shall be marked with a non-corrosive metal plate or label securely attached to the reel and plainly stating the Buyer's Contract or Purchase Order number, reel number, length of cable on the reel, number and size of conductors, voltage rating, temperature rating, gross shipping weight and net weight of the cable. A shipping tag containing the same information shall be attached to the outer end of the cable.

6. GUARANTEES

- A. The Seller shall guarantee that the materials furnished conform to the requirements set forth herein and to the specified Codes and Standards, and that all specified tests have been satisfactorily completed and passed.

- B. The Seller shall guarantee all physical and electrical properties tabulated in the Bid Data Section of the Specification to which this Engineering Standard is attached.
- C. The foregoing shall not be construed in any way to limit or negate any other standard guarantee or portion thereof which may provide a more comprehensive guarantee than those required by this Specification.

TABLE 1
INSULATION PROPERTIES

A. Physical characteristics before aging:	
a. Minimum tensile strength, psi	500
b. Minimum elongation at rupture, percent	250
B. Physical characteristics after air oven aging of 7 days at 136°C:	
a. Typical tensile strength, percent of unaged value	110
b. Typical elongation at rupture, percent of unaged value	80
C. Accelerated water absorption, electrical method (EM-60) at 70°C.	
a. Dielectric constant after 24 hours, typical	3.9
b. Increase in dielectric constant from 1 to 14 days, typical	8.7
c. Increase in dielectric constant from 7 to 14 days, typical	4.9
d. Stability factor after 14 days, maximum	.8
D. Accelerated water absorption, Gravimetric Method:	
Absorption, mg per square inch, typical	17
E. Insulation resistance constant at 60°F:	
K not less than	21,000
F. Cold bend per IPCEA, 1 hour at minus 40°C (Mandrel diameter 8x), withstand, volts ac/mil	
	80

TABLE II
JACKET PROPERTIES-CHLOROSULFONATED
POLYETHYLENE AND NEOPRENE

	<u>Chlorosulfonated Polyethylene</u>	<u>Neoprene</u>
Physical characteristics before aging:		
a. Minimum tensile strength, psi	1200	1800
b. Minimum elongation at rupture, percent	250	300
Physical characteristics after air oven aging at 136°C for 168 hours:		
a. Minimum tensile strength, percent of unaged value	104	75
b. Minimum elongation at rupture, percent of unaged value	91	50
Physical characteristics after oil immersion aging at 121°C for 18 hours:		
a. Minimum tensile strength, percent of unaged value	95	60
b. Minimum elongation at rupture, percent of unaged value	75	60
Set, maximum percent	25	30
Cold bend per IPCEA, 1 hour at minus 40°C	No cracks	No cracks
Oxygen index		
a. As made (see flame test)	29	30
b. Aged - 7 days 143°C (simulate your life) Reg. Guide 1-131	79 VG-24-P Passes	30

July 11, 1980
(For Purchase)

SPECIFICATION

S-R F235.1

D.O.E. NO. 40 E 700 - 19S

for

**480-VOLT LOAD CENTER
AND
480-VOLT MOTOR CONTROL CENTERS**

for

**10MW_e SOLAR PILOT PLANT
SOLAR - ONE
DAGGETT, CA.**

Prepared by:

Stearns-Roger
ENGINEERING CORP.

PROJECT NO. C-21700

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SPECIAL INSTRUCTIONS

An asterisk has been placed in the right-hand margin to denote changes made to the "For Bid" specification. The subject changes were made to conform this document to awardee's proposal and subsequent updating and/or negotiations.

All further changes to this "For Purchase" document shall be made by the issuance of a numbered revised copy.

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DETAILED SPECIFICATION
FOR
480-VOLT LOAD CENTER AND
480-VOLT MOTOR CONTROL CENTERS

SECTION I - GENERAL

1. SCOPE

A. General

The equipment to be furnished and delivered shall consist of one (1) 480-Volt Load Center and two (2) 480-Volt Motor Control Centers for the 10 MWe Solar Pilot Plant, as specified in Sections II and III herein, complete with all accessories specified or required for complete and operational equipment.

B. Definitions

Engineer: Shall mean Stearns-Roger Engineering Corporation

2. SUPPLEMENTS

The following supplements are included with and form a part of this Specification.

A. Stearns-Roger Engineering Standards:

- a. JF16.02.40, Specification for Load Centers, dated 3/23/79, 12 pages.
- b. JF16.01.01, Electrical Wiring Diagram and Information Procedure, dated 2/7/79, 7 pages.
- c. Specification for Motor Control, Form JF30.30.01:

<u>For</u>	<u>No. of Pages</u>	<u>Date</u>	
MCC-B	3	7/11/80	*
MCC-C	3	7/11/80	*

d. Low Voltage Control Diagrams:

<u>No.</u>	<u>Title</u>	<u>Date</u>
JF30.40.05	FVNR thru Size 3	3/14/79
JF30.40.10	FVR thru Size 3	5/1/79

SECTION I (CONTD)

- e. Specification No. FJ50.50, Documentation, dated 11/3/76, 7 pages.
- f. FJ60.60, Documentation Requirements, dated 3/12/80, 1 page.

B. Stearns-Roger Engineering Corp. Drawings and Sketches

a. Drawings

<u>Drawing No.</u>	<u>Sheet No.</u>	<u>Rev.</u>	<u>Title</u>	
40E3005132029	E2-5	0	One-Line Diagram Load Center-A	*
40E7005133192	E2-3	0	One-Line Diagram 480V MCC-B	*
40E7005133193	E2-4	0	One-Line Diagram 480V MCC-C	*
40E7005133188	E1-1	2	Electric Legend and Symbols	*

b. Sketches

<u>Sketch No.</u>	<u>Date</u>	<u>Title</u>	
SK-E75	7/11/80	FVNR Starter Internal Wiring With 1 Auxiliary Relay	*
SK-E76	7/11/80	FVR Starter Internal Wiring With 2 Auxiliary Relays	*
SK-E77	5/15/80	Load Center-A Plan-Layout	
SK-E78	5/15/80	Load Center-A Elev.-Layout	

3. DOCUMENTATION REQUIREMENTS

- A. Prior to fabrication or delivery to the jobsite of equipment to be furnished under this Specification, the Seller shall submit to the Engineer, for review and comment, the drawings and descriptive data called for in this Specification. Drawings and data submittals shall be in accordance with Specification No. FJ50.50 and Engineering Standard No. FJ60.60, both attached.
- B. Wiring diagrams for the 480-volt load center that provide information relating to interface terminal blocks to be used for interconnecting with remote devices by Buyer's cables shall be prepared in accordance with Engineering Standard No. JF16.01.01 for Class I and Class III equipment as applicable.
- C. Wiring diagrams shall not be furnished for motor control centers.

SECTION II
480-VOLT LOAD CENTER

1. SCOPE

This Section II states the conditions and requirements applicable to furnishing a 480-Volt Load Center for the 10 Mw Solar Pilot Plant. The load center shall consist of one (1) single-ended load center assembly, complete with a 1000 KVA power transformer, low voltage switchgear, nonsegregated phase bus and all accessories specified or required for complete and operational equipment.

2. EQUIPMENT TO BE FURNISHED

One (1) single-ended load center assembly, complete from high voltage incoming line terminals to outgoing low voltage feeder terminals and with the accessories specified, shall be furnished by the Seller. Incidental items which are essential but which may not be specifically described by this Specification shall be furnished in accordance with the Seller's design for a complete and operable load center.

<u>Item</u>	<u>Nameplate</u>
1	Load Center-A

3. EQUIPMENT AND SERVICES FURNISHED BY OTHERS

The following will be furnished by others:

- A. Receiving, unloading, installation, and field inspection and testing.
- B. Design and construction of foundations; and concrete, reinforcing steel and anchor bolts.
- C. All external wiring and devices for power and control.
- D. 125-Volt dc control power.

4. OPERATING CONDITIONS

A. Environmental

The equipment shall be designed and constructed to operate successfully at the rated values under the following environmental conditions:

a. Location:

(1) Load center transformer	Outdoors
(2) Low-voltage switchgear	Indoors

SECTION II (CONTD)

- b. Plant elevation: 1950 feet above mean sea level
- c. Ambient temperature range, degrees:
 - (1) Indoors 12 C to 45 C
 - (2) Outdoors Minus 10 C to plus 45 C
- d. Plant is located in Uniform Building Code Seismic Zone 3. Equipment shall be designed and supported to withstand lateral seismic forces generated by a ground acceleration of 0.25g.

B. The load center transformer will be supplied from a 4160-volt underground system.

5. DESIGN AND CONSTRUCTION

A. General

- a. The equipment to be furnished hereunder shall have a service life of thirty (30) years. The equipment shall consist of essentially standard design and quality which meets or exceeds the requirements of this Specification. Materials shall be in accordance with ASTM requirements, be new and of first quality, and shall be free of all defects which could affect performance or service life of the equipment, or which would cause unsightly or unworkmanlike appearance.
- b. The load center assembly and accessories shall be in accordance with Engineering Standard No. JF16.02.40 modified as follows:
 - (1) Wherever the term "Equipment Specification" appears, it shall be deemed to read "Detailed Specification."
 - (2) Wherever the term "Buyer" appears it shall be deemed to read "others."
 - (3) Paragraph 2.E. on Page 12 shall be deleted as written and the following substituted: "Nonsegregated phase bus shall be constructed and furnished in accordance with the Detailed Specification and sketches."

B. Codes, Standards and Regulations

In addition to the Codes, Standards and Regulations specified in Engineering Standard No. JF16.02.40, the latest applicable standards and requirements of the following shall apply:

- a. UL - Underwriters' Laboratories, Inc.

SECTION II (CONTD)

b. UBC - Uniform Building Code

If there is a conflict between any of the requirements of this Specification and the requirements of the Williams-Steiger Occupational Safety and Health Act of 1970, Part 1910, "Occupational Safety and Health Standards," as amended, the state of California OSHA Standards and/or any other applicable statute, ordinance or code, then the requirement which is most stringent or has governing jurisdiction shall apply. Seller shall not be liable for factors over which it has no control, e.g., incorrect installation, operation and maintenance.

C. Ratings and Design Parameters

a. Load Center Incoming Line Section

(1) Air-Filled Terminal Chamber

(a)	Rated maximum voltage, kV	5
(b)	Insulation level 60 cycle withstand, kV	19
(c)	BIL, kV	60

(2) Interrupter Switch

(a)	Type	3-pole, single-throw,
nonfusible, load-break
(b)	BIL, kV	60
(c)	Continuous current, amperes	600
(d)	Interrupting capacity at 4160 volts,
symmetrical rms amperes	600
(e)	Minimum momentary current rating,
amperes asymmetrical	40,000

(3) Incoming Cables

(a)	Number of conductors per phase	1
(b)	Insulation rating, kV	5
(c)	Conductor size, AWG	No. 2/0
(d)	The incoming cable will be a 1-conductor, shielded
power cable with ethylene propylene rubber
insulation.	*

SECTION II (CONTD)

b. Load Center Transformer

(1)	Continuous capacity, 65 C rise, OA/FA, KVA	1000/1150
(2)	Temperature rise design altitude to provide above ratings, feet	3300
(3)	Frequency, hertz	60
(4)	Phase	3
(5)	High voltage winding, delta connected, volts	4160
(6)	Low voltage winding, wye connected, volts	480Y/277
(7)	Insulation liquid	Mineral Oil
(8)	Fan motor power supply, 60 hertz, number of phases/volts	1-phase/240 or 120 volts
(9)	Impedance on 1000 KVA base, percent	5.75
	Impedance tolerance, percent	7.5
(10)	Insulation class, kV	5
(11)	BIL, kV	60
(12)	Low frequency test, kV	19
(13)	Taps, high voltage winding	
	(a) Quantity - percent above normal	2 - 2-1/2
	(b) Quantity - percent below normal	2 - 2-1/2

c. Low Voltage Switchgear

(1)	Rated nominal current, amperes	1600
(2)	Rated operating voltage, volts	480
(3)	Rated maximum voltage, volts	600
(4)	60 hertz withstand voltage, rms volts	2200
(5)	Number of phases - wires	3-3

SECTION II (CONTD)

(6) Low voltage power circuit breakers:

(a) Short-circuit rating at 480 volts

<u>Frame Size, Amperes</u>	<u>Symmetrical</u>		<u>Symmetrical Close and Latch and 30 Cycle Short-Time Rating, Amperes</u>
	<u>Instan- taneous Trip, Amperes</u>	<u>Delayed Trip, Amperes</u>	
800	30,000	30,000	30,000
1600	50,000	50,000	50,000

(b) Rated control voltage

(1) Volts dc 125

(2) Volts ac 115

(c) Tripping voltage range, volts dc 70-140

(d) Closing voltage range volts dc 100-140

d. Voltage Transformers

(1) Type Dry

(2) Voltage ratio, volts 480/120

(3) Insulation class, volts 600

(4) Thermal rating at 55 C, VA 200

e. Current Transformers

(1) Continuous thermal rating at 55 C
ambient, percent of rated current 100

SECTION II (CONTD)

(2) Accuracy:

Primary Ampere Range	Accuracy Class			Relay Accuracy C
	B-0.1	B-0.5	B-2.0	
Above 1200	0.3	0.3	0.3	100
1200	0.3	0.3	0.3	100
800	0.3	0.3	0.6	50
600	0.3	0.3	1.2	50
400	0.3	0.3	1.2	50
300	0.6	1.2	2.4	20
200	0.6	1.2	2.4	20
150	0.6	2.4	---	20
100	0.6	2.4	---	20
75	0.6	2.4	---	20
50	1.2	2.4	---	10

f. Low-Voltage Nonsegregated Phase Bus

(1)	Nominal rated voltage, volts	600
(2)	Maximum rated voltage, volts	635
(3)	Frequency, hertz	60
(4)	Voltage withstand level at 60 hertz, one minute, dry, kV	2.2
(5)	Maximum hottest-spot total temperature, C	
(a)	Bus	105
(b)	Enclosure	80
(6)	Minimum continuous current rating at specified maximum ambient temperature and altitude, amperes	1600
(7)	Minimum momentary current rating, amperes symmetrical	40,000

D. Specific Requirements

This paragraph gives specific requirements for the load center equipment. The Seller shall furnish all load center components required for the successful operation of the load center. The load center shall be furnished as a single-ended secondary load center unit substation. The load center equipment and nonsegregated phase bus furnished shall be in accordance with the drawings and sketches and as specified herein.

SECTION II (CONTD)

a. Low Voltage Switchgear

The low voltage switchgear shall be furnished with the following:

- (1) Stationary housings as required complete with necessary primary and secondary disconnecting devices, circuit breaker positioning devices, small wiring and other equipment necessary for the successful operation of the power circuit breakers.
- (2) Manually operated removable air circuit breakers, each equipped with a shunt trip including an auxiliary switch. Each circuit breaker shall have a solid-state trip device.
- (3) The circuit breakers shall have bell alarm device contacts, one (1) normally open and one (1) normally closed, actuated to indicate tripping of breaker from overload. Bell alarm devices shall be manually reset.
- (4) Spaces shall be provided for two (2) future 800-ampere manually operated, removable air circuit breakers. Each space shall include a complete unit less the removable circuit breaker element.
- (5) The following current transformers, voltage transformers, relays, meters and switches shall be provided, installed and connected in accordance with the one-line diagram:
 - (a) One (1) undervoltage relay, General Electric Co. Type GEIAV53K (Device 27UV), range 120 volts ac adjustable 55-140 volts, or Engineer-approved equal.
 - (b) One (1) overvoltage relay, General Electric Co. Type GEIAV51D (Device 59G), range 199 volts ac adjustable 16-64 volts, or Engineer-approved equal.
 - (c) Three (3) single-phase current transformers with ratio as shown on drawing for metering.
 - (d) Four (4) 480-120 volt fused voltage transformers for metering. *
 - (e) One (1) ac indicating ammeter and one (1) ammeter transfer switch.
 - (f) One (1) ac indicating voltmeter.
 - (g) One (1) ground resistor, 200 ohm, 250 watt, 125 volts ac, for use with overvoltage relay Device 59G.

SECTION II (CONTD)

- (6) One (1) 480-240/120-volt fused control power transformer, connected as shown on drawing, for cooling equipment power.

b. Transformer

(1) Forced-Air Cooling Equipment

- (a) The Seller shall provide cooling equipment fan motor power from the switchgear control power transformer.
- (b) All cooling equipment fan motors shall be rated single phase, 240 or 120 volts, 60 hertz.
- (c) The motors furnished shall be designed, manufactured and routine tested and shall operate in accordance with the latest applicable NEMA, IEEE and ANSI Standards.
- (d) All motors shall operate successfully at their specified rating at the ambient temperature and altitude specified.
- (e) The continuous horsepower nameplate rating of the motors shall be greater than or equal to the maximum brake horsepower required by the driven equipment when the driven equipment is operating at the design load conditions. Service factor ratings shall not be used to meet this requirement.
- (f) All motors shall have Class B insulation unless the ambient temperatures and operating conditions for the application require Class F or H insulation for increased service life or better motor performance.
- (g) Where Class F or H insulation is furnished on continuously rated motors, the temperature rise shall be the same as for motors with Class B insulation.
- (h) The maximum hottest-spot temperature of the motor winding shall not exceed 130 C when operating under the condition of maximum load, maximum ambient temperature and elevation specified.
- (i) Exterior motors shall have totally-enclosed, fan-cooled or nonventilated enclosures.
- (j) Totally-enclosed integral horsepower motors shall have at least one drain outlet equipped with an automatic breather drain plug.

SECTION II (CONTD)

- (k) Integral horsepower motors shall have a NEMA design B torque characteristic unless otherwise required by the driven equipment.
- (l) Motor starting current shall not exceed 6.5 times full load current.

(2) Accessories

The transformer shall be furnished with the following accessories:

- (a) Drain and sampling valve.
- (b) Filter press connections.
- (c) Filling plug and liquid level gage with alarm contacts which open to initiate an alarm.
- (d) Top liquid dial type thermometer with maximum indicator, contacts for cooler, and alarm contacts which open to initiate an alarm.
- (e) Pressure-vacuum gage.
- (f) Pressure relief device with mechanical trip indicator and alarm contacts which open to initiate an alarm.
- (g) Sudden pressure relay including complete seal-in and reset control with three (3) electrically separate contacts wired to terminal blocks in the control cabinet.
- (h) Ground pads.

c. Low Voltage Metal-Enclosed Nonsegregated Phase Bus

- (1) Nonsegregated phase bus shall be provided for connection between the transformer low voltage winding terminals and the low voltage switchgear. The nonsegregated phase bus shall be 600-volt class and shall have a continuous current rating equal to the load center bus rating. See Sketch Nos. SK-E77 and SK-E78.
- (2) The bus metal enclosures shall be formed from not less than No. 11 USS gage sheet steel or aluminum welded whenever possible for maximum rigidity. The enclosures shall be adequately braced. All removable access covers shall be bolted.

SECTION II (CONTD)

- (3) Bus conductors shall be copper or aluminum with all bolted joints silver-surfaced. Bolts shall be of a corrosion-resistant material and shall be nonmagnetic where required. Expansion joints shall be provided as required.
- (4) Buses shall be three-phase, three-wire type. Buses shall be capable of carrying rated current continuously without exceeding temperature limits as required by ANSI C37.20, as last revised.

d. Switchgear Accessories

The following accessories shall be furnished with the low voltage switchgear:

- (1) Lifting yoke and lifting device for breaker removal and handling.
- (2) Hand cranks for racking mechanism (minimum of two).
- (3) Special manufacturer's tools required for breaker servicing and operation.

