Title: PRODUCTION TESTING OF AC LINE REGULATORS

Scope: To establish a guideline for the testing of AC line regulators manufactured by Power Conversion Products Inc.

Purpose: To incorporate Power Conversion Products Test Plan.

Description: Process Specification PS-79-3 will be used for testing of all AC line regulators.

A. Mechanical Inspection

The regulator will be given a complete visual and mechanical inspection. The following inspection points will be verified.

1. All units to be checked to assure there are no loose nuts, bolts, screws, or parts loose in chassis.
2. No components missing.
3. All components tight.
4. All nuts tight.
5. Lockwashers on all screws, except where a rivnut is used.
6. Screws in all holes.
7. Proper size hardware used: lugs, screws, nuts, etc.
8. Wires extending through lugs flush or not over 1/16 inch.
9. Lugs will be mounted as follows: 1 lug, open side down, 2 lugs, bottom one, open side down and top one, open side up.
10. Stress bend in all wires and leads.
11. Wires harnessed and run neatly.
12. Wires not within 2" over, or 1" below or on side of any heat-producing component which could cause deterioration of wire insulation.
13. No burned insulation or components.

STONE & WEBSTER ENGINEERING CORPORATION
- [x] APPROVED AS DEFINED IN THE SPECIFICATION
- [ ] UNACCEPTABLE
- [ ] APPROVED AS REVISED AS DEFINED IN THE SPEC.
- [ ] REVIEWED

I.O. NO. 12241
SPEC. NO. PS-79-3
DATE 12-29-82
BY S Rajpurohit

DISTRIBUTION

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✓	✓

Revision 1, Revised pages 6 & 7, 11/25/81

Written by	Approved	Revision	Issued	Page 1 of
4/28/82	4/20/82	4	4/20/82	

Title: PRODUCTION TESTING OF AC LINE REGULATORS

A. Mechanical Inspection (cont.)

14. Wires not too tight or too much excess wire.

15. Components flush on board except where mounted with clamp or potted.

16. Tracks on P.C. boards not cut or broken.

17. Proper soldering of all solder connections.

18. Serial number tag installed.

19. P.C. boards and all components and parts clean of all solder and flux.

20. No scratches on chassis or units.

21. All units to be blown out.

B. Electrical Inspection

1.0 SPECIFICATIONS: The following sequence of priority shall apply in determining the authority of specifications.

1.1 Customer documentation shall be governed and defined by his purchase order and shall establish first priority of authority.

1.2 Supplimental customer communications, when properly documented, can ammend the contractual requirements of the purchase order.

1.3 This specification shall have next priority.

1.4 Further process specifications shall ammend this procedure, when issued.

1.5 Test configuration and test equipment shall be arranged as shown in Dwg. Q-55-13498.

1.6 Input waveform of the supply line shall not contain more than 3% waveform distortion from a normal sinewave.

1.7 If the supply voltage is polyphase, the line to line unbalance must be less than 5% at the start of test. Line balance shall be verified with the unit operating at full load.

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Written by	Approved	Revision	Issued	Page 2 of 3
L Lutz 4/20/82	Michael Baker 4/20/82	4	4/20/82 — —	

1.8 Adjustment shall be provided in the AC main supply that will allow adjusting the input voltage to the unit under test (UUT), as measured at the input terminal connections, to be adjusted to the nominal input voltage, ±1%, the maximum required input voltage +2%, -0% and the minimum input voltage +0%, -2%.

NOTE: Where "continuously" adjustable input voltage cannot be used (i.e. Input powers in excess of 48 KVA) step adjustments may be used and voltage adjustments made as close as possible to the required limits, with attempts made to have the input maximum in excess of the upper specification limit, and input minimum below the lower specification limit. If the input voltage tolerance of Paragraph 1.8 cannot be met the actual AC input as measured shall be recorded.

NOTE: Maximum and minimum input voltages will be ± 10% of nominal, unless otherwise specified.

1.9 Input Metering Requirements.

1.9.1 Input voltages to the UUT shall be measured with an AC Voltmeter accurate to at least ±1% and readable to ±1%. Voltage measurements shall be made at the UUT input terminal connections. When testing a polyphase unit, measurements shall be made on all phases (not necessarily simultaniously) and the requirements of paragraph 3.2 verified. For recording data the mean reading of input voltage shall be used.