6. TEST REQUIREMENTS

A Factory Tests

a. Transformer

The Seller shall perform the following commercial tests on the transformer in accordance with ANSI Test Code for Transformers, C57.12.90, as latest revised:

- (1) Resistance measurements of all windings on the rated voltage connection and on the tap extremes.
- (2) Ratio tests on the rated voltage connection and on all tap connections.
- (3) Polarity and phase-relation tests on the rated voltage connection.
- (4) No-load loss tests at rated voltage on the rated voltage connection.
- (5) Exciting current tests at rated voltage on the rated voltage connection.

SECTION II (CONTD)

- (6) Impedance and load loss tests at rated current on the rated voltage connection and on the tap extremes.
- (7) Applied potential tests.
- (8) Induced potential tests.
- (9) Temperature tests on all nameplate KVA ratings unless similar data for a thermal duplicate is already available. A test report on the thermal duplicate shall be furnished. The thermal duplicate shall have equal or less radiating area, equal or greater load loss and equal or greater no-load loss.

b. Switchgear

- (1) The switchgear shall be completely assembled in the factory and subjected to all routine tests. All circuit breakers and operating parts shall be completely adjusted for proper operation. All controls shall be operated sufficiently to ensure proper functioning of the equipment.
- (2) All buses and power circuit breakers shall undergo a one-minute 60 hertz dielectric withstand test. The test voltage shall be 2200 volts.

B. Field Tests

Field tests will be made after installation at the expense of the Buyer to determine that all equipment is in conformance with the Specification requirements. If such tests or inspection indicate that the Specification requirements, including circuit breaker trip device calibration, have not been met, the Seller shall pay for the cost of all corrective measures and additional field tests until such time as the Specification requirements have been met.

7. FINISHING AND PAINTING

Steel surfaces shall be thoroughly cleaned by manufacturer's standard process. Painting shall be in accordance with the requirements of Engineering Standard No. JF16.02.40.

8. PREPARATION FOR SHIPMENT

- A. The equipment shall be shipped in the smallest practical number of shop fabricated sections. Each section shall be shipped in watertight and dustproof containers, as required.
- B. Each container shall be marked for identification and to indicate contents to permit orderly field assembly.

SECTION II (CONTD)

- C. Each assembly of switchgear units shipped as a section shall be provided with a suitable means for lifting the complete section.
- D. Openings and terminal connections shall be protected by covers or wood guards and, wherever applicable, parts shall be factory containerized to prevent shipping and weather damage.

9. SPECIAL TOOLS AND DEVICES

One (1) complete set of new and unused special tools and devices, including the switchgear accessories specified hereinbefore, required for operation and maintenance of the equipment shall be furnished and delivered with the equipment in a separate container.

10. DOCUMENTATION

Documentation shall be in accordance with Paragraph 3 of Section I and with the following:

- A. Item 1A of Engineering Standard No. FJ60.60 shall include equipment weights.
- B. Items 1F and 1G of Engineering Standard No. FJ60.60 shall include:
 - a. Elementary diagrams
 - b. Connection diagrams
 - c. Wiring diagrams
 - d. Nameplate data

11. GUARANTEES

- A. The Seller shall guarantee that the equipment furnished conforms to the requirements set forth and to the specified Codes, Standards and Regulations and that all specified tests have been satisfactorily completed.
- B. In addition, the Seller shall offer the transformer loss guarantees specified in the Bid Data Section.
- C. In the event actual losses exceed the losses guaranteed, as determined by tests performed in accordance with the applicable provisions of ANSI Standard Test Code C57.12.90, Section 4, "Transformers, Regulators and Reactors," the Buyer shall have the right either to reject the equipment or to accept the equipment under certain conditions. These are, provided, (1) that the Seller shall pay the Buyer an amount to compensate for the excess losses and, (2) that the temperature rise performance shall not exceed, as confirmed by actual test, that proposed and guaranteed in the Proposal. The amount due the Buyer shall be equal to the algebraic sum of the evaluated differences between the actual and guaranteed losses. The evaluated differences shall be calculated as follows:

SECTION II (CONTD)

- a. Actual minus guaranteed transformer no-load losses (kW) at 100 percent rated voltage, multiplied by the applicable evaluation factor.
- b. Actual minus guaranteed transformer full-load stray and copper losses including any cooling equipment demand (kW), multiplied by the applicable evaluation factor.
- c. No credit will be allowed to the Seller for loss performance less than that guaranteed except as allowed to reduce the Seller's obligation to the Buyer for excess losses.
- D. The foregoing shall not be construed in any way to limit or negate any other standard guarantee or portion thereof which may provide a more comprehensive guarantee than those required by this Specification.

12. SCHEDULE

Required Date at jobsite:

Load Center A

2/12/81

SECTION II (CONTD)
EQUIPMENT BID DATA

NAME OF BIDDER

ABBOTT POWER CORPORATION

In addition to other data and descriptive material furnished with Bidder's Proposal, Bidder shall fill in all spaces of the following Bid Data Section:

1. LOAD CENTER A

A. Weight, pounds

a. Incoming section	<u>2400</u>
b. Transformer section	<u>7200</u>
c. Low voltage switchgear section	<u>5000</u>
d. Total assembled weight	<u>14600</u>

B. Guaranteed transformer losses at 85 C winding temperature, kW

a. No-load loss at rated voltage	<u>1.8</u>	*
b. Total losses at lowest self-cooled rating (base rating)	<u>10.8</u>	*
c. Total losses at maximum forced-air cooled load (including fans)	<u>13.78</u>	*

C. Transformer regulation, percent

a. At 0.8 power factor	<u>5.01</u>
h. At 1.0 power factor	<u>1.135</u>

D. Transformer impedance, percent

High voltage to low voltage on self-cooled KVA base	<u>5.75</u> at <u>1000</u> KVA	*
---	--------------------------------	---

E. Maximum permissible emergency overload, KVA

C57.92 ANSI Table
92-01 250 A & B

F. Transformer dimensions, inches (including incoming section)

a. Maximum width	<u>79</u>
b. Maximum depth	<u>59</u>
c. Maximum height	<u>78</u>

SECTION II (CONTD)
EQUIPMENT BID DATA (CONTD)

NAME OF BIDDER	ABBOTT POWER CORPORATION
G. Low voltage switchgear dimensions, inches	
a. Maximum width	63
b. Maximum depth	66
c. Maximum height	92
2. <u>LOAD CENTER COMPONENT INFORMATION</u>	
A. Power transformer manufacturer	MGM
B. High voltage interrupter switch manufacturer	WESTINGHOUSE
C. Metal-enclosed switchgear manufacturer	ABBOTT POWER
D. Power circuit breaker manufacturer	WESTINGHOUSE
E. Relay manufacturer	G.E.
F. Instrument manufacturer	YEW
G. Control switch manufacturer	G.E.
H. Voltage and current transformer manufacturer	ABBOTT MAGNETICS
I. Items manufactured in a foreign country	NONE
J. Manufacturer's tripping device designation	52 TC
K. Number of circuit breaker auxiliary switch contacts available for Engineer's use	2NO/2NC
L. Bus material	COPPER
M. Type of bus plating	SILVER @ JOINTS
N. Control wire	
a. Type	SIS
b. Size, AWG	14

SECTION II. (CONTD)

EQUIPMENT BID DATA (CONTD)

NAME OF BIDDER

ABBOTT POWER CORPORATION

O. Breaker close time (initiate spring release to contact make), cycles	<u>4.5</u>
P. Breaker opening time (energize <u>shunt trip</u> coil to arc extinction), cycles	<u>5</u>

3. NONSEGREGATED PHASE BUS

A. Bus manufacturer	<u>ABBOTT POWER</u>
B. Bus conductor material, copper/aluminum	<u>ALUMINUM</u>
C. Impedance, ohms/foot	<u>50x10=6</u>
D. Type of insulated bus support	<u>MARPLEX</u>
E. Bus conductor size, inches	<u>2 (3/8x3)</u>
F. Cross sectional dimensions of bus with enclosure, inches	<u>9x18</u>
G. Removable section length, inches	<u>46</u>
H. Overall dimensions, inches	
a. Indoor 90 degree horizontal elbow	<u>22-1/8x22-1/8x11-1/8</u>
b. Outdoor 90 degree horizontal elbow	<u>22-1/8x22-1/8x11-1/8</u>
c. Indoor 90 degree vertical elbow	<u>20-1/4x13-1/8x13-1/8</u>
d. Outdoor 90 degree vertical elbow	<u>20-1/4x13-1/8x13-1/8</u>
I. Indoor straight bus length, feet	<u>4-1/2</u>
J. Outdoor straight bus length, feet	<u>6</u>

4. SPECIAL TOOLS

List all special tools required and included for operation, maintenance and repair of equipment:

NONE

SECTION III
480-VOLT MOTOR CONTROL CENTER

1. SCOPE

This Section III states the conditions and requirements applicable to furnishing two 480-Volt Motor Control Centers for the 10 MW_e Solar Pilot Plant, complete with all accessories specified or required for complete and operational equipment.

2. EQUIPMENT TO BE FURNISHED

Two (2) motor control centers, complete from incoming line terminations to outgoing line terminations and with the accessories specified, shall be furnished by the Seller. Incidental items which are essential but which may not be specifically described by this Specification shall be furnished in accordance with the Seller's design for complete and operable motor control centers.

<u>Item</u>	<u>Nameplate</u>
1	MCC-B
2	MCC-C

3. EQUIPMENT AND SERVICES FURNISHED BY OTHERS

The following will be furnished by others:

- A. Receiving, unloading, installation, and field inspection and testing.
- B. Concrete foundations and anchor bolts.
- C. All external wiring and devices for power and control.

4. OPERATING CONDITIONS

A. Environmental

The equipment shall be designed and constructed to operate successfully at the rated values under the following environmental conditions:

- a. Location: Indoors
- b. Plant elevation: 1950 feet above mean sea level
- c. Ambient temperature range, degrees 12 C to 45 C

SECTION III (CONTD)

- d. Plant is located in Uniform Building Code Seismic Zone 3. Equipment shall be designed and supported to withstand lateral seismic forces generated by a ground acceleration of 0.25g.
- B. The motor control centers will be supplied from a 480-volt ungrounded system.

5. DESIGN AND CONSTRUCTION

A. General

- a. The equipment to be furnished hereunder shall have a service life of thirty (30) years. The equipment shall consist of essentially standard design and quality which meets or exceeds the requirements of this Specification. Materials shall be in accordance with ASTM requirements, be new and of first quality, and shall be free of all defects which could affect performance or service life of the equipment, or which would cause unsightly or unworkmanlike appearance.
- b. Each motor control center and accessories shall be in accordance with the Specification for Motor Control, Form JF30.30.01, with the One-Line Diagram and with this Specification.

B. Codes, Standards and Regulations

All equipment specified herein shall be manufactured and tested in accordance with the latest applicable Standards and requirements of the following:

- a. ANSI - American National Standards Institute
- b. ASTM - American Society for Testing and Materials
- c. AWS - American Welding Society
- d. IEEE - Institute of Electrical and Electronic Engineers
- e. NEMA - National Electrical Manufacturers Association
- f. OSHA - Occupational Safety and Health Act
- g. UBC - Uniform Building Code

If there is a conflict between any of the requirements of this Specification and the requirements of the Williams-Steiger Occupational Safety and Health Act of 1970, Part 1910, "Occupational Safety and Health Standards," as amended, the state of California OSHA Standards and/or any other applicable statute, ordinance or code, then the requirement which is most stringent or has governing

SECTION III (CONTD)

jurisdiction shall apply. Seller shall not be liable for factors over which it has no control, e.g., incorrect installation, operation and maintenance.

C. Ratings and Design Parameters

a. Rated voltage, volts	600
b. Rated operating voltage, volts	480
c. Rated frequency, hertz	60
d. Phase - Wire	3 - 3
e. Enclosure	NEMA 12
f. Horizontal and vertical bus short circuit current rating in rms symmetrical amperes	22,000 (minimum)
g. Horizontal bus continuous current rating, amperes	600
h. Vertical bus continuous current rating, amperes	300
i. Molded-case feeder circuit breaker interrupting capability in rms symmetrical amperes at 480 volts	25,000 (minimum)
j. Circuit breakers for all combination starters shall be of the magnetic only (MCP) type, 3-pole, rated 600 volts and 60 hertz. Feeder circuit breakers shall be the thermal-magnetic type.	
k. NEMA Class of wiring	I
l. NEMA Type of wiring	B

D. Arrangement

Motor control centers shall have all starters and circuit breakers front mounted only. Each starter, circuit breaker or blank position shall be designated by a number and letter indicating location in the motor control center as follows:

- a. The vertical sections shall be numbered sequentially left to right (starting with "1") when viewed from the front.
- b. The starter or circuit breaker positions shall be lettered sequentially top to bottom starting with "A."

SECTION III (CONTD)

- c. If a starter or circuit breaker occupies more than one position vertically, it shall be designated by the letter corresponding to the uppermost position:
- d. If two or more circuit breakers occupy a single position, they shall be further designated by the letters "L," "R," "T," or "B" for left, right, top or bottom.
- e. If a special vendor's designation is required for manufacturing reasons, the Buyer's designation must also be provided as specified above.

E. Structures

Each motor control center shall be of the unitized metal-enclosed type. Indoor sections shall be approximately 90 inches high and 20 inches wide, joined together to form a rigid, free-standing, completely dead-front assembly. Sections shall be approximately 20 inches deep. Sections shall be constructed of welded and bolted steel members. The main structure framework shall consist of formed sections of not less than No. 12 USS gage. Side, back and top sheets and all doors shall be not less than No. 14 USS gage. The motor control centers shall be arranged and bused to accommodate either fixed or removable starters and circuit breakers, depending on size. Detachable lifting angle or angles at top shall be provided to facilitate installation. The motor control centers shall be arranged so that additional sections may be readily added to both ends. Guide rails or other means shall be provided in the section structures for supporting and aligning starters and circuit breakers during removal or replacement. Each vertical section shall have a horizontal wiring compartment located at the top and bottom, and a vertical wiring compartment equipped with cable-tie supports for position wiring. Separately hinged doors shall be provided for each vertical wiring compartment. A rear compartment, accessible from the rear, with hinged doors, shall be provided for additional vertical wiring space. Space shall be available for outgoing cables at both the top and the bottom of the sections.

F. Incoming Line Terminal Facilities

Burndy Type YA copper compression lugs with 2-hole tongues and long barrels shall be furnished for terminating the incoming line cables for MCC-B. The terminals shall be suitable for terminating Class B stranded copper cable. The terminals shall be positioned so that there shall be a minimum of 13 inches clearance between the terminals and the incoming power cable entrance surface so that incoming leads can be quickly positioned and connected. Incoming line cables shall enter from the top or bottom, as shown on the drawings.

G. Main Horizontal Bus

The main horizontal common power bus shall be located at the top or near the center and shall be continuously silver plated copper,

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continuously tin plated copper or continuously tin plated aluminum. The bus shall be insulated by bus supports of high dielectric strength, nonhygroscopic material. The bus and all bolted connections shall be accessible from the front of each vertical section after barrier removal, and barrier isolated from below and from the horizontal wire trough. The bus shall be braced to withstand fault currents of 22,000 rms symmetrical amperes, minimum. The bus shall have a continuous rating as specified herein.

H. Vertical Bus

Power shall be distributed to the starter and circuit breaker positions in each vertical section by means of a three-phase vertical bus of the same material as the horizontal bus. The bus supports shall be of high dielectric strength, nonhygroscopic material. Full height barriers shall be provided for complete isolation of the vertical buses from both the front and rear. The vertical buses shall also be fully barrier isolated from below. The vertical buses shall have an adequate continuous current rating for the section load and shall be braced for the same short circuit as the main horizontal bus. Unplated aluminum bus joints are not acceptable. Belleville type spring washers shall be used on all aluminum-to-aluminum bus joints made up with non-aluminum bolts.

I. Continuous Ground Bus

A continuous copper ground bus of at least 1/4-inch by 1-inch size shall be provided in a conveniently accessible location near the bottom of the vertical structure. The short circuit current rating of the ground bus shall be at least equal to the main bus. The ground bus shall be provided with Burndy Type YA copper compression type lugs for No. 2/0 AWG cable attachment to the ground grid at two points. Ground bus splice joints shall not be coincident with bolts which support the bus. Bolted connections to the ground bus shall be separate from the support and splice joint bolts.

J. Starter and Circuit Breaker Position Doors

- a. Each starter and circuit breaker position shall be provided with an individual front door. Starter and circuit breaker position doors shall be interlocked mechanically with the disconnecting circuit breaker to prevent unintentional opening of the door with power ON or unintentional application of power while the door is open. Means shall be provided to release the interlock for intentional access to the interior at any time and for intentional application of power, if desired, while the door is open. Padlocking arrangements suitable for a minimum of three (3) padlocks shall permit locking of the disconnect device in the OFF position with the door closed.
- b. The circuit breaker disconnect devices shall be operable from outside the enclosure and shall show position of the circuit breaker whether the position door is closed or open.

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- c. The overloads for single-speed starters shall be provided with a single externally operated manual reset button, mounted on the door of the position, which is capable of resetting any bimetallic overload in the position. Two-speed starters may have two overload reset buttons mounted on the position door.

K. Combination Starters

- a. Combination starters shall be of the full voltage, magnetic, combination circuit breaker type with an individual control transformer, and three thermal overload relays. NEMA size 4 and smaller starters shall be of the drawout type with positive pressure stabs for connecting to the vertical bus.
- b. Reversing and two-speed motor starters shall be electrically and mechanically interlocked to prevent the simultaneous energization of contactors.
- c. Preferably, thermal overload relays shall be of the ambient temperature compensated, manually reset, bimetallic type, adjustable between 85 and 115 percent of their nominal trip rating. Ambient temperature insensitive type thermal overload relays may be acceptable when approved by the Engineer.
- d. Thermal overload relay heater elements shall be sized based upon motor full load current data. Overload relay heater elements for spare starters shall be sized based upon the maximum continuous current rating of the starter.
- e. Motor full load current data will be supplied to the successful Bidder as soon as it becomes available. All thermal overload relays shall include the heater elements. If necessary, however, to prevent delaying shipment of the motor control centers, the manufacturer shall ship the overload relay heater elements separately.
- f. An individually fused 480-120 volt control transformer shall be furnished with each combination starter. The control transformer shall be sized by the manufacturer to have a minimum of 20 percent capacity in excess of the continuous voltampere requirements of the holding coil, indicating lights and any externally located devices such as solenoid valves, external relays, etc. The control transformer shall be capable of operation with an inrush current twenty (20) percent greater than required by the holding coil, indicating lights and external device, if any.
- g. AC controls shall be suitable for operation on 120 volts. All starters, size 4 and larger, shall include an interposing relay(s).

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- h. At least two (2) N.O. and one (1) N.C. auxiliary switch contacts in addition to the seal-in contact shall be furnished on each contactor. In the event that the number of auxiliary switch contacts specified exceeds the number which can be mounted on the starter, the manufacturer shall furnish auxiliary relays with the type and quantity of specified spare auxiliary switch contacts.
- i. Auxiliary relays (control relays) shall be furnished for the combination motor starters as listed on Form JF30.30.01, Specification for Motor Control, and shown on Sketches SK-E75 and SK-E76. The relays shall be Westinghouse Style No. ARB420AR, or Engineer-approved equal, 4-pole, 300-volt ac with 120-volt ac coil, with two (2) N.O. contacts and two (2) N.C. contacts rated for 6 amperes inductive load at 120 volts.

L. Circuit Breakers

- a. All circuit breakers shall be of the molded-case type with an interrupting capability as specified in this Specification.
- b. Combination starter circuit breakers shall have magnetic-only tripping mechanisms (MCP). Thermal-magnetic breakers shall have trip ratings in accordance with Paragraph 5.L.c. below. Magnetic-only breakers shall have front adjustable trip ratings in accordance with industry standards.
- c. Feeder circuit breakers shall have thermal-magnetic tripping mechanisms. The magnetic trip rating shall be 9 to 14 times the thermal trip rating for breakers with frame sizes of 100 amperes and smaller. Larger breakers shall have front adjustable magnetic trip ratings of 5 to 10 times the thermal trip rating.
- d. After opening the position door, the circuit breaker rating shall be visible without dismantling the breaker operating mechanisms.

M. Operators

The general construction of the pushbuttons, selector switches and selector pushbutton operators shall be similar and shall be heavy duty oil tight. Ferrules shall be chrome plated steel. Terminals, complete with pan head screws, shall accept ring-tongue compression barrel wiring terminations. Contacts shall be of a silver alloy, rated ten (10) amperes continuous, sixty (60) amperes make and six (6) amperes break at 120 volts ac. The voltage rating of the contact block assembly shall be 600 volts. Pushbutton color-coded inserts shall be removable and interchangeable with other color-coded inserts.

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N. Indicating Lights

Indicating lights shall be metal base, heavy duty oil tight; shall provide maximum visibility with unshrouded color caps; shall be suitable for panel mounting and shall incorporate a transformer with a No. 51 or No. 55 6- to 8-volt lamp. Terminals shall be complete with pan-head screws, suitable for ring-tongue compression-barrel wiring terminations.

O. Nameplates

- a. Nameplates shall be provided for each motor control center, for the front of each starter and circuit breaker position and for each major device thereon, such as meters, instruments and control switches. Nameplate material shall be 1/16-inch thick black and white laminated phenol resin. The engraving shall extend through a semimatte black surface to give white letters of adequate readability. Size of letters and figures shall be approximately 1/8-inch for component nameplates and 7/16-inch for position nameplates. Nameplate description, type and size shall be subject to Engineer's approval.
- b. Each motor control center nameplate shall be engraved with the nomenclature specified in the "Nameplate" column of Paragraph 2., hereinbefore.

P. Control Wiring

- a. Unless otherwise specified in this Specification, all motor control centers shall be NEMA Class I with Type B wiring.
- b. All control wiring shall be stranded, single-conductor copper, rated 600 volts with Type SIS or other approved insulation, shall in no case be smaller than No. 14 AWG and shall have a maximum operating temperature of not less than 90 C.
- c. Ring-tongue terminals with insulated compression barrels shall be used for all control wiring connections to terminal blocks and, where feasible, on other compartments within each position.
- d. Terminal blocks for control wiring shall have a rating of 600 volts and be suitable for No. 10 AWG wire and smaller. The terminal blocks shall be of the barrier type, complete with marking strips identifying all control wiring. Terminal blocks shall be of the washer-head screw type, similar to General Electric Type EB-25.
- e. Adequate control cable terminating space shall be provided in all starter and circuit breaker positions.

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- f. All wiring shall be in strict accordance with Stearns-Roger wiring diagrams. Manufacturers are not required to furnish wiring diagrams and, if furnished, they will not be checked or approved.

Q. Power Wiring

- a. All power wiring shall be stranded, single-conductor copper rated 600 volts with Type SIS or other approved insulation and shall have a maximum operating temperature of not less than 90 C.
- b. The continuous current rating of the power connections between the vertical bus and circuit breaker shall be equal to or greater than 125 percent of the current rating of the circuit breaker frame size. The minimum acceptable wire sizes for these connections are as follows:

- (1) 100 ampere frame size - No. 4 AWG/phase
- (2) 225 ampere frame size - No. 2/0 AWG/phase
- (3) 400 ampere frame size - 350 MCM/phase

Combinations of conductors equivalent to the above will be considered.

- c. Adequate power cable terminating space shall be provided in all starter and circuit breaker positions.

6. FACTORY TESTS

- A. The motor control centers shall be completely assembled in the factory and subjected to all routine tests. All breakers and operating parts shall be completely adjusted for proper operation. All controls shall be operated sufficiently to ensure proper functioning of the equipment.
- B. All buses and power circuit breakers shall undergo a one minute, 60 hertz dielectric withstand test. The test voltage shall be 2200 volts.

7. FINISHING AND PAINTING

A. General

All metallic equipment surfaces shall be cleaned and painted by the manufacturer before shipment, except for surfaces finished in a noncorrosive material such as aluminum, zinc (galvanized) or similar material.

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B. Surface Preparation

Surfaces to be painted shall be thoroughly cleaned in accordance with the manufacturer's standard practice. All mill scale, loose metal particles, weld spatter and other foreign matter shall be removed. All burrs shall be removed, all sharp edges eased and all surfaces wire brushed as necessary to provide a smooth surface. Prior to painting, the entire surface shall be cleaned with solvent cleaner to remove oil, grease and any residue from prior cleaning operations.

C. Painting

All steel surfaces shall be given one (1) coat of a rust-resisting primer and one (1) coat of finish paint. Preferred finish is light gray, ANSI Z55.1, No. 61. Manufacturer's standard finish may be acceptable, however, and will be considered. Extra paint shall be supplied for field touch up.

8. PREPARATION FOR SHIPMENT

- A. The equipment shall be shipped to the jobsite in the smallest practical number of shop fabricated sections.
- B. Each section shall be sealed to prevent entrance of water and dust during shipment. Each box, crate and shipping section shall be marked for identification and to indicate contents to permit orderly field assembly.
- C. Openings and terminal connections shall be protected by covers or wood guards. Wherever applicable, parts shall be factory boxed, crated or otherwise suitably prepared to prevent shipping and weather damage.

9. DOCUMENTATION

Documentation shall be in accordance with Paragraph 3. of Section I. Item 1A of Engineering Standard FJ60.60 shall include equipment weights and nameplate data. Item 1G of FJ60.60 shall not include wiring diagrams for the motor control centers.

10. GUARANTEES

- A. The Seller shall guarantee that the equipment and materials furnished conform to the requirements set forth and to the specified Codes, Standards and Regulations and that all specified tests have been satisfactorily completed.
- B. The foregoing shall not be construed in any way to limit or negate any other standard guarantee or portion thereof which may provide a more comprehensive guarantee than those required by this Specification.

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11. SCHEDULE

Required Date at jobsite:

Motor Control Center B 11/27/80

Motor Control Center C 11/27/80

III-DS-11

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EQUIPMENT BID DATA

NAME OF BIDDER

ABBOTT POWER CORPORATION

In addition to other data and descriptive material furnished with Bidder's Proposal, Bidder shall fill in all spaces of the following Bid Data Section:

1. WEIGHTS, POUNDS

A. Weight of heaviest shipping package	<u>2800</u>
B. Weight of individual motor control centers	
a. MCC-B	<u>2800</u>
b. MCC-C	<u>2000</u>

2. DIMENSIONS - WIDTH x DEPTH x HEIGHT, INCHES

A. MCC-B	<u>140x16x90</u>
B. MCC-C	<u>100x16x90</u>

3. COMPONENT INFORMATION

A. Control center manufacturer	<u>ABBOTT POWER</u>
B. Control center type	<u>SIM TO WEST 5 STAR</u>
C. Starter manufacturer	<u>WESTINGHOUSE</u>
D. Starter type	<u>A206</u>
E. Circuit breaker manufacturer	<u>WESTINGHOUSE</u>
F. Circuit breaker type(s)	<u>THERMAL MAGNETIC</u>
G. Terminal block manufacturer/type	<u>GE / EB</u>
H. Auxiliary relay manufacturer/type	<u>WEST / ARB</u>

4. CABLE SIZE INFORMATION

American Wire Gauge cable sizes used in power wiring between vertical bus and circuit breakers:

A. Size 1 combination starter	<u>#4</u>
B. Size 2 combination starter	<u>#4</u>
C. Size 3 combination starter	<u>#4</u>
D. 100-ampere frame circuit breaker	<u>#4</u>

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EQUIPMENT BID DATA (CONTD)

NAME OF BIDDER	<u>ABBOTT POWER CORPORATION</u>
E. 150-ampere frame circuit breaker	<u>#4</u> *
F. 225-ampere frame circuit breaker	<u>#210</u> *
G. 400-ampere frame circuit breaker	<u>350 MCM</u> *
5. <u>BUS INFORMATION</u>	
A. Continuous current rating of main bus, amperes	<u>600</u>
B. Continuous current rating of vertical bus, amperes	<u>300</u>
C. Short circuit current rating of main and vertical bus, rms symmetrical amperes	<u>22000</u>
D. Bus material	<u>Copper</u>
E. Type of bus plating	<u>Silver</u>
6. <u>CONTROL TERMINAL BLOCKS</u>	
Maximum number of control terminal blocks obtainable with each of the following size starters without an increase in standard space requirements:	
A. Size 1 Combination FVNR	<u>18 Terminals</u>
B. Size 2 Combination FVNR	<u>18 Terminals</u>
C. Size 3 Combination FVNR	<u>18 Terminals</u>
D. Size 1 Combination FVR	<u>18 Terminals</u>
7. <u>CONTROL WIRE</u>	
A. Type	<u>THHN</u>
B. Size, AWG	<u>16</u>

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1. GENERAL

- A. Each 480-volt load center and its accessories shall be in accordance with the Equipment Specification to which this supplement is attached, and with the requirements specified herein.
- B. The equipment shall consist of essentially standard design and quality which meet or exceed the requirements of this Specification.
- C. All equipment specified herein shall be manufactured and tested in accordance with the latest applicable standards and requirements of the following:
 - a. ANSI - American National Standards Institute
 - b. ASTM - American Society for Testing and Materials
 - c. AWS - American Welding Society
 - d. IEEE - Institute of Electrical and Electronic Engineers
 - e. NEC - National Electrical Code
 - f. NEMA - National Electrical Manufacturers Association
 - g. OSHA - Occupational Safety and Health Act
- D. If there is an apparent discrepancy between any of the requirements of this Specification and the Equipment Specification, or of the standards and requirements stipulated in Paragraph 1.C. above, or of any applicable statute, ordinance or code, then the most stringent requirements shall apply. The Engineer shall be apprised of all apparent discrepancies for his resolution.

2. DESIGN AND CONSTRUCTION

A. Incoming Line Sections

The incoming line sections shall consist of removable, floor mounted, sheet steel enclosures, closely coupled to the transformer. The incoming line sections shall enclose the incoming high voltage cable connections and other equipment specified in the Equipment Specification, and shall provide sufficient space for stress-cone fabrication. All through-type current transformers installed around nonshielded high voltage cables shall have a metallic shield between the current transformer and the cable. Necessary compression type terminal connectors shall be provided for connecting incoming copper cables to the transformer or other incoming line equipment.

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B. Transformers

a. General

- (1) Transformer tanks or housings shall be fabricated from high quality steel plates. Cores shall be built up of laminations of high-grade magnetic alloy steel, held securely by clamping or insulated core bolts.
- (2) Tanks shall be rectangular in shape with rounded corners. The bottom of the tank shall be provided with a rigid under support. The base design shall incorporate provisions for jacking and towing and shall permit moving of the transformer on rollers in any direction. Ventilating openings shall be provided in the under support members to prevent condensation. Lugs for lifting and for jacking the complete transformer shall be provided.
- (3) Tanks for liquid-filled transformers shall be of the sealed type with a minimum of electrically welded seams and with welded-on cover construction. All seams shall be welded inside and out, as required, multiple passes being used to ensure strong, leakproof joints. Adequate gas space shall be provided above the insulating liquid to limit internal pressure due to normal load cycles.
- (4) Enclosures for ventilated dry type transformers shall be fabricated of bolted sections with adequate ventilation openings.

b. Emergency Overloading

All liquid-filled transformers shall be designed and constructed to allow emergency short-time overloading in accordance with ANSI C57.92, "Guide for Loading Oil-Immersed Distribution and Power Transformers" or NEMA TR-98, "Guide for Loading Oil-Immersed Power Transformers with 65 C Average Winding Rise." Emergency overloading shall not exceed 25 percent of the maximum rating of the transformer.

c. De-Energized Tap Changer

Each tap changer for de-energized operation shall have its operating handle brought out through the top or side of the tank. The taps on each winding shall operate simultaneously. Each tap changer shall have provisions for padlocking and shall provide visible indication of the tap position without unlocking. Removable internal links or straps shall be provided on ventilated dry type transformers for changing taps.

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d. Low Voltage Transition Compartment

Connection from the transformer low voltage circuit to the low voltage switchgear shall be made by close-coupled construction unless specified otherwise in the Equipment Specification. Where low voltage windings are to be grounded-wye connected, the transformer neutral lead shall be brought out by means of a neutral bushing and connected by bus to the switchgear ground bus. In the case of 3-phase, 4-wire service, the transformer neutral bushing shall be connected to the switchgear insulated grounded neutral bus.

e. Bushings

All transformer bushings shall be porcelain or cast resin and shall be rated at least equal to the voltage class and BIL of the windings. The continuous current rating shall be equal to or greater than 125 percent of the highest or future highest rating of the transformer.

f. Insulating Liquid

- Insulating liquid shall be pure mineral oil for outdoor transformers and shall be an approved fire resistant liquid for indoor transformers. The insulating liquid shall meet the test requirements set forth in ANSI C59.2 and shall have a dielectric strength of not less than 30 kV when tested in accordance with ASTM D877 or ASTM D901. Any liquid supplied for use in indoor transformers shall meet OSHA requirements, shall be accepted by Factory Mutual System and other insurance underwriting groups and shall be in compliance with Article 450-23 of the 1978 National Electrical Code. Transformers shall be shipped completely filled with insulating liquid.

g. Forced-Air Cooling

All transformers 750 KVA and larger shall have provisions for the future addition of forced-air cooling if forced-air cooling is not supplied initially.

h. Nameplates

A stainless steel (ASTM A167-63) diagrammatic nameplate, which shall include complete information on the transformer and all information as required by ANSI and NEMA Standards, shall be furnished with each transformer.

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i. Accessories

Accessories shall be furnished as specified in the Equipment Specification.

C. Low Voltage Metal-Enclosed Switchgear

a. Type

The switchgear shall be of the indoor metal-enclosed, low voltage power circuit breaker type, as defined by ANSI C37.20c, consisting of stationary housings, drawout air circuit breakers and miscellaneous components.

b. General

- (1) The low voltage drawout air circuit breaker switchgear shall contain removable power circuit breaker elements, stationary structure, bus and connections and associated equipment such as current and voltage transformers, instruments, relays and switches, as shown on the drawings and/or specified in the Equipment Specification.
- (2) The switchgear unit structures shall consist of vertical frames having a uniform height, assembled to form a complete, rigid, free-standing assembly. The top shall be completely closed with sheet metal to form a part of the frame. Formed sheet steel doors and panels shall enclose the front. The sides and rear shall be of flat sheets.
- (3) Removable circuit breaker elements of the same size, rating and method of operation shall be interchangeable, and shall be quickly and easily inserted or withdrawn from the operating position by releasing the mechanical interlock. All breakers shall have a spring-charged stored energy operating mechanism to provide high-speed closing of the breaker contacts during either manual or electrical closing of the breaker.
- (4) Equipped switchgear units, where required for future breakers, shall be completely equipped for the future addition of a removable circuit breaker element.
- (5) Doors and panels shall be flanged and all corners shall be welded and ground or formed round. Doors and panels shall be held in place by slotted head screws with retainers which shall fit into adjustable nuts on the frame.

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(6) Switchgear unit compartments shall be identified as to location. Vertical units shall be numbered left to right as 1, 2, 3, etc., when viewed from the front. Compartments in the vertical unit shall be identified top to bottom as A, B, C, and D.

(7) All control and instrument fuses and control relays shall be located in an auxiliary compartment accessible from the front of the switchgear but completely isolated from the 480-volt bus by metal barriers. The control fuses shall be furnished in a pullout type fuse holder which will allow removal of the fuses without the use of any tools or fuse pullers.

c. Buses and Connections

(1) Buses shall be nontapered, high conductivity copper or aluminum and shall be sized for the rated continuous and momentary currents within allowable temperature rise. Copper bus joints shall be all welded or high pressure, bolted. Aluminum bus joints shall be all welded except at shipping splits and other field connections. Silver-plated copper ring bolt holes, flash butt welded to the aluminum bus, are preferred for field connections. All bolted joints shall be silver or tin surfaced. Unplated aluminum bus joints are not acceptable. Bolts shall be nonmagnetic, where required, and of a corrosion-resistant material. Belleville type spring washers shall be used on all aluminum to aluminum bus joints made up with non-aluminum bolts.

(2) Buses shall be supported on insulating supports. Main buses shall have a rated continuous current-carrying capacity of at least 125 percent of the highest current rating of the associated transformer. Bus taps to circuit breakers shall have a continuous current-carrying rating at least equal to the circuit breaker rating. The total temperature of the buses and the cable connections in the enclosed assemblies shall not exceed the limits specified in ANSI C37.20, as last revised, for the environmental conditions specified in the Equipment Specification. The momentary and short time current ratings of the buses shall correspond to the ratings of the associated breakers.

(3) Copper or aluminum ground bus shall be included and shall extend through the structure. The ground bus shall have a momentary current rating not less than the momentary current rating of the main buses. Ground bus splice

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joints shall not be coincident with bolts which support the bus. Bolted connections to the ground bus shall be separate from the support and splice joint bolts. The ground bus shall be furnished with a compression type terminal at each end for external cable connections. Cable sizes will be furnished later.

- (4) A one-half capacity, insulated, groundable neutral bus shall extend from the transformer neutral bushing to circuit breaker units on all 4-wire secondary systems when specified in the Equipment Specification. Compression terminals for Class B stranded copper conductor shall be furnished on the bus for load connections by others. Cable sizes will be furnished later. The neutral bus shall be insulated from the equipment; however, a cable or bus connection shall be provided between the neutral bus and the ground bus.

d. Air Circuit Breakers

(1) Type

The term breaker or circuit breaker as used in this Specification shall mean air circuit breaker of the drawout type.

(2) General

- (a) Circuit breakers shall be of the electrically or manually operated stored energy, drawout type and shall be equipped with a mechanism for proper alignment during the connecting and disconnecting operation. Electrically operated breakers shall be for operation from an external dc source to be furnished by others or an internal ac source as specified on the drawings or in the Equipment Specification.
- (b) Breakers shall be mechanically and electrically trip free and shall have mechanical interlocks to prevent closing of the breaker, unless the primary contacts are in either full contact or test position, and to prevent moving the breaker to or from the connected position with the breaker closed.
- (c) With the breaker in the test position, the primary contacts shall be separated and the secondary contacts shall be connected.

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DIVISION USAGE <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 10%;">MM</td> <td style="width: 10%;">P</td> <td style="width: 10%;">PP</td> <td style="width: 10%;">SH</td> <td style="width: 10%;">FI</td> <td style="width: 10%;">SP</td> </tr> <tr> <td></td> <td style="text-align: center;">X</td> <td></td> <td></td> <td></td> <td></td> </tr> </table>						MM	P	PP	SH	FI	SP		X					PAGE 7 OF 12	
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(d) Circuit breaker closing springs shall be automatically recharged immediately upon opening of the breaker.

(e) Fused circuit breakers are not acceptable unless specifically permitted in the Equipment Specification.

(3) Disconnecting and Control Devices

The primary disconnecting devices shall consist of blade and multi-finger contacts. Parts shall be self-aligning and shall be silver-plated. A heavy-duty ground disconnect device shall be included which will ground the breaker frame while in test or connected position. Separable type contacts shall be provided for disconnecting secondary and control circuits. The devices shall consist of pressure type self-aligning contacts, and contact shall be made when the breaker is in the fully connected and in the test position. Electrically operated breakers shall operate from a remote location, when in the connected position and in the test position, upon control transfer when specified in the Equipment Specification. A disconnected test position shall be provided for test and inspection purposes. Either a pushbutton mounted in the breaker compartment, or when specified in the Equipment Specification, a control switch mounted on a common instrument panel shall be provided for tripping and closing the electrically operated breaker only when the breaker is in the test position.