1.9.2 Input current to the UUT shall be measured with a current transformer type AC ammeter accurate and readable to at least ±1%. Care shall be taken that the meter shall read only the UUT current. When testing a polyphase unit the current of each phase shall be monitores (not necessarily simultaneously) and the mean reading shall be the one recorded.

NOTE: If the UUT input current inbalance exceed 10% discontimue testing.

1.9.3 Input power (watts) shall be measured with a suitable ranged dynamometer type wattmeter accurate and readable to at least ±2%. On polyphase units the input connections, to the extent practicle, shall be the voltage measurement on the mean voltage phase, and the 2 current readings on the highest and lowest current phases (when unbalanced).

Written by	Approved	Revision	Issued	Distribution C	Distribution M
Lawrence G. Lutz 9-12-79	W. F. Neilson 9-18-79	4	6-17-82	X	X

Title: PRODUCTION TESTING OF AC LINE REGULATORS

2.0 Output connections

Unless otherwise specified, the UUT output shall be connected to the resistive load bank cables and bundled together.

2.1 UUT output voltage shall be measured at the UUT output terminals with a meter accurate to ± 1/2%. NOTE: For routine testing of identical products, the voltage measurment may be made with an AC Voltmeter accurate to ±1% and repeatable to ±1% provided that:

a. Periodically the product is verified to conform to specification requirements with a meter of ± 1/2% accuracy, and

b. The UUT performance is such that the worst case of meter error and unit performance combined will be within specification limits.

2.2 UUT output current shall be measured with a calibrated current transformer and A.C. Ammeter accurate to ± 1/2%. The current transformer shall be connected in accordance with Q-55-13498. NOTE: For routine testing of identical products the output current readings may be make with a calibrated direct reading ammeter or current transformer and A.C. Ammeter accurate to ±2% provided that the output current is set by the load conditions such that the load current shall be at least 2% above the required FLC.

3.0 Proof of Performance Testing.

3.1 Each new design and each unit of an established design, when of a nonhomogenious lot, shall be subjected to this test sequence.

3.2 Additional units of a homogenious lot shall be tested in accordance with the same test sequence except that certain data requirements are eliminated as shown on the following Table 1.

3.3 Testing will be in the sequence listed in Table 1. However, for reasons of efficiency, the test sequence may be altered, provided that:

a. In all cases, the dielectric strength test must be performed before any other electrical testing is attempted, and

b. All of the tests required by Table 1 are completed.

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TABLE 1

Test Name	Spec. Para.	Proof of Performance	Subsequent Item
Dielectric Strength	4.1	100%	100%
Circuit Operation	4.2	100%	100%
Range Adjustment	4.3	100%	100%
Voltage Regulation	4.4	100%	100%
Harmonic Distortion	4.5	100%	100%
Maximum Output Current Test	4.6	100%	-
Short Circuit Test	4.7	100%	100%
* Surge Withstand	4.8	100%	-
* Conversion Efficiency & Power Factor (when required by customer specification)	4.9	100%	-
High Voltage Shutdown	4.10	100%	100%

4.0 Detailed Test Procedures

4.1 Dielectric Test

The dielectric strength of the regulator shall be tested in accordance with the following table:

A. 1000 VAC plus 2 times the input voltage from the primary terminals to dead metal for 1 minute.

B. 1500 VAC from the output terminals to dead metal for 1 minute.

C. 1000 VAC plus 2 times the input voltage from the primary terminals to the output terminals for 1 minute.

For this test, all semiconductors, capacitors, and sensitive control components may be short circuited; printed circuit control boards may be removed.

* REQUIRED ON 1ST DESIGN TEST OF EACH REGULATOR TYPE ONLY.

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4.2 Circuit Operation

Circuit operation testing shall proceed only after successful completion of the dielectric strength test.

4.2.1 Apply AC voltage to the UUT, while monitoring the input current, input voltage, output voltage, and the UUT meters. As soon as it is established that the UUT is performing properly, adjust the input AC to its nominal value, verify adjustment of controls, etc.

4.3 Range Adjustment

Range adjustment shall be performed with the UUT operating under nominal input conditions, and an output load of approximately 50%. The output voltage shall be continuously adjustable within ± 10% of the nominal output voltage rating.

4.4 Voltage Regulation

Voltage regulation testing shall be performed to demonstrate that the combined effects of line and load variations will not result in a deviation in regulator output greater than that allowed by the UUT specifications. Proper readings of meters should be noted during regulation testing.

Definitions of Regulation

$$\pm\% \text{ Regulation} = \frac{E(h) - E(l) \times 100}{E(h) + E(l)}$$

Where: E(h) is the highest UUT output voltage recorded.
E(l) is the lowest UUT output voltage recorded.

4.4.1 Voltage regulation records for performance testing will be taken with the UUT delivering nominal output voltage, resistive load connected, and the input voltages of rated low, nominal and high line. A minimum of five different levels of load current shall be taken as follows: 100% FLC, 75% FLC, 50% FLC, 25% FLC, 0% FLC.

4.4.2 Voltage regulation records for subsequent items need only have 3 load current variations recorded and when adequate data is available on any type design, nominal line readings may be omitted as well. (i.e. Readings at minimum and maximum input with 100% FLC, 50% FLC, and 10% FLC or "0" FLC as required.)

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4.5 Harmonic Distortion Test.

During the regulation test measure the output waveform harmonic distortion with a calibrated distortion analyzer. Harmonic distortion shall not exceed 5% of the fundamental waveform.

4.6 Maximum Output Current Test.

At the completion of the regulation test, the load shall be increased as a step function until the current and voltage begins to decrease. This current shall not ne more than 250% of full load rated output current. Measure and record this value of current.

4.7 Apply a bolted short circuit to the output terminals of the UUT. The value of input current under this condition shall not exceed 150% of the full load rated input current. Measure and record this value of current.

4.8 Surge Withstand Test.

Perform surge withstand capability test in accordance with PCP Process Specification PS-79-5 and IEEE-472-1974.

4.9 Conversion Efficiency and Power Factor.

4.9.1 The efficiency of the regulator shall be determined by measuring the total power at the input terminals by means of watt-meters and by measuring the RMS values of the output voltage and current at the output terminals at rated output. From the values thus measured, the efficiency shall be calculated as follows:

$$\%\text{Efficiency} = \frac{\text{Output Watts}}{\text{Input Watts}} \times 100$$

%Eff. ≥ 90%@ F/L Nominal Input Voltage

4.9.2 The power factor for single and three phase regulators shall be calculated as follows:

$$PF = \sum \frac{\text{Watts Per Phase}}{\text{RMS VA Per Phase}}$$

P.F. ≥ 92%@ F/L Nominal Input Voltage

For single phase regulators, the input watts can be measured with a suitable wattmeter and the volt amperes can be calculated from the measurements of the true RMS input current, using RMS responding meters.

Written by	Approved	Revision	Issued	Distribution			
Lawrence G. Lutz 9-12-79	Michael F. Behr 12-3-82	4 correct 2 eff calculations to watts/watts	J Granger 12-3-82	C	X	M	X

For a balanced three phase source and load, the input power factor may be calculated as follows:

$$PF = \frac{\text{Input Watts}}{\sqrt{3}\ (\text{RMS Phase Volts})\ (\text{RMS Line Current})}$$

PF ≥ 92%@ F/L Nominal Input Voltage

4.10 High Voltage Shutdown

Verify that the high voltage shutdown trips the input circuit breaker at 115% of rated output voltage.

Written by	Approved	Revision	Issued	Distribution	
Laurence C. Lutz	W P Wallace	J	[illegible]	C	M

forty two east street, crystal lake, illinois 60014, telephone: 815/459-9100. twx 910/634-3356

Rev E

FINAL INSPECTION DATA - PS-79-3

power conversion products inc. BY _____ DATE _____

CUSTOMER _____ PCP JOB _____

MODEL _____ SERIAL _____ 1st _____ SUBSQ _____

TESTED ON BENCH # _____

DESCRIPTION OF INSTRUMENTATION

DESCRIPTION	INSPECTION NO.	DESCRIPTION	INSPECTION NO.
INPUT VOLTS	_____	WATTMETER	_____
INPUT AMPS	_____		_____
OUTPUT VOLTS	_____		_____
OUTPUT AMPS	_____	CURRENT TRANSFORMER	_____
HI-POT TESTER	_____		_____
DISTORTION ANALYZER	_____		_____