(4) Power Terminal Connectors

Terminal connectors shall be provided for the connection of all power cables to the switchgear. Connectors shall be of the compression type and shall be rated to carry the full load rating of the cable being terminated. Cable conductors will be copper and will have rubber or synthetic insulation. Cable sizes will be furnished later.

(5) Trip Devices

Each breaker shall have a three-phase, solid-state or electromechanical trip device as specified in the Equipment Specification. The trip devices are identified as being "Dual Selective," "Dual," or "Dual Selective with Instantaneous Trip."

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- (a) "Dual Selective" trip devices shall consist of a long time delay element and a short time delay element. These devices will be applied to main, tie and motor control center feeder breakers.
- (b) "Dual" trip devices shall consist of a long time delay element and an instantaneous element. These devices will be applied to all motor feeder breakers.
- (c) "Dual Selective with Instantaneous Trip" trip devices shall consist of long time delay, short time delay and instantaneous elements. These devices will be applied to all breakers feeding transformers.
- (d) All long time delay and short time delay elements, specified in (a), (b) and (c) above, shall be available with maximum, intermediate and minimum time bands as described in ANSI C37.17 as last revised.
- (e) All motor feeder circuit breaker trip devices shall be rated in accordance with the following table:

<u>Horsepower</u>	<u>50</u>	<u>60</u>	<u>75</u>	<u>100</u>	<u>125</u>	<u>150</u>	<u>175</u>	<u>200</u>	<u>250</u>	<u>300</u>
Minimum rated continuous current, amperes	100	125	150	200	250	275	300	350	400	500

- (f) The continuous current rating of each trip device shall equal or exceed the minimum rating in the table above. Long time delay elements shall have a setting range of at least 80 to 125 percent of the trip rating values. Instantaneous elements shall have a setting range of at least 600 to 1000 percent of the trip rating values. Short time delay elements shall have alternative setting ranges of at least 200 to 500 percent or 400 to 1000 percent of trip rating values. The setting range will be provided to the Seller later.
- (g) All circuit breaker trip devices which are electromechanical type shall be continuously adjustable, marked and calibrated at minimum 20 percent intervals. Static type trip devices shall be calibrated and marked at 10 percent intervals or less. All trip devices shall be set and coordination characteristics test checked at the factory.

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<p>(h) In the event the trip devices are not factory set with the settings provided by the Buyer and factory tested as specified, the Seller shall bear the cost of field setting and testing. Settings provided by the Buyer may be in addition to standard calibration.</p> <p>e. <u>Control Switches</u></p> <p>Control switches shall be rotary operated, multicontact type and shall be ruggedly constructed with barriers between adjacent contacts. Switch contacts shall be rated 600 volts. Control switches shall be complete with operating handles, enclosures and escutcheon plates. Escutcheon plates with mechanically operated targets shall be furnished on circuit breaker switches. Handles shall be pistol grip for circuit breaker switches, knurled for instrument switches and oval for selector switches.</p> <p>f. <u>Instruments and Meters</u></p> <p>Instruments and meters shall be provided as shown on the drawings or specified in the Equipment Specification and shall be of the semiflush switchboard type with rectangular dustproof enclosing cases and antiglare glass. Indicating instruments shall be approximately 4-1/4 x 4-1/4 inches square and shall have white dials with black marking, antiparallax scales approximately 250 degrees and 7 inches long, accuracy within one (1) percent of full scale and external zero adjustment. Watthour meters, if required, shall be of the switchboard drawout type with provision for testing. Unless otherwise specified, instruments and meters shall be suitable for operation from instrument transformers with nominal 5 ampere and 120-volt secondaries. Scale ranges and dial constants shall be provided to match the primary current and voltage ratings.</p> <p>g. <u>Instrument transformers</u></p> <p>Instrument transformers shall be provided as specified in the Equipment Specification and/or as shown on the drawings.</p> <p>h. <u>Wiring</u></p> <p>(1) Control wiring shall be switchboard type, 600-volt, type SIS or other approved type, and shall not be smaller than No. 14 AWG stranded, tinned copper conductor. No. 12 AWG is <u>preferred</u> for current transformer secondary circuits.</p>								

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Wiring associated with compartment doors shall be extra flexible, hinge type, composed of a minimum of 37 strands. All wiring shall be capable of passing the IPCEA Flame Resisting Test, IPCEA S-61-402, Section 6.5.

- (2) All interconnecting wiring between items in compartments and to items in other compartments in the switchgear shall be furnished. Each shipping section shall be furnished with a terminal block to facilitate the connection to the respective adjacent shipping section. All secondary and control wiring for external connection from each switchgear unit shall be terminated on fabricated terminal blocks with lettering strips.
- (3) All internal wires shall be marked at each end, either on the wire or adjacent to the terminal to which the wire connects, with the appropriate wire number from Stearns-Roger schematic diagrams or with identifying numbers assigned by the manufacturer if the wires are entirely internal to the switchgear.
- (4) Splices shall not be made in any control wiring except for connections made at terminal blocks.
- (5) No more than two wires shall be terminated at any one connection point.
- (6) All unused relay contacts, auxiliary switches or other control and indicating components shall be wired to terminal blocks.

i. Terminal Blocks and Fuses

- (1) Terminal blocks shall be provided for all external secondary connections. Terminal blocks shall be 600-volt, barrier type, suitable to accept No. 10 AWG wire and shall be complete with marking strips identifying all internal and external wiring. Terminal screws shall be accessible without removing marking strips. Terminal blocks shall be of the washer-head screw type similar to General Electric Type EB-25, suitable for ring-tongue terminals having insulated compression barrels. Each terminal block shall have at least 20 percent spare terminals. Terminal blocks for current transformer connections shall be the short circuiting type.

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(2) All terminal blocks shall be located in such a manner that the terminal blocks will be easily and safely accessible for connection, testing and maintenance, even after all load cables have been connected and the switchgear energized.

(3) All fuses shall be located in such a manner that the fuses will be readily accessible and can be easily pulled or changed out without the use of tools.

j. Indicating Lights

Indicating lights, when specified in the Equipment Specification, shall be metal base, heavy-duty and oiltight and shall provide maximum visibility with unshrouded color caps. The lights shall be suitable for panel mounting and shall incorporate a transformer with a No. 51 or No. 55, 6-8 volt ac lamp, or a resistor with 24 volt dc, 0.75 watt, telephone slide-base lamp, as applicable. Terminals shall be complete with washer-head screws, suitable for ring type compression terminals.

k. Nameplates

Nameplates shall be provided for each switchgear unit and for each device thereon, such as meters, instruments, and control switches. Nameplate material shall be laminated 1/16-inch thick black and white phenol resin. The engraving shall extend through a semimatte black surface to give white letters of adequate readability. Size of letters and figures shall be approximately 1/8 inch for component nameplates and 7/16 inch for switchgear unit nameplates. Gothic letters shall be provided with a weight to height ratio of 1 to 8. The switchgear unit nameplate shall be 1 inch high and 3 inches wide. Nameplate mounting screws shall be of the washer-head, self-tapping type. The switchgear assembly of each load center shall have a 1-1/2 inch by 6-inch nameplate with 3/8 inch letters.

l. Space Heaters

Adequate space heaters and thermostats shall be provided in all outdoor switchgear and in indoor switchgear when specified in the Equipment Specification. Heater voltage and source shall be as specified.

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D. Motor Control Centers

If a motor control center is included as part of a load center, the motor control center shall be constructed and furnished in accordance with the Equipment Specification and Engineering Standard No. JF16.02.45, Specification for Motor Control Centers.

E. Low Voltage Nonsegregated Phase Bus

If low voltage nonsegregated phase bus is included as part of a load center, the nonsegregated phase bus shall be constructed and furnished in accordance with the Equipment Specification and Engineering Standard No. JF16.02.22, Specification for Nonsegregated Phase Bus.

3. PAINTING

A. Preferred finish for load centers is as follows:

- a. Light gray, ANSI Z55.1, No. 61 for indoor switchgear, motor control centers and nonsegregated phase bus.
- b. Light gray, ANSI Z55.1, No. 61 or No. 70 for indoor transformers.
- c. Dark gray, ANSI Z55.1 No. 24 for outdoor switchgear, transformers and nonsegregated phase bus.

B. The manufacturer's standard finish may be acceptable, however, and will be considered. Extra paint shall be supplied for field touchup.

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1. SCOPE

This standard outlines the general procedures to be followed in the exchange of the information required for the preparation of acceptable electrical wiring diagrams for the following classes of equipment or panels:

- A. Class I - Metal-clad and metal-enclosed switchgear assemblies.
- B. Class II - Control boards and panels for which design is initiated by Stearns-Roger.
- C. Class III - Control boards, panels, and any equipment for which design is initiated by the manufacturer.

2. SPECIFICATION INFORMATION

The specification to which this standard is attached contains information on each class of equipment as follows:

- A: Class I - Metal-clad and metal-enclosed switchgear:
 - a. One-line diagrams showing instruments, meters, and relays, and showing unit numbering and arrangement.
 - b. A list of estimated quantities and types of auxiliary relays not shown on the one-line diagrams, but required to be furnished with the switchgear may be included at the option of Stearns-Roger Incorporated.
- B. Class II - Control boards and panels for which design is initiated by Stearns-Roger:
 - a. Unless otherwise stated in the equipment specifications, Stearns-Roger will furnish elevations of the boards or panels showing suggested device and equipment locations and identification.
 - b. Stearns-Roger instrument data sheets showing detailed information of equipment to be mounted on the panel.
 - c. Schematic diagrams and/or written descriptive logic and/or procurement drawings showing the required panel equipment functions and external input-output wiring.

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- C. Class III - Control boards, panels, and any equipment for which design is initiated by the manufacturer.

Since design is initiated by the manufacturer, the specification will contain only general requirements and restrictions for the equipment to be furnished. No detailed design information will be furnished by Stearns-Roger with the specification.

3. INFORMATION TO SUCCESSFUL BIDDER

The following additional information will be furnished by Stearns-Roger to the successful Bidder to aid in the preparation of wiring diagrams:

- A. Class I - Metal-clad and metal-enclosed switchgear:

- Three-line diagram showing metering and relaying. Only typical metering and relaying will be shown for similar units.
- Schematic diagrams for all circuit breakers showing all interlocks, inter-unit connections, wire numbers, etc.
- Stearns-Roger electrical department design sheets, Forms JF30.10.01 or JF30.10.02, showing cabling of external connections to switchgear units along with identifying circuit numbers for use in adding external circuits to manufacturer's wiring diagrams.

- B. Class II - Control board and panels for which design is initiated by Stearns-Roger:

- Control boards and panels utilizing electromechanical relays and devices:
 - Three-line diagrams showing metering and relaying connections required for equipment on the panels.
 - Schematic diagrams, switch developments, etc., for all equipment to be controlled from the panel.
 - Cut-out and dimension drawings of equipment and devices not being furnished by the manufacturer.
 - Stearns-Roger electrical department design sheets, Forms JF30.10.01 or JF30.10.02, showing cabling of external connections and identifying circuit numbers for use in adding external connections to the wiring diagrams.

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b. Control boards and panels utilizing solid state devices:

All additional information, i.e., schematic diagrams, device details, etc., necessary to completely define the system and the interface with other equipment.

c. Class III - Control boards, panels and any equipment for which design is initiated by the manufacturer:

As information on the system the manufacturer is furnishing is received, Stearns-Roger electrical department design sheets, Forms JF30.10.01 or JF30.10.02, will be supplied to the manufacturer for use in grouping internal connections on terminal blocks to coordinate with external cable connections and for use in adding external circuits to the wiring diagrams.

4. CONTRACTOR INFORMATION REQUIRED PRIOR TO PREPARATION OF WIRING DIAGRAMS

Before preparing wiring diagrams, the manufacturer shall submit the following information to Stearns-Roger for approval:

A. Class I - Metal-clad and metal-enclosed switchgear.

No submittals are required prior to preparing wiring diagrams.

B. Classes II and III - Control boards and panels:

a. Dimensional location and arrangement of terminal blocks.

Terminal block locations, arrangement and numbering shall be limited as shown on Pages 6 and 7 of this standard.

b. Dimensions of wireways or spaces available for external cables to enter terminal blocks, etc.

c. Drawings showing actual dimensional arrangement of panel-mounted equipment. For Class II equipment these drawings shall be based on the Stearns-Roger drawings if furnished with the original specification.

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5. WIRING DIAGRAMS AND EQUIPMENT DATA FROM THE MANUFACTURER

The manufacturer shall submit wiring diagrams to Stearns-Roger for the various types of equipment as required by the following paragraphs. The wiring diagrams shall show terminal points and terminations for all wiring. Complete harness and routing diagrams will not be required. Devices and terminal blocks shall be shown on the wiring diagrams in positions which approximate their physical location on the control boards or panels. Terminal blocks shall be arranged as shown on Page 7 of this standard.

A. Class I - Metal-clad and metal-enclosed switchgear assemblies:

- a. Wiring diagrams for this class of equipment shall show all equipment wiring with associated terminal blocks for all external connections shown on the same diagram.
- b. All terminal blocks used for external connection shall be identified with the wire numbers as shown on Stearns-Roger schematic diagrams.
- c. Separate diagrams shall be furnished for each unit of switchgear. Typical diagrams for similar or identical units will not be accepted.

B. Classes II and III - Control boards and panels:

- a. Control board and panels utilizing electro-mechanical relays and devices:
 - (1) Wiring diagrams for this type of equipment shall show all equipment internal wiring with associated terminal blocks for all external connections. Terminal blocks and devices shall be shown on the diagrams to approximate their physical locations.
 - (2) Wiring diagrams shall show wire designations as shown on Stearns-Roger schematic diagrams or, if not shown by Stearns-Roger, as assigned by the manufacturer for external devices interfacing with the control board or panel. These wire numbers shall be identified on panel conductors, terminal blocks, or on terminal points at devices. Individual terminal block points shall be grouped to accommodate multiconductor cables for external connections.
- b. Control boards or panels utilizing solid-state equipment and devices:

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- (1) The wiring diagrams for this type of equipment shall show terminal blocks required for external connections.
- (2) The terminal blocks shall be shown on the diagrams to approximate the physical location on the control board or panel. Terminal blocks shall be marked to show the wire numbers that are shown on Stearns-Roger schematic diagrams or, if not shown by Stearns-Roger, as assigned by the manufacturer for external connections that interface with the panel. Individual points on terminal blocks shall be grouped together to accommodate multiconductor cables for external connections.

- c. Typical wiring diagrams for identical units will be accepted for Class III equipment provided that tables are furnished to adapt the wiring diagrams to each unit supplied.

6. SUBMITTAL AND APPROVAL OF MANUFACTURER'S DRAWINGS

The number, size, type and quality of drawings to be submitted by the manufacturer and the Stearns-Roger approval procedure shall be in accordance with the specification to which this standard is attached and the following:

- A. Page 7 of the standard.
- B. Approval prints shall not be reduced by more than two-thirds of manufacturer's original drawing size.
- C. All electrical equipment internal wiring and external wiring interface terminal block arrangement drawings after approval shall be resubmitted on matte finish, direct positive wash-off film Mylar, DuPont Cronaflex DPWO, or approved equal. Sepias, vellum, or gelatin mediums will not be accepted for this submittal.
- D. Reproducibles shall not be reduced by more than two-thirds of the manufacturer's original drawing size. Where reduction is necessary, terminal blocks shown on the original drawing shall be increased proportionately to assure that the minimum space requirements and sizes specified on page 7 are met on the reduced drawing.
- E. Reproducibles shall be fully legible and free from blemishes and background shadows so as to permit reproducible prints to be made without the necessity of "touching up" the line and letter work. Reproducibles failing to comply with these requirements will be rejected. If rejected, the Seller shall resubmit a new set of reproducibles at his own expense within 15 calendar days.

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FIGURE 1 - TERMINAL BLOCK LOCATIONS

Vertical, metal-enclosed wireways shall be distributed along walkway as required for external cables. See Detail 1 for terminal block location.

Detail 1

Metal-enclosed wireway, area of sufficient size for external cable groups

(Terminal blocks shall not be mounted on outer periphery cabinet sheets.)

DUPLEX WALKTHROUGH PANEL

FIGURE 2 - TERMINAL BLOCK LOCATION RESTRICTIONS

Dimensions "a" and "b" shall be sized to allow sufficient space for cable entry through top or bottom of terminal cabinet and for bending cable into terminal block.

Elevation

Panel Sheet

Plan View

Terminal blocks shall not be mounted directly on panel sheet. Dimensions "c" and "d" shall be sized to give adequate area for external cables.

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Note: All external connections to panel equipment shall go through terminal blocks unless otherwise approved by Stearns-Roger Incorporated.

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STEARNS-ROGER INCORPORATED SPECIFICATION FOR MOTOR CONTROL

DATE 7-11-80

JOB NO. 21700 CUSTOMER MCDONNELL DOUGLAS LOCATION DAGGETT, CA
 CONTROL CENTER NO. MCC-B INCOMING CABLE 2 PER PHASE 350 MCM ENTERING AT TOP OF SECTION 1

POSITION NUMBER	EQUIPMENT NAMEPLATE DESIGNATION	HORSE POWER	FULL LOAD CURRENT	SIZE AND TYPE ++	BRKR TRIP	SPACE REQ'D	MODIFICATIONS							WIRE PER FORM NO.	
							INTERLOCKS **		SWITCHES		RELAYS				OTHER
							N.O.	N.C.	PB+	HOA	I*	II*	III*		
	INCOMING LINE					18"									
	AUX EXTRACTION OIL	10			30										
	PUMP P-305														
	SPARE			1	30	MCP	1								
	SPARE														
				1	30	MCP	1								
	FLASH TANK DRAIN	1		1	3	MCP					1				
	PUMP P-307														
	SPARE			1	3	MCP	1								
	NITROGEN SUPPLY UNIT	5		1	15	MCP	1								
	SA-701														

- * - CONTROL RELAY; II - LATCHING RELAY; III - TIMING RELAY
 ** - INTERLOCKS ARE IN ADDITION TO THOSE SHOWN ON WIRING FORMS
 + - SS - START-STOP; ST - START ONLY; SP - STOP ONLY; FRS - FORWARD-REVERSE-STOP
 ++ - FVNR UNLESS SUBSCRIBED BY R IN WHICH CASE FVR

FORM JF30.30.01
 REV. 10/10/75

Stearns-Roger

INCORPORATED

STEARNS-ROGER INCORPORATED SPECIFICATION FOR MOTOR CONTROL

DATE 7-11-80

JOB NO. 21700 CUSTOMER McDONNELL DOUGLAS LOCATION DAGGETT, CA

CONTROL CENTER NO. mcc-13 INCOMING CABLE 2 PER PHASE 350 MCM ENTERING AT TOP OF SECTION 1

POSITION NUMBER	EQUIPMENT NAMEPLATE DESIGNATION	HORSE POWER	FULL LOAD CURRENT	SIZE AND TYPE ++	BRKR TRIP	SPACE REQ'D	MODIFICATIONS							WIRE PER FORM NO.	
							INTERLOCKS **		SWITCHES		RELAYS				OTHER
							N.O.	N.C.	PB+	HOA	I*	II*	III*		
	SEPARATOR SLUDGE PUMP	0.5		1	3	MCP	1								
	P-716														
	CALORIA MAKE-UP PUMP	.33		1	3	MCP	1								
	P-306														
	MCC 1				90										
	MCC 2				90										
	MCC 3				90										
	LIGHTING PANEL LP4				50										
	HEAT TRACE PNL PP2				50										
	TSU AREA SUMP PUMP	1		1	3	MCP	1								
	P-717														
	TSU AREA SUMP PUMP				15										
	OIL-WATER SEPARATOR UNIT				70										