TEST DATA

SPEC. PARA.	DESCRIPTION	
4.1	DIELECTRIC STRENGTH	INPUT TO GROUND _____, INPUT TO OUTPUT _____ OUTPUT TO GROUND _____
4.2	CIRCUIT OPERATION	VERIFIED _____
4.3	ADJUSTMENT RANGE	OUTPUT VOLTS _____ TO _____
4.4	REGULATION	SEE REVERSE SIDE
4.5	HARMONIC DISTORTION	
4.6	MAXIMUM OUTPUT CURRENT TEST	MAXIMUM CURRENT _____ OUTPUT VOLTAGE _____
4.7	SHORT CIRCUIT TEST	OUTPUT CURRENT _____
4.8	SURGE WITHSTAND TEST	PERFORMED YES _____ NO _____
4.9	CONVERSION EFFICIENCY AND POWER FACTOR	SEE REVERSE SIDE
4.10	HIGH VOLTAGE SHUTDOWN	TRIP VOLTAGE _____

INPUT CONDITIONS FOR TESTS 4.3, 4.6, 4.7, 4.8, 4.9

" I Hereby Certify That This Test Data Is Correct And Is Authorized To Ship.

successor to rectifier products division of Fansteel Inc. _____ Date _____

MIN. AC _____ INPUT

ITPUT AMPS	OUTPUT VOLTS		HARMONIC DISTORTION	INPUT AMPS	INPUT WATTS			

NOM. AC _____ INPUT

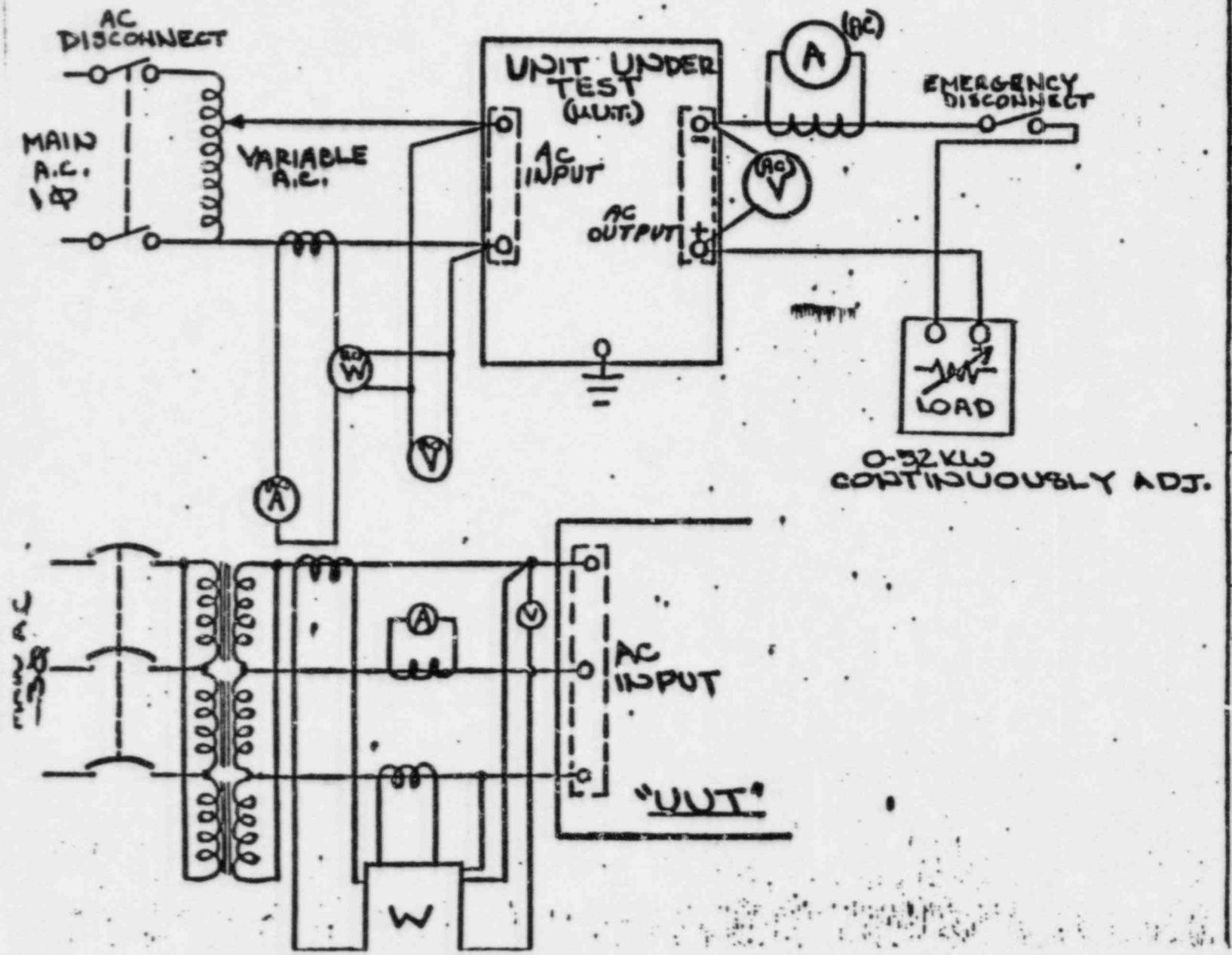
_____ Hz

MAX. AC _____ INPUT

Rev 11

ALL DIMENS ARE IN INCHES
UNLESS OTH. ..SE SPECIFIED.

ALLOWABLE VARIATION ON ALL DIMENSIONS
** UNLESS OTHERWISE SPECIFIED &



PART NO. Q-55-13498

power conversion produc
crystal lake, illinois 6001

TITLE UNIT TESTING CONFIGURATION AC LINE REGULATOR

SCALE	DATE	DRAWN	THIRD
NONE	10/1/80	EA	

MATERIAL:

WEIGHT PER 1000 PIECES
GROSS NET

TREATMENT AND FINISH:

CUSTOMER'S NAME:

REVISIONS

NO.	DATE	DESCRIPTION
		REV. 4

Power Conversion Products, Inc.

Process Specifications | PS-79-3

Title: Addendum for testing of 3 phase RTF's