* - CONTROL RELAY; II - LATCHING RELAY; III - TIMING RELAY

** - INTERLOCKS ARE IN ADDITION TO THOSE SHOWN ON WIRING FORMS

+ - SS - START-STOP; ST - START ONLY; SP - STOP ONLY; FRS - FORWARD-REVERSE-STOP

++ - FVNR UNLESS SUBSCRIPTED BY R IN WHICH CASE FVR

FORM JF30.30.01
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Stearns-Roger

INCORPORATED

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JOB NO. 21700 CUSTOMER McDONNELL DOUGLAS LOCATION DAGGETT, CA.
 CONTROL CENTER NO. MCC-B INCOMING CABLE 2 PER PHASE 350 MCM ENTERING AT TOP OF SECTION 1

POSITION NUMBER	EQUIPMENT NAMEPLATE DESIGNATION	HORSE POWER	FULL LOAD CURRENT	SIZE AND TYPE ++	BRKR TRIP	SPACE REQ'D	MODIFICATIONS							WIRE PER FORM NO.	
							INTERLOCKS **		SWITCHES		RELAYS				OTHER
							N.O.	N.C.	PB+	HDA	I*	II*	III*		
	TSS FEED WATER			1R	3	MCP					2				
	MOV - 1132														
	TSS MAIN STEAM			1R	3	MCP					2				
	MOV - 1030														
	EPGS MAIN STEAM			1R	3	MCP					2				
	MOV - 1031														
	SPARE			1	7	MCP	1								
	SPARE			1	3	MCP	1								
	SPARE			1	15	MCP					1				
	SPARE			1	15	MCP					1				
	WELDING RECEPTACLES				70										
	TSS AREA														
	WELDING RECEPTACLES				70										
	PSS AREA														
					15										
	MAINTENANCE OIL SUMP														
	PUMP P-718														

* - CONTROL RELAY; II - LATCHING RELAY; III - TIMING RELAY

** - INTERLOCKS ARE IN ADDITION TO THOSE SHOWN ON WIRING FORMS

+ - SS - START-STOP; ST - START ONLY; SP - STOP ONLY; FRS - FORWARD-REVERSE-STOP

++ - FVNR UNLESS SUBSCRIBED BY R. IN WHICH CASE FVR

FORM JF30.30.01
REV. 10/10/75

Stearns-Roger

INCORPORATED

STEARNS-ROGER INCORPORATED SPECIFICATION FOR MOTOR CONTROL

DATE 7-11-80

JOB NO. 21700 CUSTOMER MCDONNELL DOUGLAS LOCATION DAGGETT, GA
 CONTROL CENTER NO. MCC-C INCOMING CABLE 2 PER PHASE 350 MCM ENTERING AT BOTTOM OF SECTION 1

POSITION NUMBER	EQUIPMENT NAMEPLATE DESIGNATION	HORSE POWER	FULL LOAD CURRENT	SIZE AND TYPE ++	BRKR TRIP	SPACE REQ'D	MODIFICATIONS							WIRE PER FORM NO.	
							INTERLOCKS **		SWITCHES		RELAYS				OTHER
							N.O.	N.C.	PB+	HOA	I*	II*	III*		
	INCOMING BREAKER			600											
	DEMINERALIZED WATER	5		1	15										
	TRANSFER PUMP P-710														
	FIRE MAINTENANCE														
	BUCKET PUMP P-707	20		-	50										
	RAW SERVICE WATER	40		3	100	MEP	1								
	PUMP P-703														
	RAW SERVICE WATER	40		3	100	MEP	1								
	PUMP P-704														
	LIGHTING PANEL LP3				70										
	LIGHTING PANEL LP5				50										
	HEAT TRACE PANEL PP3				50										

* - CONTROL RELAY; II - LATCHING RELAY; III - TIMING RELAY

** - INTERLOCKS ARE IN ADDITION TO THOSE SHOWN ON WIRING FORMS

+ - SS - START-STOP; ST - START ONLY; SP - STOP ONLY; FRS - FORWARD-REVERSE-STOP

++ - FVNR UNLESS SUBSCRIPTED BY R IN WHICH CASE FVR

FORM JF30.30.01
REV. 10/10/75

Stearns-Roger

INCORPORATED

STEARNS-ROGER INCORPORATED SPECIFICATION FOR MOTOR CONTROL

DATE 7-11-80

JOB NO. 21700 CUSTOMER MCDONNELL DOUGLAS LOCATION DAGGETT, CA

CONTROL CENTER NO. MCC-C INCOMING CABLE Z PER PHASE 350 mcm ENTERING AT BOTTOM OF SECTION 1

POSITION NUMBER	EQUIPMENT NAMEPLATE DESIGNATION	HORSE POWER	FULL LOAD CURRENT	SIZE AND TYPE ++	RRKR TRIP	SPACE REQ'D	MODIFICATIONS							WIRE PER FORM NO.	
							INTERLOCKS **		SWITCHES		RELAYS				OTHER
							N.O.	N.C.	PB+	HOA	I*	II*	III*		
	PRIMARY ELECTRIC FIRE	125			225										
	PUMP P-705														
	RAW/SERVICE WATER														
	SUMP PUMP P-715	1		1	3	MCP	1								
	SPARE				30										
	SPARE				15										
	SPARE				30										
	EXHAUST FANS	1			15										
	EF-2, EF-3														
	RAW SERVICE WATER	1			15										
	SUMP PUMP P-715														

* - CONTROL RELAY; II - LATCHING RELAY; III - TIMING RELAY

** - INTERLOCKS ARE IN ADDITION TO THOSE SHOWN ON WIRING FORMS

+ - SS - START-STOP; ST - START ONLY; SP - STOP ONLY; FRS - FORWARD-REVERSE-STOP

++ - FVNR UNLESS SUBSCRIBED BY R IN WHICH CASE FVR

FORM JF30.30.01
REV. 10/10/75

Stearns-Roger

STEARNS-ROGER INCORPORATED SPECIFICATION FOR MOTOR CONTROL

DATE 7-11-80

JOB NO. 21700 CUSTOMER Mc DONNELL DOUGLAS LOCATION DAGGETT, CA.

CONTROL CENTER NO. MCC-C INCOMING CABLE 2 PER PHASE 350 MCM ENTERING AT BOTTOM OF SECTION 1

[illegible]

- * - CONTROL RELAY; I - LATCHING RELAY; III - TIMING RELAY
 ** - INTERLOCKS ARE IN ADDITION TO THOSE SHOWN ON WIRING FORMS
 + - SS - START-STOP; ST - START ONLY; SP - STOP ONLY; FRS - FORWARD-REVERSE-STOP
 ++ - FVNR UNLESS SUBSCRIBED BY R IN WHICH CASE FVR

FORM JF30.30.01
REV. 10/10/75

Project No. C-21700
Spec. No. FJ50.50

November 3, 1976

SPECIFICATION

NO. FJ50.50

FOR

DOCUMENTATION

FOR

10MW_e SOLAR PILOT PLANT
SOLAR - ONE
DAGGETT, CA.

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STEARNS-ROGER ENGINEERING CORP.
DENVER, COLORADO

PROJECT NO. C-21700

Project No. C-21700Spec. No. FJ50.50DOCUMENTATION1. SCOPE

- A. This Specification outlines the requirements for, and the procedures associated with, the preparation and exchange of documentation for the work, equipment and/or materials specified in the Contract or Specification to which this Specification is a supplement.
- B. This Specification supplements requirements in Engineering Standard No. FJ60.60.
- C. This Specification also supplements requirements, where specified, in Paragraph DOCUMENTATION of the Contract or Specification to which this Specification is a supplement.
- D. This Specification and supplementary references specified in the foregoing paragraphs cover minimum requirements for documentation and are not intended to limit the amount of additional documentation which may be required for the engineering coordination, use or maintenance of the work, equipment and/or materials being furnished. Such additional documentation shall be provided by Seller or Contractor.
- E. All references to "Seller" herein shall apply to Seller or Contractor. All references to "Buyer" herein shall apply to the Buyer or the Owner. All references to "Engineer" herein shall apply to Stearns-Roger Engineering Corp.

2. TYPE, QUANTITIES AND QUALITY OF COPIES

The type and quantities of copies for required documentation are specified on Engineering Standard No. FJ60.60. Quality requirements shall be as follows:

A. Reproducible Drawings

All reproducible drawings submitted to Engineer shall be furnished on ozalid vellum, auto-positive vellum or Mylar, black line on vellum, or other Engineer-approved medium, each to be suitable for legible reproduction by the diazo copy process. Reproducible drawings shall be rolled, not folded, and enclosed in mailing tubes when mailed to Engineer or otherwise handled.

B. Prints

Where designated by the word "Prints" on Engineering Standard No. FJ60.60, it shall be understood to mean suitable "blueprint print/copy," "blueprint," or other Engineer-accepted reproduction of an original Seller-prepared tracing or sepia.

Project No. C-21700Spec. No. FJ50.50**2. TYPE, QUANTITIES AND QUALITY OF COPIES (CONTD)****C. Other Documentation**

Where designated by the word "Copies" on Engineering Standard No. FJ60.60, applicable documentation shall be submitted on legible, black on white, 8-1/2-inch by 11-inch pages.

3. DOCUMENTATION BY SELLER**A. General**

- a. Required types of documentation are specified on Engineering Standard No. FJ60.60. Where this Standard does not fully describe individual categories of documentation that are required, such detailed categories are specified in Paragraph DOCUMENTATION of the Contract or Specification to which this Specification is a supplement.
- b. Where equipment for Units 1 and 2 is identical, or where equipment is common to Units 1 and 2, one (1) set of documentation shall be furnished. If equipment is identical, Seller shall certify, on each document, that it is applicable to both Units 1 and 2. Where equipment is neither identical for nor common to Units 1 and 2, two (2) complete, individual sets of documentation shall be furnished, appropriately identified.
- c. The title block of each drawing shall denote the applicability of the drawing either to "Unit 1," "Unit 2" or "Units 1 and 2." Other documentation submitted by Seller shall carry similar identification.
- d. The following information shall be included in each drawing:
 - (1) Buyer's Name.
 - (2) Engineer's Project Number.
 - (3) Plant or station name.
 - (4) Unit number (if applicable).
 - (5) Buyer's Purchase Order Number.

Other documentation submitted by Seller shall carry similar identification.

- e. Unless specifically approved by the Engineer, "typical" or "similar" documentation is not acceptable for review.

Project No. C-21700Spec. No. FJ50.50**3. DOCUMENTATION BY SELLER (CONTD)****A. General (Contd)**

- f. "Standard Hardware Items" are defined as standard commercial items, such as air and hydraulic cylinders and operating valves, gear reducers, small motors, instruments, etc. For such items, review drawings are not required. Certified sheets showing exact mounting dimensions, overall dimensions, cross-sectional arrangement, parts nomenclature and material designation shall be submitted. Details of parts shall be furnished when requested by Buyer.
- g. Within 30 days after written notice of award, Seller shall submit a complete Definitive Drawing List, by drawing and title, of all drawings that will be submitted to Engineer. On this list, each drawing shall be identified by its appropriate category as defined in Items 1 or 2 on Engineering Standard No. FJ60.60, and as supplemented in Paragraph DOCUMENTATION of the Contract or Specification. Any drawing that does not fall under these predefined categories shall be identified on the list as "Miscellaneous." This list shall include proposed submittal dates for each drawing. This drawing list and schedule, together with any subsequent modifications, shall be subject to Engineer's review and comments.

B. Progress Reports

Seller shall furnish Engineer monthly progress reports and schedule status reports. These reports and schedules shall cover the complete status and progress of engineering, documentation, fabrication, materials, labor and shipment.

C. Review and Comment

- a. Entries in the column "WEEKS AFTER AWARD" on Engineering Standard No. FJ60.60 designate maximum time spans for Seller's submittal of documentation for review after the date of Buyer's written notification of award, whether such notification be in the form of a Purchase Order, a Letter of Intent or similar written authorization.
- b. All documentation to be certified and submitted by Seller for interface coordination shall show sufficient details of design so that the Engineer may proceed with his overall project design where interrelated with Seller's design.
- c. All documentation submitted in the correct and complete form to Engineer for his review and comment will be processed and a copy sent to Seller within 2 weeks after receipt of Seller's submittal. If more than 2 weeks review time is necessary, Engineer will advise Seller in writing as to his review schedule for such data. Seller shall then advise Engineer in writing what effect the extended review schedule has on the scheduled delivery of Seller's materials and equipment.

Project No. C-21700Spec. No. FJ50.50**3. DOCUMENTATION BY SELLER (CONTD)****C. Review and Comment (Contd)**

- d. Drawings and data will be returned to Seller marked either "REVIEWED/NO COMMENTS," "REVIEWED/SEE COMMENTS" or "REVISE PER COMMENTS AND RESUBMIT FOR REVIEW."
- e. When the documentation is returned marked "REVIEWED/NO COMMENTS" or "REVIEWED/SEE COMMENTS," final certified submittals incorporating the noted changes shall be furnished, unless otherwise authorized by Engineer in writing, within 3 weeks from the time of receipt of copy by Seller or at least 3 weeks before the scheduled delivery of Seller's work, whichever is earlier. Where Engineering Standard No. FJ60.60 stipulates that drawing review is required before release for fabrication, "REVIEW/SEE COMMENTS" shall constitute such release.
- f. When the documentation is returned marked "REVISE PER COMMENTS AND RESUBMIT FOR REVIEW," the documentation with the noted revisions incorporated shall be resubmitted for review and comment within 3 weeks from the time of receipt of copy by Seller. The review and comment and final submittal schedule shall be as specified in Sub-paragraphs 3.C.c. and 3.C.e. above.
- g. The documentation submittal schedules shall be adhered to by Seller, unless otherwise authorized by Engineer in writing. In any case, final submittals shall be furnished at least 3 weeks before the scheduled delivery of Seller's work.
- h. When reviewed information is subsequently revised by Seller, or is subsequently found to be deficient because of Seller's error or omission, additional Seller submittals shall be made to Engineer as developed. Any Engineer's design changes and any changes in equipment or construction by others which are required to make such subsequent revisions an integral part of the overall project shall be made at Seller's expense.
- i. Fabrication or shipment shall be at Seller's risk, whether or not Engineer has reviewed Seller's drawings as specified on Engineering Standard No. FJ60.60.
- j. Seller will be notified of review by a stamped copy of Stearns-Roger Form 02.145 or TRMSR05A stating "Supplier: As to all Drawings/Data listed on this transmittal: PROCEED TO FABRICATE." All Seller drawings which are submitted as final shall be stamped "Final." Where specified on Engineering Standard No. FJ60.60, final drawings shall be certified for construction.
- k. Neither review of, nor comment or revision on drawings by Engineer relieves Seller or Contractor from compliance with Specifications or with all other requirements of Purchase Order or Contract, nor shall the procedures outlined herein be cause for delay of equipment deliveries, except as otherwise specified herein.

Project No. C-21700
Spec. No. FJ50.503. DOCUMENTATION BY SELLER (CONTD)C. Review and Comment (Contd)

1. Notations made during the review of drawings shall not be construed to authorize contractual changes in price or delivery of equipment or materials furnished by Seller. If the scope of work has been changed as a result of such notations, Seller shall request a change in Purchase Order price and/or delivery date(s). Seller shall make the request in writing to Engineer before proceeding with the work.

D. Operation and Maintenance Manualsa. General

- (1) Seller shall furnish Operation and Maintenance Manuals which shall be complete for all equipment and systems furnished by Seller and by Seller's suppliers. Any differences between equipment supplied for Unit 1 and Unit 2 with regard to operation and maintenance shall be clearly defined in these Manuals.
- (2) Manuals shall be forwarded four (4) weeks prior to complete delivery of equipment in accordance with Engineering Standard No. FJ60.60.
- (3) If the publication of a subassembly manufacturer does not contain a complete operation, maintenance and parts breakdown meeting the intent of this Specification, then it shall be the responsibility of Seller to include such information in the Operation and Maintenance Manual.
- (4) All necessary precautions and warnings relative to the safety of life and equipment shall be included.

b. Operation

As a minimum, the Operation Section of the Manual shall contain the following:

- (1) Starting instructions, including, as applicable, instructions for initial startup, normal starting, starting after overhaul and startup after emergency trip.
- (2) Operating instructions, including trouble-shooting procedures.
- (3) Shutdown instructions, for both normal and emergency shutdown.
- (4) Design data for all equipment and systems, specifying horsepower, kilowatts, voltage, amperage, pressure, temperature, revolutions per minute, flow, etc.

Project No. C-21700Spec. No. FJ50.50**3. DOCUMENTATION BY SELLER (CONTD)****D. Operation and Maintenance Manuals (Contd)****c. Maintenance**

As a minimum, the Maintenance Section of the Manual shall contain the following:

- (1) Disassembling and reassembling instructions.
- (2) Preventive maintenance and lubrication information.
- (3) Description and identification of special maintenance tools.
- (4) Settings, clearance and adjustment data.

d. Parts Breakdown

The Parts Breakdown Section of the Manual shall contain:

- (1) A list of replacement parts, including drawings and data for all equipment assemblies and subassemblies. The material shall cover all information required for ordering replacement parts such as part name, part number, equipment serial number, supplier, address and normal delivery time.
- (2) Complete instructions for procuring replacement parts. Recommended forms for tabulating replacement part information and instructions for returning material to the factory shall also be included. Special storage, handling or packaging procedures required for any particular parts shall be noted.

E. Bills of Material

Detailed Bills of Material are required to facilitate identification by constructors of the items received. Shipment, therefore, shall be preceded by submittal of Bills of Material in accordance with Engineering Standard No. FJ60.60, Item 4 C.

4. DRAWINGS BY ENGINEER

- A. For applicable equipment, prints of drawings prepared by Engineer for use by others in constructing foundations, building components and major piping and wiring requiring coordination with the work associated herewith will be furnished to Seller for review as soon as possible after Engineer's receipt from Seller of the certified equipment drawings and design information necessary for their preparation.
- B. Where material, locations, etc., are marked HOLD on Engineer's Drawings, that material, location, etc., shall not be detailed or fabricated by Seller until the HOLD is removed by Engineer.

Project No. C-21700
Spec. No. FJ50.50**4. DRAWINGS BY ENGINEER (CONTD)**

- C. Within 30 calendar days after the date of transmittal to Seller, Seller shall return to Engineer two (2) copies of each of these drawings marked to indicate Seller's review thereof either without change, or with any corrections or necessary changes clearly marked thereon in red or other contrasting color.
- D. After making such corrections or changes as shown on the review copies returned by Seller, Engineer will release these drawings for construction. Subsequent changes or corrections to foundations, building components, wiring or piping fabricated or installed in accordance with drawings corresponding to the review copies approved by the Seller, such changes having been necessitated by Seller-initiated modifications, shall be done in a manner satisfactory to Buyer and at Seller's expense.

5. TRANSMITTALS

When transmitting documentation, Seller shall:

- A. Prepare original and four (4) copies of transmittal letters to accompany each submittal of documentation. Drawing transmittal letters shall identify the purpose of the transmittal (drawings for review, revised drawings, final drawings), the piece of equipment or material involved, and shall list the drawing numbers with applicable revision numbers or dates.
- B. Identify each letter and parcel with Buyer's Project Name, Engineer's Project Number, Purchase Order Number and Seller's Shop Order Number, and transmit it by air mail or first class mail. Each parcel shall contain an enclosed copy of the transmittal letter.
- C. Stamp each document to be submitted with reproduction date and purpose of the transmittal, e.g., "For Review," "Revised," "Final," etc.

6. SPECIAL CONSIDERATIONS

- A. It is understood that upon delivery of Seller's documentation without any restrictive notations concerning such work, they shall become Buyer's property and may be used in any manner desired for obtaining replacements, repairs and spare parts.
- B. Seller's final invoice will not be paid by Buyer until all materials and/or equipment governed hereunder have been received complete at the delivery point, and final certified submittals of all specified documentation have been received by Engineer.

DIVISION USAGE						Stearns-Roger		STANDARD NUMBER				
MM	P	PP	SH	FI	SP	ENGINEERING STANDARD		FJ 60.60				
APPROVALS: Des. Sect. <i>[Signature]</i> Sect. Supv. <i>[Signature]</i> Div. <i>[Signature]</i>						DOCUMENTATION REQUIREMENTS PROJECT: SOLAR ONE CONTRACT/REQUISITION NUMBER: F235.1 TITLE: 480-VOLT LOAD CENTER AND 480-VOLT MOTOR CONTROL CENTERS		C-21700 ISSUED 3/12/80 REVISED				
TYPE OF DOCUMENTATION						TYPE OF COPIES	FOR REVIEW		FINAL		REVIEW REQ'D BEFORE FAB.**	CTFY. FINAL ISSUE ***
							NO. OF COPIES	WEEKS AFTER AWARD*	NO. OF COPIES	"X" IF REQ'D		
1-ENGINEERING DRAWINGS						Repro-ducibles	4		4			
A-Outline, General Arrangement and Principal Dimensions						Prints	8	6-8	8	X	X	X
B-Cross Sections												
C-Foundation Requirements, including Loadings & Anchoring Locations								6-8		X	X	X
D-Physical Locations of Piping and/or Wiring Terminals												
E-Control Diagrams								6-8		X	X	X
F-Electrical Schematic Diagrams								6-8		X	X	X
G-Wiring Diagrams, Including Internal External and Interconnecting												
H-Standard Hardware Items								6-8		X	X	X
2-ERECTION OR INSTALLATION INFO.						Repro-ducibles	4		4			
A-Shop Fabrication Drawings						Prints	4		8			
B-Erection or Installation Drawings								6-8		X		X
C-Erection or Install. Instructions						Copies	3	6-8		X		X
3-SPECIAL DOCUMENTATION												
A-Performance Data, including Curves						Copies			3	X		X
B-Design Calculations						Copies						
C-Test Reports						Copies			3	X		X
D-Code Papers and Certificates						Copies						
E-Shop Fab. and/or Welding Proced.						Copies						
F-Shop Fabrication Reports						Copies						
G-Welder's Qualification Reports						Copies						
H-Operating Certificates						Copies						
4-MISCELLANEOUS												
A-Operation and Maintenance Manuals						Manuals			3	X		(FJ50.50 Para. 3.D.a(2))
B-Recommended Spare Parts List for 1 Year's Operation, with Unit Prices						Copies			3	X		X
C-Bills of Material						Copies			3	X#		X
D-Definitive Drawing List						Copies				See FJ50.50, Para. 3.A.g.		
*-Entries in the column "WEEKS AFTER AWARD" designate which types of review documentation are required. Blank spaces in this column denote that review documentation is not required. **-"X" in this column means drawing review req'd. before fabric. release. ***-"X" in this column means final issue must be certified for construction. #-At least 2 weeks before each shipment, detailed Bills of Material shall be sent to the plant site, c/o Stearns-Roger Resident Engineer, with 3 copies to Stearns-Roger Denver office. This form supplements requirements, where specified, in Para. DOCUMENTATION in the Specification, and in Specification FJ50.50.											Except where otherwise specified, send all Documentation to: Stearns-Roger Engineering Corp. P.O. Box 5888 Denver, Colorado 80217 Attn: Mr. R.K. Brushell

FVNR STARTER INTERNAL WIRING MCC-B

Stearns-Roger

MAT'L LIST NO.

ORDER NO. 21700

DATE 4-21-80

REVISED 7-11-80 G.D.Y.

DRW. CEW

CHK. JFD

DRAWING NO.

SK-E 75

MAT'L LIST NO.

ORDER NO. 21700

DATE: 4-21-80

REVISED: 7-11-80 G.D.Y.

Stearns-Roger

DRW. CEW CHK. JIC/TH/BJD

APP.

DRAWING NO. SK-E 76

MAT'L LIST NO.
ORDER NO. C21700 DATE: 4-21-80
LOAD CENTER "A"
PLAN

DRW. 102
CHK.
APP. REV. 5-15-80

SKETCH
DRAWING NO. SK-E77

ELEVATION VIEW-A

SCALE: 3/8"=1'-0"

MAT'L LIST NO.
 ORDER NO. C-21700 DATE: 4-21-60
LOAD CENTER A
ELEVATION

Stevens-Dager
 DRA. CEW
 APP. REV. 5-15-60
 DRAWING NO.
SK-E 78

APPENDIX II

PURCHASE ORDERS

FOR

ELECTRICAL AND I&C

CONSTRUCTION PACKAGE 11

LONG LEAD MATERIAL

<u>Spec No.</u>	<u>P.O. No.</u>	<u>Description</u>
F235.1	4004	Low Voltage Non-Segregated Bus, 480 Volt Load Center and 480 Volt Motor Control Centers
F010.3	4005	Cable, Power & Control
F010.3	4006	Cable, Instrumentation and Coaxial
F010.3	4007	Cable, Thermocouple Extension
F010.3	4008	Cable, 5 KV, Non-Shielded

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Stearns-Roger

PURCHASE ORDER

PAGE NO. 1 of 5	DATE Jul 29/80	REQUISITION F5 REV 2	ACCOUNT	REL. NO.	ORDER NO. 4004 C21700
REQUIRED AT DESTINATION See Below			SELLER'S SHIPPING PROMISE See Below		
F.O.B. POINT Destination F/A			SHIPPING POINT Buena Park, CA		
SELLER ABBOTT POWER CORPORATION 7650 Stage Road Buena Park, CA 90621 Attn: Ms. M. E. Heiser (213) 921-1421			TERMS OF PAYMENT AND INVOICING INSTRUCTIONS ARE STATED AFTER LAST NUMBERED ITEM OF THIS ORDER DIRECT CORRESPONDENCE CONCERNING THIS ORDER TO: STEARNS-ROGER ENGINEERING CORPORATION BOX 5888, DENVER, CO 80217 ATTN: Mr. A. L. Higgason PHONE (303) 758-1122 TWX 910-931-0453 TELEX 045-540		

CONSIGN TO: TOWNSEND AND BOTTOM INC., c/o J. M. ABRAM, Construction
Manager, Solar-One Pilot Plant, Daggett, CA 92327

ROUTE VIA: Prepaid - Truck - Vendor's Option

SUPPLEMENT SUMMARY - SELLER MUST CHECK EACH REVISION AND COMPLY WITH ALL CHANGES.
PREVIOUS SUPPLEMENT SUMMARIES, IF ANY, ARE RECOUNTED ON THE LAST NUMBERED PAGE OF THIS ORDER.

CONFIRMING ORDER - DO NOT DUPLICATE

<u>ITEM</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>	<u>UNIT PRICE</u>
1		LOW VOLTAGE NON-SEGREGATED BUS, 480 volt Load Center & 480 volt Motor Control Centers, all in accordance with Stearns- Roger Specification F235.1 D.O.E. 40E700- 19S dated Jul 11, 1980. CHARGE, for Low Voltage, Non-Segregated Bus Duct	\$5,671.00
		UNIT PRICING for the above shall apply: Pricing for 3 phase per foot, for 1600A, 3W, 600 volt metal enclosed non-segre- gated phase bus, indoor and outdoors	\$145.00 Ft.

GENERAL CONDITIONS FOR JOB C21700 SUBCONTRACT TO
D.O.E. PRIME CONTRACT NO. DE-AC-03-79SF10499 ATTACHED
SPECS. ALREADY IN VENDOR'S POSSESSION
DWGS. ALREADY IN VENDOR'S POSSESSION
TERMS AND CONDITIONS FORM TC 5-76 ATTACHED

APPROX TOTAL VALUE OF ORDER \$66,618.00
ORDER IS SUBJECT TO TERMS, CONDITIONS AND SPECIFICATIONS STATED HEREIN AND ATTACHED. ORDER AND ACCOUNT NUMBERS MUST BE STATED ON ALL INVOICES, CORRES- PONDENCE, SHIPPING DOCUMENTS AND PACKAGES.

BUYER
STEARNS-ROGER ENGINEERING CORPORATION

BY

THIS DOCUMENT CONSISTS OF 5 PAGE(S) NOT
INCLUDING REFERENCED ATTACHMENTS.

169 1652p/ALH/tw

Stearns-Roger

PURCHASE ORDER

PAGE NO. 2	ABBOTT POWER CORPORATION	REL. NO.	ORDER NO. 4004 C21700
---------------	--------------------------	----------	--------------------------

<u>ITEM</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>	<u>UNIT PRICE</u>
-------------	-----------------	--------------------	-------------------

2	1	480 Volt Load Center "A" Wt: Incoming Section - 2400 lbs. Transformer Section - 7200 lbs. Low Voltage Switchgear Section - 5000 lbs. Total assembled wt.-14600 lbs.	\$44,968.00
---	---	--	-------------

The following unit pricing shall apply:

- (a) Drawout Unit complete with 800 amp frame size, manually operated Circuit Breaker, complete with housing 2,737.00
- (b) Drawout Unit complete with 1600 amp frame size, manually operated Circuit Breaker, complete with housing 4,866.00
- (c) Circuit Breaker only, 800 amp frame size, manually operated drawout type 2,100.00
- (d) Circuit Breaker only, 1600 amp frame size, manually operated drawout type 4,200.00
- (e) Portable Circuit Breaker test kit for static trip device 1,250.00
- (f) Cost per point, per Circuit Breaker trip unit, for special calibration in addition to standard calibration points 50.00
- (g) Cost for changing range or characteristic on a 3 phase static trip unit 150.00
- (h) Deduct from base bid for the alternate 60KV Bil interrupter switch minus 212.00
- (i) Deduct for reducing Power Transformers from 5 pieces to 4 pieces minus 50.00

Stearns-Roger

PURCHASE ORDER

PAGE NO. 3	ABBOTT POWER CORPORATION	REL. NO.	ORDER NO. 4004 C21700
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<u>ITEM</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>	<u>UNIT PRICE</u>
		(j) Addition to base bid for load losses as follows: 1. No load loss at rated voltage 1.8 2. Total losses at lower self-cooled rating (base rating) 10.87 3. Total losses at maximum forced-air cooled load (including fans 13.78) add 1,265.00	
3	1	LINEUP, of 480 volt Motor Control Centers, indoor MCC "B" Wt: 2,800 lbs.	\$9,328.00
4	1	LINEUP, of 480 volt Motor Control Centers, indoor MCC "C" Wt: 2,000 lbs.	6,651.00

NOTE

The above starters for items 3 & 4 to be furnished complete with OL/CPT, 3 auxillary contacts and auxillary relay 4 pole, 2 push-buttons and 2 indicating lights.

The following unit prices shall apply:

- (a) Combination starter unit, size 1, FVNR 325.00
- (b) Combination starter unit, size 2, FVNR 401.00
- (c) Combination starter unit, size 3, FVNR 565.00
- (d) Combination starter unit, w/auxillary relay size 1, FVNR 375.00
- (e) Combination Starter Unit, size 1, FVR 456.00
- (f) Combination starter unit, w/2 auxillary relays, size 1 FVR 496.00

Stearns-Roger

PURCHASE ORDER

PAGE NO. 4	ABBOTT POWER CORPORATION	REL. NO.	ORDER NO. 4004 C21700
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ITEM	QUANTITY	DESCRIPTION	UNIT PRICE
		(g) Circuit Breaker, 100A frame	173.00
		(h) Circuit Breaker, 150A frame	453.00
		(i) Circuit Breaker, 225A frame	453.00
		(j) Circuit Breaker 400A frame	630.00
		(k) Circuit Breaker 600A frame	889.00
		(l) Vertical Section for future use, complete with bus & hardware	250.00
		(m) Cost for changing volt ampere rating of control transformer in a combination starter unit to manufacturer's next larger size	65.00
5		CHARGES, for field service rates: Per Day 350.00 Per Trip 150.00	
6		DRAWINGS AND DATA in accordance with Specification No. FJ 50.50 and Engineering Standard FJ 60.60	N/C

NOTE: The above itemized costs shall be adjusted at time of shipment thru the application of unit pricing as shown above.

FIRM PRICES

TOTAL WEIGHT: 19,400 lbs. (approx.)

TAXES

This Purchase is exempt from California Sales/Use Tax under California Tax Permit No. SY-AL-93-003153 for Resale by Authority of the McDonnell Douglas-Corporation.

Stearns-Roger

PURCHASE ORDER

PAGE NO.		REL. NO.	ORDER NO.
5	ABBOTT POWER CORPORATION		4004 C21700

TERMS OF PAYMENT:

Net 30 days

INVOICING INSTRUCTIONS:

Mail original and 4 copies with original shipping documents to:

STEARNS-ROGER ENGINEERING CORP.

P. O. Box 5888

Denver, CO 80217

REQUIRED AT DESTINATION

Item 2 - Feb 12/81

Items 3 & 4 - Nov 27/80

SELLER'S SHIPPING DATE

Item 2 - Feb 01/80

Items 3 & 4 - Dec 1/80

GOVERNMENT CONTRACT

This Purchase Order is issued under Government Contract No. DE-AC-03-79SF10499 (Department of Energy)

CONFIRMING ORDER

This confirms telephone order of Jul 18/80 to your Ms. M. E. Heiser by our A. L. Higgason.

REFERENCE

For reference purposes only and not by way of incorporating the same in this Purchase Order, see your written quotation numbered #80-145, 146, 147 of May 30/80, letter of Jun 02/80, TWXS of Jun 16/80 & Jun 17/80 by Ms. M. E. Heiser.

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Stearns-Roger

SUPPLEMENTED PURCHASE ORDER

Changes are underscored on lines identified in their left margin by the letter designator of the supplement. Pages changed by this supplement are reissued herewith. Remove the previous issue of these page(s) and replace them with current issue. All other terms and conditions of the original order and previous supplements, if any, remain unchanged.

PAGE NO. 1 of 5	DATE Aug 26/80	REQUISITION F6A REV 1	ACCOUNT	REL. NO.	ORDER NO. 4005 C21700
REQUIRED AT DESTINATION Dec 01/80			SELLER'S SHIPPING PROMISE See Below		
F.O.B. POINT Jobsite, F/A			SHIPPING POINT New Haven, CT		
SELLER THE ROCKBESTOS COMPANY P. O. Drawer 1102 New Haven, CT 06504 Attn: Mr. Harry Conte, Jr. (800) 243-4737			TERMS OF PAYMENT AND INVOICING INSTRUCTIONS ARE STATED AFTER LAST NUMBERED ITEM OF THIS ORDER DIRECT CORRESPONDENCE CONCERNING THIS ORDER TO: STEARNS-ROGER ENGINEERING CORPORATION BOX 5888, DENVER, CO 80217 ATTN: Mr. A. L. Higgason PHONE (303) 758-1122 TWX 910-931-0453 TELEX 045-540		

CONSIGN TO: TOWNSEND AND BOTTOM, INC., c/o Mr. J. M. Abram, Construction Manager, Solar-One Pilot Plant, Daggett, CA 92327

ROUTE VIA: Prepaid - Truck - Vendor's Delivery

SUPPLEMENT SUMMARY - SELLER MUST CHECK EACH REVISION AND COMPLY WITH ALL CHANGES.	
a	Supp. No. 1 - Sep 03/80 - Rev. pgs. 1, 2 and 3 to correct description on Items 4 and 8. No change in TVO. <i>LBW</i>
PREVIOUS SUPPLEMENT SUMMARIES, IF ANY, ARE RECOUNTED ON THE LAST NUMBERED PAGE OF THIS ORDER.	

Prime contract No. DE-AC-03-79SF 10499 U.S. Dept. of Energy

CONFIRMING ORDER - DO NOT DUPLICATE

ITEM	QUANTITY	DESCRIPTION	UNIT PRICE
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		CABLE, POWER AND CONTROL, All in accordance with Stearns-Roger Spec. F010.3 and D.O.E. No. 40E 700-21S dated Aug 15/80 "For Purchase." Complete with Engineering Standard JF16.03.01, pages 1 thru 11 issued Apr 25/78 and Spec. FJ50.50, pages 1 thru 7 dated Nov 03/76 and Engineering Standard FJ60.60, Documentation Requirements of 1 page, dated Jul 16/79 and Bid Data Sheets pgs. DS-9, DS-10, DS-16, DS-17, DS-18, DS-19, DS-20, DS-21 and DS-26	
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SPECS. ATTACHED (Vendor Only)
 BID DATA SHEETS ATTACHED (Vendor Only)
 PRICE ADJUSTMENT CLAUSE ATTACHED
 GENERAL CONDITIONS FOR JOB C21700, SUBCONTRACT TO D.O.E.
 PRIME CONTRACT NO. DE-AC-03-79SF10499 ATTACHED
 TERMS AND CONDITIONS FORM TC 5-76 ATTACHED

APPROX TOTAL VALUE OF ORDER \$57,426.00
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ORDER IS SUBJECT TO TERMS, CONDITIONS AND SPECIFICATIONS STATED HEREIN AND ATTACHED. ORDER AND ACCOUNT NUMBERS MUST BE STATED ON ALL INVOICES, CORRESPONDENCE, SHIPPING DOCUMENTS AND PACKAGES. VIS # 4192
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BUYER
 STEARNS-ROGER ENGINEERING CORPORATION

BY *A. L. Higgason*

THIS DOCUMENT CONSISTS OF 5 PAGE(S) NOT INCLUDING REFERENCED ATTACHMENTS.
 175 2547p/ALH/gd/gd

Stearns-Roger

PURCHASE ORDER

PAGE NO. 2	THE ROCKBESTOS COMPANY	REL. NO.	ORDER NO. 4005 C21700
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ITEM	QUANTITY	DESCRIPTION	UNIT PRICE
		POWER CABLE, 600v, cross-linked polyethylene insulation, Firewall III 90°C, emergency overload temperature rating of 130° C for periods not to exceed 100 hrs. per year and a short-circuit temperature rating of 250°C. The cables shall provide satisfactory service under the above conditions when installed in trays, conduits or ducts, when used for direct earth burial or when used as suitable supported aerial cable.	
1	1,000 Ft.	#12-7 str, 1/c, T.C., 30 mil EPR, 15 mil black flame resistant CSPE (Hypalon) jacket, FW EP (on 1 x 1,000 ft. reel)	\$120.00 MFT
2	8,000 Ft.	#12-7 str, 2/c, T.C., 30 mil flame resistant cross-linked polyolefin, color coded, ICEA Method I, cabled with polypropylene fillers, flame resistant binder tape, 45 mil black flame resistant neoprene jacket FW III (on 1 x 5,000 ft. and 1 x 3,000 ft. reels)	415.00 MFT
3	1,500 Ft.	#10-7 str, 2/c, T.C. 30 mil flame resistant cross-linked polyolefin, color coded, ICEA Method I, cabled with polypropylene fillers, flame resistant binder tape, 45 mil black flame resistant neoprene jacket FW III (on 1 x 1,500 ft. reel)	550.00 MFT
a 4	3,500 Ft.	#12-7 str, 3/c, T.C. 30 mil flame resistant cross-linked polyolefin, color coded, ICEA Method I, cabled with polypropylene fillers, flame resistant binder tape, 45 mil black flame resistant neoprene jacket FW III (on 1 x 3,500 ft. reel)	515.00 MFT
5	2,000 Ft.	#10-7 str, 3/c T.C. 30 mil flame resistant cross-linked polyolefin, color coded, ICEA Method I, cabled with polypropylene fillers, flame resistant binder tape, 45 mil black flame resistant neoprene jacket FW III (on 2-1,000 ft. reels)	685.00 MFT
6	1,000 Ft.	#8-7 str, 3/c, T.C. 45 mil flame resistant cross-linked polyolefin, color coded, ICEA Method IV, cabled with 3 #14-7 str B.C. Grd wires, flame resistant binder tape, 60 mil black flame resistant neoprene jacket (on 1 x 1,000 ft. reel)	1,165.00 MFT