All test methods and requirements are as specified in the body of PS-79-3. Load is applied as three resistance banks connected from each line to neutral. Monitor and record all three line currents and line -to - neutral voltages, adjusting load banks as required to balance load currents to at least ± 5%. Harmonic distortion is specified as the distortion of each line - to - neutral voltage.

For short-circuit test, test a single-phase bolted fault from any line to neutral and a three-phase fault from all three lines to neutral.

Record data for all three phases as required by PS-79-3.

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Written by	Approved	Revision	Issued	Page 1 of 1
[signature]	[signature] 4/1/81	4	4-5-81 M. Wollmann	

2030 (EN DL

OR Power Conversion Products Inc
CONTRACT NO. 82K5-830802

PLANT OR PROJECT: Sequoyah/Watts Bar Nuclear Plants

TENNESSEE VALLEY AUTHORITY
VENDOR'S LIST OF SUBMITTALS TO MATERIALS ENGINEER, VLS-M
— PREPARED BY VENDOR —

Deseret Technology — WORKMANSHIP QUALITY CONTROL ASSURANCE

M NO.	② FORMAT CODE	③ DOCUMENT NUMBER	④ TITLE OR DESCRIPTION OF THE DOCUMENT	⑤ SUB - SUPPLIER (If Applicable)	⑥ REV NO. or ISSUE DATE	⑦ LINE ITEM CHANGE ?	⑧	⑨ (TVA USE) STATUS CODE
	Doc	PS-76-11 Rev.2 (2 pages)	Spray Painting(Durex Enamel)	N/A	Rev 0;6/25/82			
	Doc	PS-79-3 Rev.3 (12 pages)	Production Testing of AC Line Regulators REV. 4	N/A	Rev 0;6/25/82 Rev 1,12/3/82	 X		

E: Each item listed except [illegible] must bear a TVA - supplied [illegible] or equivalent stamp.

② FORMAT CODES:
DWG - Drawing
DOC - Bound Document
SHT - Single Sheet
PNT - Computer Printout

⑥⑦ See "Revising the VLS-M", other side of this form

⑦ Line item added, deleted, or changed by this submittal to TVA

⑨ Status C Codes:
AM - Accepted by Materials Engineer
P - Preliminary

F SUBMITTAL OF THIS SHEET FOR REVISION TO TVA

p.o. box 380, forty two east street, crystal lake, illinois 60014, telephone: 815/459-9100, twx 910/634-3356

power conversion products inc.

512506

1982 DEC 10 AM 9:39

Date: December 8, 1982

Subject: P.O. # 2BV-337
F/N 21102
Station Duquesne Light Co.

Stone & Webster Engineering Corp.
P.O. Box 2325
Boston, Massachusetts 02107

Attn: Project Engineer for
Job No. 12241

The following drawings and/or instruction manual(s) are being sent:

- [x] For Approval
- [ ] Revised Drawings for Approval
- [ ] Per Your Request
- [ ] Final Drawings
- [ ] Other _____

Quantity Prints	Repro.	Drawing Number & Description
3		PS-79-3 Production Testing of AC Line Regulator

ACTION REQUIRED:

- [ ] Please review and approve these drawings ASAP--manufacturing is on hold.
- [x] Please review and approve these drawings ASAP--manufacturing will proceed in anticipation of your approval.
- [ ] No further action required.

Very truly yours,

POWER CONVERISON PRODUCTS INC.

Donald L. Ogden
Sales Engineer

STONE & WEBSTER ENGINEERING CORPORATION

BEAVER VALLEY POWER STATION - UNIT 2
DUQUESNE LIGHT COMPANY
J.O. 12241

SUPPLIER'S DOCUMENT DATA FORM

REVIEW & RETURN TO SUPPLIER REQUIRED (E1)

FOR INFORMATION ONLY – NO REVIEW REQUIRED (E1)

3 SUPERSEDES S & W FILE NO. (E1) (25-34) (35-38)

REMARKS (LIMIT TO 22 CHARACTERS & BLANKS) (53-74)
(CODES OR SPECIAL REQUIREMENTS)

NAME

RESP. ENG. S. KAMPANELLAS — DEPT./DIV. 39 (E1)

REVIEWER G. FLUGG — DEPT./DIV. 39 (E1)

2 S & W EQUIP. I.D. CODE (E1) (25-36): N A — AREA DESIGNATION CODES (E1) (75-80)

DATE TO REVIEWER (E1): 6/28/83 — REQUIRED RETURN DATE (E1): 7/13/83

MFR'S DOC. NO. (E1) (LIMIT TO 24 CHARACTERS & BLANKS) (37-60)
(INCLUDE DOC. REV. OR DATE)
21102-501, L01

REVIEW STATUS (R)

✓	APPROVED	AS DEFINED IN SPECIFICATION
	APPROVED AS REVISED	
	UNACCEPTABLE	

MFR'S NAME (E1) (LIMIT TO 20 CHARACTERS & BLANKS) (61-80)
POWER CONVERSION PROD.

1 DATE RECD (C): MONTH 06 DAY 24 YR (25-30) 83 — DOC TYPE (E1) (31): E — MAX DAYS IN REVIEW (E1) (32-33): 15

REVIEWER'S SIGNATURE (R): G. Flugg — DATE: 7-12-83

FUNCTIONAL TITLE (E1) (LIMIT TO 44 CHARACTERS & BLANKS) (37-80)
TEST DATA
ISOLATING VOLTAGE REG. 5KVA

RESPONSIBLE ENGINEER'S DATE STAMP (E2)
RCVD JUL 12 1983

(C) PROJECT CLERK (R) REVIEWER
(E1) RESPONSIBLE ENGINEER PRIOR TO REVIEW
(E2) RESPONSIBLE ENGINEER AFTER REVIEW

DUP S & W FILE NO. (E1) (C) (11-20): 2701340337 — (21-24): 08A

JOB ORDER NO. 12241 00 (4-10)

TYPE CODE: A3.22 — SEQUENCE NO. (C): FL8307130006

REVIEWER COMMENTS:

NO COMMENT

JUL 12 1983

FILMED

ATTACH TO DOCUMENT

forty two east street, crystal lake, illinois 60014 telephone: 815/459 9100 twx 910/634 3356

power conversion products inc.