Stearns-Roger

PURCHASE ORDER

PAGE NO. 3	THE ROCKBESTOS COMPANY	REL. NO.	ORDER NO. 4005 C21700
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ITEM	QUANTITY	DESCRIPTION	UNIT PRICE
7	1,500 Ft.	#6-7 str, 3/c, T.C. 45 mil flame resistant cross-linked polyolefin, color coded, ICEA Method IV, cabled with 3 #12-7 str B.C. Grd wires, flame resistant binder tape, 60 mil black flame resistant neoprene jacket (on 1 x 1,500 ft. reel)	\$1,920.00 MFT
a 8	1,200 Ft.	#2-7 str, 3/c, T.C. 45 mil flame resistant cross-linked polyolefin, color coded, ICEA Method IV, cabled with 3 #10-7 str B.C. Grd wires, flame resistant binder tape, 80 mil black flame resistant neoprene jacket (on 1 x 1,200 ft. reel)	3,290.00 MFT
9	1,000 Ft.	#1/0-19 str, 3/c, T.C. 55 mil flame resistant cross-linked polyolefin, color coded, ICEA Method IV, cabled with 3 #10-7 str B.C. Grd wires, flame resistant binder tape, 80 mil black flame resistant neoprene jacket, FW III (on 1 x 1,000 ft. reel)	4,685.00 MFT
10	1,500 Ft.	#350 mcm-37 str, 3/c, T.C. 65 mil flame resistant cross-linked polyolefin, color coded, ICEA Method IV, cabled with 3 #10-7 str B.C. Grd wires, flame resistant binder tape, 110 mil black flame resistant neoprene jacket, FW III (on 1 x 1,500 ft. reel)	11,990.00 MFT
11	690 Ft.	#500 mcm-37 str, 3/c, T.C. 65 mil flame resistant cross-linked polyolefin, color coded, ICEA Method IV, cabled with 3 #5-7 str B.C. Grd wires, flame resistant binder tape, 110 mil black flame resistant neoprene jacket, FW III (on 1 x 690 ft. reel)	16,175.00
CONTROL CABLE, 600v, cross-linked polyethylene insulation, Firewall III 90°C, emergency overload temperature rating of 130° C for periods not to exceed 100 hrs. per year and a short-circuit temperature rating of 250°C. The cables shall provide satisfactory service under the above conditions when installed in trays, conduits or ducts, when used for direct earth burial or when used as suitable supported aerial cable.			
12	9,000 Ft.	#14-7 str, 3/c, T.C., 30 mil flame resistant cross-linked polyolefin, color coded, ICEA Method I, cabled with polypropylene fillers, flame resistant binder tape, 45 mil black flame resistant neoprene jacket, 90°C, 600v, FW III (on 1 x 3,936, 1 x 3,922 and 1 x 1,142 ft. reels)	405.00 MFT

Stearns-Roger

PURCHASE ORDER

PAGE NO. 4	THE ROCKBESTOS COMPANY	REL. NO.	ORDER NO. 4005 C21700
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ITEM	QUANTITY	DESCRIPTION	UNIT PRICE
13	4,000 Ft.	#14-7 str, 5/c, T.C., 30 mil flame resistant cross-linked polyolefin, color coded, ICEA Method I, cabled with polypropylene fillers, flame resistant binder tape, 45 mil black flame resistant neoprene jacket, 90°C, 600v, FW III (on 2 x 2,000 ft. reels)	\$615.00 MFT
14	1,500 Ft.	#14-7 str, 7/c, T.C., 30 mil flame resistant cross-linked polyolefin, color coded, ICEA Method I, cabled with polypropylene fillers, flame resistant binder tape, 45 mil black flame resistant neoprene jacket, 90°C, 600v, FW III (on 1 x 1,500 ft. reel)	740.00 MFT
15	1,000 Ft.	#14-7 str, 9/c, T.C., 30 mil flame resistant cross-linked polyolefin, color coded, ICEA Method I, cabled with polypropylene fillers, flame resistant binder tape, 60 mil black flame resistant neoprene jacket, 90°C, 600v, FW III (on 1 x 1,000 ft. reel)	950.00 MFT

TOTAL WEIGHT: 18,990 lbs. (approx.)

TAXES

This purchase is exempt from California Sales and Use Tax under California Tax Permit No. SY-A-93-003153 for resale by authority of the McDonnell-Douglas Corporation.

TERMS OF PAYMENT:

Net 30 days

INVOICING INSTRUCTIONS:

Mail original and 4 copies with original shipping documents to:
STEARNS-ROGER ENGINEERING CORPORATON
P. O. Box 5888
Denver, CO 80217

SELLER'S SHIPPING DATE

Items 1 thru 7, 9, 11 thru 15 - Sep 22/80
Items 8 and 10 - Oct 03/80

SHIPPING TOLERANCE

The shipping tolerance for this order is plus or minus 10%.

REELS

All of the above Cable shall be shipped on no charge non-returnable reels, lengths as shown by each Item.

Stearns-Roger

PURCHASE ORDER

PAGE NO.	REL. NO.	ORDER NO.
5		4005 C21700

NOTE

Test reports to be submitted shall be the same as samples received with your bid proposal dated Jun 19/80.

CONFIRMING ORDER

This confirms telephone order of Aug 12/80 to your Mr. Michael D. Wall by our Mr. A. L. Higgason, and telephone order of Aug 25/80 to your Mr. Harry Conte by our Mr. A. L. Higgason.

REFERENCE

For reference purposes only and not by way of incorporating the same in this Purchase Order, see your written quotation numbered 72-177 of Jun 19/80 by Mr. George Felix, and Jun 30/80 by Mr. Michael Wall.

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Stearns-Roger

PURCHASE ORDER

PAGE NO. 1 of 3	DATE Aug 28/80	REQUISITION F6B REV 1	ACCOUNT	REL. NO.	ORDER NO. 4006 C21700
REQUIRED AT DESTINATION Dec 01/80			SELLER'S SHIPPING PROMISE See Below		
F.O.B. POINT Jobsite F/A			SHIPPING POINT Willimantic, CT		
SELLER BRAND-REX COMPANY c/o DHS Associates, Inc. 4874 North Broadway Denver, CO 80216 Attn: Mr. Wally Anderson (303) 629-1207			TERMS OF PAYMENT AND INVOICING INSTRUCTIONS ARE STATED AFTER LAST NUMBERED ITEM OF THIS ORDER DIRECT CORRESPONDENCE TO: STEARNS-ROGER ENGINEERING CORPORATION BOX 5888, DENVER, CO 80217 Attn: Mr. A. L. Higgason PHONE (303) 758-1122 TWX 910-931-0453 TELEX 045-540		

CONSIGN TO: TOWNSEND AND BOTTOM, INC., c/o Mr. J. M. Abram, Construction
Manager, Solar-One Pilot Plant, Daggett, CA 92327

ROUTE VIA: Prepaid - Truck - Vendor's Delivery

SUPPLEMENT SUMMARY - SELLER MUST CHECK EACH REVISION AND COMPLY WITH ALL CHANGES.
PREVIOUS SUPPLEMENT SUMMARIES, IF ANY, ARE RECOUNTED ON THE LAST NUMBERED PAGE OF THIS ORDER.

Prime contract No. DE-AC-03-79SF 10499 U.S. Dept. of Energy

CONFIRMING ORDER - DO NOT DUPLICATE

ITEM	QUANTITY	DESCRIPTION	UNIT PRICE
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CABLE, INSTRUMENTATION AND COAXIAL, All in accordance with Stearns-Roger Spec. F010.3 and D.O.E. No. 40E 700-21S dated Aug 15/80 "For Purchase." Complete with Engineering Standard JF16.03.02, pages 1 thru 12 issued Apr 26/78 and Spec. FJ50.50, pages 1 thru 7 dated Nov 03/76 and Engineering Standard FJ60.60, Documentation Requirements of 1 page, dated Jul 16/79 and Bid Data Sheets DS-10, DS-11, DS-13, DS-21, DS-22, DS-23 and DS-26

SPECS. ATTACHED (Vendor Only)
BID DATA SHEETS ATTACHED (Vendor Only)
GENERAL CONDITIONS FOR JOB C21700, SUBCONTRACT TO D.O.E.
PRIME CONTRACT NO. DE-AC-03-79SF10499 ATTACHED
TERMS AND CONDITIONS TC 5-76 ATTACHED

APPROX TOTAL VALUE OF ORDER
\$74,941.00

ORDER IS SUBJECT TO TERMS, CONDITIONS AND SPECIFICATIONS STATED HEREIN AND ATTACHED. ORDER AND ACCOUNT NUMBERS MUST BE STATED ON ALL INVOICES, CORRESPONDENCE, SHIPPING DOCUMENTS AND PACKAGES.

VIS #126

BUYER

STEARNS-ROGER ENGINEERING CORPORATION

BY

[Signature]

THIS DOCUMENT CONSISTS OF - 3 - PAGE(S) NOT INCLUDING REFERENCED ATTACHMENTS.

181 2512p/ALH/gd

Stearns-Roger

PURCHASE ORDER

PAGE NO. 3	REX-BRAND COMPANY	REL. NO.	ORDER NO. 4006 C21700
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TAXES

This purchase is exempt from California Sales and Use Tax under California Tax Permit No. SY-A-93-003153 for resale by authority of the McDonnell-Douglas Corporation.

TERMS OF PAYMENT:

1/2% 10 days, net 30 days

INVOICING INSTRUCTIONS:

Mail original and 4 copies with original shipping documents to:
STEARNS-ROGER ENGINEERING CORPORATON
P. O. Box 5888
Denver, CO 80217

TEST REPORTS

Test reports to be submitted shall be the same as attached to DS-26 received with your Proposal W20062, dated Jun 19/80.

SHIPPING TOLERANCE

The shipping tolerance for this order is plus or minus 10%.

SELLER'S SHIPPING DATE

Items 1 thru 7 - Feb 09/81
Items 8 and 9 - Nov 24/80

NOTE

ALL of the above Cable shall be shipped on no charge non-re-
turnable reels, with minimum lengths as shown on Spec. Sheets
DS-2 and DS-3.

CONFIRMING ORDER

This confirms telephone order pf Aug 12/80 to your
Mr. John Parys by our Mr. A. L. Higgason.

REFERENCE

For reference purposes only and not by way of incorporating
the same in this Purchase Order, see your written quotation
numbered W 20062 of Jun 19/80 and Jul 01/80 by
Mr. Geral R. Liskom and letter of Jun 30/80 by
Mr. Wally Anderson.

Stearns-Roger

PURCHASE ORDER

PAGE NO.	REL. NO.	ORDER NO.
2	BRAND-REX COMPANY	4006 C21700

ITEM	QUANTITY	DESCRIPTION	UNIT PRICE
		INSTRUMENT CABLE, 600v, Stranded Tin-Coated, copper conductor, with cross-linked polyethylene insulation, with twisted shielded pairs or triads, shield to shield isolation between pairs or triads where applicable, and over all Hypalon jacket, minimum reel lengths are as shown on Spec. DS-2 and DS-3.	
1	24,000 Ft.	#16, 1 pair, Shielded pair	\$237.67 MFT
2	24,000 Ft.	#16, 3/c, Shielded triad	461.98 MFT
3	3,500 Ft.	#16, 4 pair Shielded pair	959.25 MFT
4	4,000 Ft.	#16, 4 Shielded triad	2,000.00 MFT
5	4,500 Ft.	#16, 8 Shielded pairs	1,720.78 MFT
6	4,000 Ft.	#16, 12 Shielded pairs	2,581.18 MFT
7	3,000 Ft.	#16, 20 Shielded pairs	4,301.82 MFT
		COAXIAL CABLE	
8	4,000 Ft.	RG-11A/U, Brand Rex #TS75285	3,110.00 MFT
9	4,500 Ft.	RG-22B/U, Brand Rex #TCD95285	750.70 MFT

ESCALATION

- Only the prices of copper content in this cable are those in effect at time of shipment; the balance is firm.
- Copper prices herein are based on the American Metals Market Publication of copper at \$.9225 per lb.
- Copper Calculation:

$$(\text{Cable weight per mft.}) \times (\% \text{ Copper Content per mft.}) \times (\text{Copper Price per lb. at time of shipment} - \$.9225) = \text{Total Escalation to be added to the unit Purchase Price of Cable.}$$
- If escalation occurs, it must be shown as a separate item on all invoices, being either an upward or downward adjustment (using the base prices and percentages as shown above) to the producer's price of copper on the promised date of shipment.
- To support any escalation, the Seller must attach a copy of the applicable American Metals Market Publication and escalation worksheet to the invoices. This worksheet must show all increases or decreases in the price of copper per item.

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Stearns-Roger

PURCHASE ORDER

PAGE NO. 1 of 3	DATE Sep 29/80	REQUISITION F6C REV 1	ACCOUNT	REL. NO.	ORDER NO. 4007 C21700
REQUIRED AT DESTINATION Dec 01/80			SELLER'S SHIPPING PROMISE Nov 18/80		
F.O.B. POINT Worcester, MA			SHIPPING POINT Worcester, MA		
SELLER THE OKONITE COMPANY 5590 E. Yale Ave. Denver, CO 80222 Attn: Mr. Ron Dearwater (303) 759-2776			TERMS OF PAYMENT AND INVOICING INSTRUCTIONS ARE STATED AFTER LAST NUMBERED ITEM OF THIS ORDER DIRECT CORRESPONDENCE CONCERNING THIS ORDER TO: STEARNS-ROGER ENGINEERING CORPORATION BOX 5888, DENVER, CO 80217 ATTN: Mr. A. L. Higgason PHONE (303) 758-1122 TWX 910-931-0453 TELEX 045-540		

CONSIGN TO: TOWNSEND AND BOTTOM, INC., c/o J.M. ABRAM, Construction Manager,
Solar-One, Pilot Plant, Daggett, CA 92327

ROUTE VIA: Prepaid - Truck - Roadway Express

SUPPLEMENT SUMMARY - SELLER MUST CHECK EACH REVISION AND COMPLY WITH ALL CHANGES.
PREVIOUS SUPPLEMENT SUMMARIES, IF ANY, ARE RECOUNTED ON THE LAST NUMBERED PAGE OF THIS ORDER.

Prime Contract No. DE-AC-03-79SF U.S. Department of Energy

CONFIRMING ORDER - DO NOT DUPLICATE

ITEM	QUANTITY	DESCRIPTION	UNIT PRICE
		CABLE, Thermocouple extension, all in accordance with Stearns-Roger Specification F010.3 and D.O.E. No. 40E700-21S Rev. 1 dated Sep 10/80 "for purchase". Engineering Standard JF16.03.02 pages 1 thru 12 issued Apr 26/80, Specification FJ50.50 pages 1 thru 7, dated Nov 03/76, Engineering Standard FJ60.60 Documentation Requirements of 1 page dated Jul 16/79.	

GENERAL CONDITIONS FOR JOB C21700 SUBCONTRACT TO D.O.E. PRIME CONTRACT NO. DE-AC-03-79SF10499 ATTACHED
 SPECS. ATTACHED (VENDOR ONLY)
 BID DATA SHEETS ATTACHED (VENDOR ONLY)
 TERMS AND CONDITIONS FORM TC 5-76 ATTACHED

APPROX TOTAL VALUE OF ORDER \$24,165.00
ORDER IS SUBJECT TO TERMS, CONDITIONS AND SPECIFICATIONS STATED HEREIN AND ATTACHED. ORDER AND ACCOUNT NUMBERS MUST BE STATED ON ALL INVOICES, CORRESPONDENCE, SHIPPING DOCUMENTS AND PACKAGES.

BUYER
 STEARNS-ROGER ENGINEERING CORPORATION

BY

THIS DOCUMENT CONSISTS OF 3 PAGE(S) NOT INCLUDING REFERENCED ATTACHMENTS.

3508p/ALH/tw

PAGE NO. 2	THE OKONITE COMPANY	REL. NO.	ORDER NO. 4007 C21700
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ITEM	QUANTITY	DESCRIPTION	UNIT PRICE
		THERMOCOUPLE EXTENSION CABLE, 600V, shielded pairs of Chromel-Alumel, Type KX, with cross-linked polyethylene insulation, shield-to-shield isolation between pairs where applicable. Material Description and quantities listed on Spec. page DS-3 paragraph 3E.	
1	3,000 Ft.	#16, 1 pair, type "KX", .015 Okezel C/C twisted w #18-7X TC drain Nomex/Mylar/aluminum tape - .020 Okezel Jacket, on 2 x 1,500 ft. non-returnable reels	\$2,703.00 MFT
2	2,000 Ft.	#20, 4 pair, type "KX", .015 Okezel C/C cabled tape, #20 - 7X TC drain Nomex/Mylar/aluminum tape - .020 Okezel Jacket on 1 x 2,000 ft. non-returnable reel	1,966.00 MFT
3	2,000 Ft.	#20, 20 pair, type "KX", .015 Okezel C/C cabled tape, #20-7X TC drain Nomex/Mylar/aluminum tape - .020 Okezel Jacket on 1 x 2,000 ft. non-returnable reel	6,062.00 MFT

ESCALATION

- Only the price of copper content in this cable are those in effect at time of shipment; the balance is firm.
- Copper prices herein are based on the American Metal Market Publication of copper at \$.91625 per lb.
- Copper Calculation:

$$(\text{Cable weight per MFT}) \times (\% \text{ Copper Content per MFT}) \times (\text{Copper price per lb. at time of shipment} - \$.91625) = \text{Total Escalation to be added to the Unit Purchase Price of Cable.}$$
- If Escalation occurs, it must be shown as a separate item on all invoices, being either an upward or downward adjustment (using the base prices and percentages as shown above to the producer's price of copper on the promised date of shipment.
- To support any escalation, the Seller must attach a copy of the applicable Americal Metals Market Publication an escalation worksheet to the invoices. The worksheet must show all increases in the price of copper per item.

Stearns-Roger

PURCHASE ORDER

PAGE NO. 3	THE OKONITE COMPANY	REL. NO.	ORDER NO. 4007 C21700
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TOTAL WEIGHT: 1,185 lbs. (approx.)

TAXES

This purchase is exempt from California Sales Use tax under California Tax permit No. SY-A-93-003153 for Resale by Authority of McDonnell Douglas Corporation.

TERMS OF PAYMENT:

1/2 of 1% 10 days, net 30

INVOICING INSTRUCTIONS:

Mail original and 4 copies with original shipping documents to:

STEARNS-ROGER ENGINEERING CORP.

P. O. Box 5888

Denver, CO 80217

SHIPPING TOLERANCE

The shipping tolerance for this order is minus 0% + 5%.

NOTE

ALL of the above cable shall be furnished on no charge non-returnable reels, with minimum lengths as shown on Spec. Sheets DS-3.

TEST REPORTS

ALL in accordance with Specification.

CONFIRMING ORDER

This confirms telephone order of Aug 13/80 & Sep 25/80 to your Mrs. Evelina Thum by our Mr. A. L. Higgason.

REFERENCE

For reference purposes only and not by way of incorporating the same in this Purchase Order, see your written quotation numbered 0-50 of Jun 24/80 and Aug 26/80 by Mr. Ron Dearwater.

BID DATA (CONTD)

NAME OF BIDDER

THE OKONITE CO.

	Weight (lbs/ 1,000 ft)	Overall Cable Dia. (Inches)	Minimum Bend Rad. (Inches)	Maximum Pulling Force (lbs)	Material Thicknesses		
					Insulation (Mils)	Insulation Covering (Mils)	Jacket (Mils)
e. 600-volt shielded thermocouple cable (90°C), twisted shielded pairs - Type KX, chromel- alumel							
(1) One (1) pair No. 16 AWG	38	.220	8	37	.015"	none	.020"
(2) Four (4) pair No. 20 AWG	74	.337	8	59	.015"	none	.020"
(3) Twenty (20) pair No. 20 AWG	268	.670	8	294	.015"	none	.020"

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BID DATA (CONTD)

NAME OF BIDDER

Okonite Co.