Stone & Webster Engineering Corporation
- [x] APPROVED AS DEFINED IN THE SPECIFICATIONS
- [ ] UNACCEPTABLE
- [ ] APPROVED AS REVISED AS NOTED IN THE SPEC.
- [x] REVIEWED

I.O. No. 12241
SPEC. No. 2BVS-337
DATE 7/12/83
BY S. Kampanella

CERTIFICATE OF CONFORMANCE

DATE June 23, 1983

TO Duquesne Light Company (Stone & Webster Eng.)

ADDRESS P.O. Box 186

CITY Shippingport STATE P.A. ZIP 15077

It is hereby certified that all the materials in the quantities as called for in purchase order 2BV-337 PCP FO# 21102 are in conformance with the requirements, specifications, and drawings listed on this order.

Part #	Quantity	Description
RTF-120/120-5	2	ISOLATION TRANSFORMERS
		S/N: 21102-501 Tag: REG*VITBS2-3C
		S/N: 21102-601 Tag: REG*VITBS2-4C

Linda D. Kasprzak
Notary Public

My Commission Expires
5-14-86

Michael Dehr
Manager, Quality Assurance

Duquesne Light Company
Beaver Valley Power Station - 2
I.O. 12241, P.O. #2BV-337
O.F.E. #10080, C.O. #6289

'orly two east street. p o box 380. crystal lake. illinois 60014 telephone 815/459-9100. twx 910/634-3358

power conversion products inc.

WELDING CERTIFICATE OF COMPLIANCE

This is to certify that the SEISMIC CABINETS ordered by Duquesne Light Company on Purchase Order #2BV-337 have been fabricated using the same type of base material and weld filler material as that which was used on the qualification unit. The welding procedures and acceptance criteria are also the same as that used on the qualification unit.

Model	Quantity	Description
RTF-120/120-5	2	ISOLATION TRANSFORMERS
		S/N: 21102-501 Tag: REG*VITBS2-3C
		S/N: 21102-601 Tag: REG*VITBS2-4C

POWER CONVERSION PRODUCTS

By _____
Michael Behr
Manager, Quality Assurance

_____
Linda D. Kasprzak
Notary Public

My commision expires 5/14/86

Duquesne Light Company
Beaver Valley Power Station - Unit 2
J.O. 12241, P.O. #2BV-337
O.F.E. #10080, C.O. #6289

423 Dennston Court
Wheeling, Illinois 60090
312/537-6066

Fabricators of Metal Products

Weber
Industries, Inc.

CERTIFICATE OF COMPLIANCE

This is to certify that the SEISMIC CABINETS ordered by POWER CONVERSION PRODUCTS, INC. on Purchase Order # 27309 has been welded by a welder certified in accordance with the American Welding Society Specification #D1.1. The test weld has been x-rayed and approved by the Magnetic Inspection Laboratories, Rosemont, Illinois. Records of this test are available from Weber Industries, Inc. All material appropriated for the noted purchase order meets or exceeds POWER CONVERSION PRODUCTS INC specifications for Dwg. # F55-2992-02.

WEBER INDUSTRIES, INC.

By J. S. Weber
JOHN S. WEBER

Title PRESIDENT

Date 9-23-82

Duquesne Light Company
Beaver Valley Power Station - 2
J.O. 12241, P.O. #2BV-337
O.F.E. #10080, C.O. #6289

JSW/mp
10/81

forty two east street, p o box 380, crystal lake, illinois 60014 telephone 815/459-9100 twx 910/634-3356

power conversion products inc.

June 1, 1983

REF: Duquesne Light Company
Beaver Valley Power Station - Unit 2
J.O. 12241
P.O. 2EV-337
O.F.E. #10080
C.O. #6289

It is hereby certified that this equipment conforms to Power Conversion Products Inc. Qualification Report No. 45999-1 from Wyle Laboratories dated March 23, 1982.

MODEL	QTY	DESCRIPTION
RTF-120/120-5	2	ISOLATION TRANSFORMERS
		S/N: 21102-501 Tag: REC*VITBS2-3C
		S/N: 21102-601 Tag: REC*VITBS2-4C

Michael Behr
Manager, Quality Assurance

Lawrence C. Lutz
Manager, Product Design