(b) Propagation following
removal of flame (Yes/No)

(c) Length of burned cable, inches

(d) Time to short circuit, seconds

(13) Design life tests

(a) Have proposed cables been
subjected to elevated
temperature testing to
demonstrate 30 year life:

Yes/No

(b) Temperatures and
test periods

Temp °C

Duration, Wks.

Test 1

Test 2

Test 3

Test 4

(c) Description of pass/
fail criteria utilized,
e.g., voltage with-
stand, tensile
strength, etc.

(d) Test report reference

e. 600-volt shielded thermocouple cable

(1) Manufacturer The Okonite Co.

(2) Material description Tefzel

(3) Catalog description Okozel

(4) Continuous temperature rating, °C 150°C

BID DATA (CONTD)

NAME OF BIDDER

Okonite Co.

	<u>Insulation</u>	<u>Insulation Covering</u>	<u>Overall Jacket</u>
(5) Physical characteristics before aging			
(a) Tensile strength, psi	<u>5000 PSI</u>	<u>N/A</u>	<u>5000 PSI</u>
(b) Elongation at rupture, percent	<u>125%</u>	<u>N/A</u>	<u>125%</u>
(6) Physical characteristics after air oven aging of 168 hours at 150°C for insulation and 168 hours at 100°C for jacket			
(a) Tensile strength, percent retained	<u>85%</u>	<u>N/A</u>	<u>85%</u>
(b) Elongation at rupture, percent retained	<u>85%</u>	<u>N/A</u>	<u>85%</u>
(7) Accelerated water absorp- tion (EM-60, 75°C)			
(a) Dielectric constant	<u>2.5</u>		
(b) Increase in SIC from 1 to 14 days, percent	<u>1% Max.</u>		
(c) Increase in SIC from 7 to 14 days, percent	<u>1/2% Max.</u>		
(d) Stability factor after 14 days	<u>.1 Max.</u>		
(e) Dielectric constant after 52 weeks	<u>2.6 Max.</u>		
(f) Stability factor after 52 weeks	<u>.2 Max.</u>		
(g) Insulation resistance constant (K) after 52 weeks	<u>10,000 meg. ohms minimum</u>		

BID DATA (CONTD)

NAME OF BIDDER

Okonite Co.

	<u>Insulation</u>	<u>Insulation Covering</u>	<u>Overall Jacket</u>
(8) Accelerated water absorption (Gravimetric Method)			
Water absorption, mg per square inch	<u>1 mg</u>		
(9) Insulation resistance constant (K)	<u>10,000 meg. ohm min.</u>		
(10) Cold bend, 24 hours at minus 25°C followed by wet voltage withstand test of 80 volts per mil ac, (pass/fail)	<u>Pass-----</u>		
(11) Oxygen index	<u>29 Minimum</u>		
(12) IEEE 383 flame test on:			
(Specify configuration)		<u>Multi P.R. Cable</u>	
(a) Burn period following removal of flame, seconds		<u>less than 60 seconds</u>	
(b) Propagation following removal of flame (Yes/No)		<u>no</u>	
(c) Length of burned cable, inches		<u>24 inches</u>	
(d) Time to short circuit, seconds		<u>not determined</u>	
(13) Design life tests			
(a) Have proposed cables been subjected to elevated temperature testing to demonstrate 30 year life:		<u>yes</u>	<u>Yes/No</u>
(b) Temperatures and test periods	<u>Temp °C</u>	<u>Duration, Wks.</u>	
Test 1	<u>150°</u>	<u>2000/hrs</u>	
Test 2	<u></u>	<u>N/A</u>	
Test 3	<u></u>	<u>N/A</u>	
Test 4	<u></u>	<u>N/A</u>	

BID DATA (CONTD)

NAME OF BIDDER

Okonite Co.

(c) Description of pass/
fail criteria utilized,
e.g., voltage with-
stand, tensile
strength, etc.

wt. loss - none

color no charge

(d) Test report reference Dupont Bulletin E-00481

f. Coaxial Cable

RG-11A/U

RG-22B/U

(1) Manufacturer

(2) Material description

(3) Catalog description

2. TESTS

List all factory tests, and their standard industry identification, that
will be performed on the materials specified herein.

Stearns-Roger

PURCHASE ORDER

PAGE NO. 1 of 3	DATE Sep 29/80	REQUISITION F6D	ACCOUNT	REL. NO.	ORDER NO. 4008 C21700
REQUIRED AT DESTINATION Dec 01/80			SELLER'S SHIPPING PROMISE Nov 17/80		
F.O.B. POINT Jobsite			SHIPPING POINT Seymour, CT		
SELLER THE KERITE COMPANY 49 Day Street Seymour, CT 06483 Attn: Ms. Nancy Tockash (800) 243-6254			TERMS OF PAYMENT AND INVOICING INSTRUCTIONS ARE STATED AFTER LAST NUMBERED ITEM OF THIS ORDER DIRECT CORRESPONDENCE CONCERNING THIS ORDER TO: STEARNS-ROGER ENGINEERING CORPORATION BOX 5888, DENVER, CO 80217 ATTN: Mr. A. L. Higgason PHONE (303) 758-1122 TWX 910-931-0453 TELEX 045-540		

CONSIGN TO: TOWNSEND AND BOTTOM, INC., c/o J. M. Abram, Construction
Manager, Solar-One Pilot Plant, Daggett, CA 92327

ROUTE VIA: Prepaid - Truck - Vendor's Option

SUPPLEMENT SUMMARY - SELLER MUST CHECK EACH REVISION AND COMPLY WITH ALL CHANGES.
PREVIOUS SUPPLEMENT SUMMARIES, IF ANY, ARE RECOUNTED ON THE LAST NUMBERED PAGE OF THIS ORDER.

<u>ITEM</u>	<u>QUANTITY</u>	<u>DESCRIPTION</u>	<u>UNIT PRICE</u>
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PRIME CONTRACT NO.: DE-AC-03-79F
U.S. Dept. of Energy

CONFIRMING ORDER - DO NOT DUPLICATE

CABLE, 5KV, Non-Shielded, all in
accordance with Stearns-Roger
Specification F010.3 and D.O.E. No.
40E-700-218, Rev. 1 dated Sep 10/80 for
"Purchase" Engineering Standard JF
16.03.03 pages 1 thru 9 Revised Apr
11/78, Specification FJ 50.50 pages 1
thru 7, dated Nov 03/76, Engineering
Standard FJ 60.60. Documentation
Requirement of 1 page dated Jul 16/79.

GENERAL CONDITIONS FOR JOB C21700 SUBCONTRACT TO
D.O.E. PRIME CONTRACT NO. DE-AC-03-79SF10499 ATTACHED
SPECS. ATTACHED (VENDOR ONLY)
BID DATA SHEETS ATTACHED (VENDOR ONLY)
TERMS AND CONDITIONS FORM TC 5-76 ATTACHED

APPROX TOTAL VALUE OF ORDER \$6,790.00
ORDER IS SUBJECT TO TERMS, CONDITIONS AND SPECIFICATIONS STATED HEREIN AND ATTACHED. ORDER AND ACCOUNT NUMBERS MUST BE STATED ON ALL INVOICES, CORRES- PONDENCE, SHIPPING DOCUMENTS AND PACKAGES.

BUYER
STEARNS-ROGER ENGINEERING CORPORATION

BY

THIS DOCUMENT CONSISTS OF 3 PAGE(S) NOT
INCLUDING REFERENCED ATTACHMENTS.

3509p/ALH/kh

Stearns-Roger

PURCHASE ORDER

PAGE NO.	REL. NO.	ORDER NO.
2	THE KERITE COMPANY	4008 C21700

ITEM	QUANTITY	DESCRIPTION	UNIT PRICE
1	3,000 Ft.	POWER CABLE, 5,000 Volt, Non-Shielded, #2/0, 1/C, 90°, Stranded Copper Conductor with high temperature Kerite insulation and HTNS jacket, material description and quantity as listed on Spec. page DS-2 paragraph 3A NOTE: The above Cable to be in parallel 3-1000 Ft. Lgths. on 1-50 in. No-Charge Non-Returnable Reel.	\$2,230.00 MFT
2		Charge for paralleling the above cable	100.00 Totl

ESCALATION

- Only the price of Copper Content in this Cable are those in effect at time of shipment; the balance is firm.
- Copper prices herein are based on the (Domestic Producer Electrolytic Wire Bar) will be adjusted to the published market price in effect on the date of shipment plus the prorated average of any wirebar surcharges or premiums which have been paid during the month preceding shipment due to industry shortages. This order was based on copper @ \$1.00625 per lb.
- Copper Calculation

$$(\text{Cable weight per mft}) \times (1\% \text{ Copper Content per mft}) \times (\text{Copper price per lb. at time of shipment} - \$1.00625) = \text{Total Escalation to be added to the Unit Purchase Price of Cable.}$$
- If Escalation occurs, it must be shown as a separate item on all invoices, being either an upward or downward adjustment (using the base price and percentages as shown above to the producer's price of Copper on the promised date of shipment.
- To support any escalation, the Seller must attach a copy of the applicable Domestic Producer Electrolytic Wirebar Publication as escalation worksheet to the invoices. This worksheet must show all increases in the price of copper.

TOTAL WEIGHT: 2,500 lbs. (approx.)

TERMS OF PAYMENT:

1/2 of 1% - 10 Days, Net 30

TAXES

This Purchase is exempt from California Sales Use Tax under California Tax permit no. SY-A-93-003153 for Resale by authority of McDonnell Douglas Corporation.

Stearns-Roger

PURCHASE ORDER

PAGE NO.		REL. NO.	ORDER NO.
3	THE KERITE COMPANY		4008 C21700

SHIPPING TOLERANCE

The Shipping tolerance for this order is minus 0% to plus 6% for each cutting length.

TEST REPORTS

Test reports to be submitted shall be the same as attached to your proposal dated Jul 25/80 your KPT-5-NS-SPS dated Aug 28/79.

INVOICING INSTRUCTIONS

Mail original and 4 copies with original shipping documents to:
STEARNS-ROGER ENGINEERING CORPORATION
P. O. Box 5888
Denver, CO 80217

CONFIRMING ORDER

This confirms telephone order of Sep 10/80 to your Ms. Nancy Tockash by our Mr. A. L. Higgason.

REFERENCE

For reference purposes only and not by way of incorporating the same in this Purchase Order, see your written quotation numbered 1-80230 of Jul 25/80 by Ms. Nancy Tockash.

BID DATA (CONTD)

NAME OF BIDDER

The Kerite Company

In addition to ther data and descriptive material furnished with the Bidder's Proposal, Bidder shall fill in all spaces of the following Bid Data Section. The specifically listed data is in no way intended to limit the data submitted, and the Bidder is invited to submit any additional information he believes necessary to complete the description of his offering:

1. GUARANTEED PHYSICAL AND ELECTRICAL PROPERTIES

	<u>Weight (lbs/ 1,000 ft)</u>	<u>Overall Cable Dia. (Inches)</u>	<u>Minimum Bend Rad. (Inches)</u>	<u>Maximum Pulling Force (lbs)</u>	<u>Material Thicknesses</u>	
					<u>Insulation (Mils)</u>	<u>Jacket (Mils)</u>
A. Weights, dimensions and physical properties						
a. 5000-volt non-shielded power cable (90°)						
Straight pull by conductor.	<u>720</u>	<u>0.89" approx.</u>	<u>4.5"</u>	<u>1065</u>	<u>125 nom.</u>	<u>80 nom.</u>
b. 600-volt power cable (90°)						
(1) 1/C - No. 12 AWG						
(2) 2/C - No. 12 AWG						
(3) 2/C - No. 10 AWG						
(4) 2/C - No. 8 AWG						
(5) 3/C - No. 12 AWG						
(6) 3/C - No. 10 AWG						

(BY OTHERS)

196 A1-10

C-21700
S-R F010.3
Rev. No. 1

BID DATA (CONTD)

NAME OF BIDDER

The Kerite Company

f. Coaxial cable

	<u>RG-11A/U</u>	<u>RG-22B/U</u>
(1) Weight, pounds per 1000 feet	_____	_____
(2) Overall cable diameter, inches	_____	_____
(3) Minimum bend radius, inches	_____	_____
(4) Maximum pulling force, pounds	_____	_____
(5) Material Thickness, mills	_____	_____
(a) Insulation	_____	_____
(b) Jacket	_____	_____
(6) Insulation Material	_____	_____

B. Cable, insulation and jacket characteristics

a. 5000-volt non-shielded power cable

(1) Manufacturer	<u>The Kerite Company</u>		
(2) Material description	<u>Non-shielded cable</u>		
(3) Catalog description	<u>2/0 (19) 5KV 125 mils, H.T. Kerite 80 mils HTNS jacket.</u>		
(4) Continuous temperature rating, °C	<u>90</u>		
(5) Emergency overload temperature rating, °C/short circuit temperature rating, °C	<u>130 / 250</u>		
	<u>Insulation</u>	<u>Insulation Covering</u>	<u>Overall Jacket</u>
(6) Physical characteristics before aging guaranteed minimum	<u>H.T. Kerite</u>	<u>N/A</u>	<u>HTNS</u>
(a) Tensile Strength, psi	<u>500</u>	<u>---</u>	<u>1200</u>
(b) Elongation at rupture, percent	<u>250</u>	<u>---</u>	<u>250</u>

BID DATA (CONTD)

NAME OF BIDDER

The Kerite Company

	<u>Insulation</u>	<u>Insulation Covering</u>	<u>Overall Jacket</u>
(7) Typical physical characteristics after air oven aging of 168 hours at 136°C for insulation and 168 hours at 136°C for jacket	H.T. Kerite	---	HTNS
(a) Tensile strength, percent retained	<u>110</u>	<u>----</u>	<u>104</u>
(b) Elongation at Rupture, percent retained	<u>80</u>	<u>----</u>	<u>91</u>
(8) Accelerated water absorption (EM-60, 75°C)			
(a) Typical Dielectric constant after 24 hours	<u>3.91</u>		
(b) Increase in SIC from 1 to 14 days, percent	<u>8.7</u>		
(c) Increase in SIC from 7 to 14 days, percent	<u>4.9</u>		
(d) Stability factor after 14 days	<u>.8</u>		
(e) Dielectric constant after 52 weeks	<u>Not available</u>		
(f) Stability factor after 52 weeks	<u>Not available</u>		
(g) Insulation resistance constant (K) after 52 weeks	<u>Not available</u>		
(9) Accelerated water absorption (Gravimetric Method)			
Water absorption, mg per square inch	<u>17</u>		
(10) Insulation resistance constant (K)	<u>21,000</u>		

BID DATA (CONTD)

NAME OF BIDDER

The Kerite Company

	<u>Insulation</u>	<u>Insulation Covering</u>	<u>Overall Jacket</u>
(11) Typical Cold bend, at 24 hours aminus 25°C followed by wet voltage withstand test of 80 volts per mil ac, (pass/fail)	<u>Pass</u>	<u>---</u>	<u>Pass</u>
(12) Oxygen index	<u>19</u>	<u>---</u>	<u>29</u>
(13) IEEE 383 flame test on:	Please see Report on Flame Test No. 75 VG 32-P enclosed.		
(Specify configuration)			
(a) Burn period following removal of flame, seconds	<u>0</u>		
(b) Propagation following removal of flame (Yes/No)	<u>No</u>		
(c) Length of burned cable, inches	<u>46" Max.</u>		
(d) Time to short circuit, seconds	<u>Not a requirement of IEEE-383 (1974)</u>		
(14) Design life tests			
(a) Have proposed cables been subjected to elevated temperature testing to demonstrate 30 year life?	<u>Yes Yes/No</u>		
(b) Temperatures and test periods	<u>Temp °C</u>	<u>Duration, Wks.</u>	
Test 1	<u>Proprietary data may be</u>		
Test 2	<u>reviewed at The Kerite Co.,</u>		
Test 3	<u>Engineering Offices,</u>		
Test 4	<u>Seymour, Conn.</u>		

REPORT ON FLAME TEST CONDUCTED ON POWER CABLES

July 28, 1975

Test Number: 75 VG 32-P

Reference Number: 1G-7/18/75

2G-7/28/75

3G-7/28/75

A. OBJECTIVE

The objective of this flame test is to demonstrate that an HTK insulated, HTNS jacketed, non-shielded power cable will not propagate a fire.

B. CABLE TESTED

1/c, #6 AWG (7) str., 5 KV, 125 mils HTK (N-98) insulation,
80 mils HTNS (HI-70) jacket.

C. TEST FACILITY

The tests were conducted July 17 and 28, 1975 at The Kerite Company Fire Test Facility. An American Gas Furnace Company 10 inch wide ribbon burner was used to provide the flame source. A direct readout Omega pyrometer was used in conjunction with a thermocouple to monitor flame temperature throughout the test. A laboratory timer was used to measure the duration of the test. The test specimen was installed in a 12 inch wide, 3 inch deep, 11 foot high ladder type tray.

D. TEST PROCEDURE (IEEE 383-1974)

A single layer of seven 8 ft. lengths of test cable were mounted in the center 6 inches of the tray, allowing a space of 1/2 cable diameter between cables.

The flame source was adjusted so that the temperature was approximately 1500°F and approximately 15 inches in length. Under dynamic conditions the following manometer readings were recorded for both air and fuel in centimeters of water.

	<u>Air</u>	<u>Fuel</u>
Test No. 1	4.4	2.5
Test No. 2	4.4	2.4
Test No. 3	4.4	2.5

These pressures were measured for both air and fuel at the inlet of the mixer.

The flame source was placed 3 inches away from the cables and allowed to burn for 20 minutes. At the end of 20 minutes, the flame source was shut off and the cable was allowed to burn until it self-extinguished or was totally consumed. All pertinent data was recorded. The temperatures indicated in the next section were measured by a thermocouple located 2-7/8" from the burner face. The test was performed three times for reproducibility.

<u>E. TEST DATA</u>		<u>Test No. 1</u>	<u>Test No. 2</u>	<u>Test No. 3</u>
1)	Time for specimen to ignite.	35 sec.	36 sec.	38 sec.
2)	Time specimen continued to burn after removal of flame source.	0 sec.	0 sec.	0 sec.
3)	Maximum length of sample burned.	34"	42"	46"
4)	<u>Minutes</u>	<u>Flame Impingement Temperature (°F)</u>		
	Start	1475	1500	1450
	1	1500	1550	1525
	2	1610	1575	1525
	3	1625	1600	1575
	4	1625	1575	1575
	5	1630	1600	1575
	6	1650	1650	1575
	7	1625	1625	1575
	8.....	1625	1675	1575
	9	1625	1675	1550
	10	1600	1625	1550

Test Number: 75 VG-32-P
 Reference Number: 1G-7/18/75
 2G-7/28/75
 3G-7/28/75

<u>Minutes</u>	<u>Flame Impingement Temperature (°F)</u>		
11	1650	1625	1540
12	1600	1625	1540
13	1590	1625	1525
14	1575	1600	1525
15	1575	1625	1525
16	1550	1675	1525
17	1575	1600	1525
18	1550	1625	1525
19	1550	1625	1500
20	1560	1600	1500

F. CONCLUSIONS AND RECOMMENDATIONS

This cable shows no evidence of propagating a fire. This type of cable thus, qualifies as a fire resistant cable in the context of the test configuration.

G. ATTESTATION

The above test was personally witnessed by the undersigned and the data presented above is accurate and complete to the best of my knowledge and belief.

 J. Osborn
 Technician

Approved:
 Paul D. Basconi
 Mechanical Engineer

Subscribed and sworn to, before me, this 28 day of July, 1975.

RECEIVED BY TIC APR 22 1981