Consumers Power Company

General Offices: 212 West Michigan Avenue, Jackson, MI 49201 • (517) 788-0550

August 26, 1981

Director of Nuclear Reactor Regulation
Attn Mr Dennis M Crutchfield, Chief
Operating Reactors Branch No 5
U S Nuclear Regulatory Commission
Washington DC 20555

DOCKET 50-155 - LICENSE DPR-6 -
BIG ROCK POINT PLANT - STATION
ELECTRIC DISTRIBUTION SYSTFM
VOLTAGES AND DEGRADED GRID
PROTECTION

Consumers Power Company was requested by letter dated July 7, 1981 to provide additional information to support the NRC's review of adequacy of station electric distribution system voltages and degraded grid protection for our Big Rock Point Plant. The requested information is provided in Enclosure 1. It should be noted that our response to Question 1 involves some additions to previously requested Technical Specification Changes (DPHoffman letter to DMCrutchfield, dated February 3, 1981). Since these additions have not been through our complete review process they must be considered "preliminary". Consumers Power Company will modify our formal request when our Plant Review Committee and Safety and Audit Review Board reviews are completed.

David P. Hoffman

David P Hoffman
Nuclear Licensing Administrator

CC Director, Region III, USNRC
NRC Resident Inspector-Big Rock Point

Enclosure

Aperture Card Dist

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ENCLOSURE 1

ADEQUACY OF STATION ELECTRIC DISTRIBUTION
SYSTEM VOLTAGES AND DEGRADED GRID PROTECTION

Big Rock Point Plant
Response to NRC Letter Dated July 7, 1981

ITEM 1

Your technical specifications do not conform with the model technical specifications in the following areas.

a. There is no time limit on a channel in the tripped position when it is removed from service.

b. There is no requirement for a monthly channel functional test.

c. Second-level undervoltage relay setpoints, time delays and allowable limits (± tolerances) are not called out.

Either provide the above items in your technical specifications or justify why each item should not be required. In particular, justify use of the three-out-of-three logic without frequent channel functional tests.

RESPONSE TO ITEM 1

a. In a February 3, 1981 letter from DPHoffman (CPCo) to DMCrutchfield (NRC), the Consumers Power Company requested that the Big Rock Point Technical Specifications be changed to include a limiting condition for operation (LCO) for the Degraded Grid Voltage Protection System (DGVPS) as stated below.

> "During power and refueling operations, the three (3) single-phase undervoltage relays 127-10XY, XZ and YZ shall be operable, except as specified below:
>
> > One (1) relay may be taken out of service for any length of time if the output of the relay is placed in a tripped condition."

The model technical specifications, forwarded to CPCo as part of a June 3, 1977 letter from DKDavis (NRC) to DABixel (CPCo), state the following as limiting conditions for operation:

> "With the number of operable channels one less than the total number of channels, operation may proceed provided both of the following conditions are satisfied:
>
> a. The inoperable channel is placed in the tripped condition within one hour.
>
> b. The minimum channels operable requirement is met; however, one additional channel may be bypassed for up to two hours for surveillance testing...".

The LCO, as requested by the Consumers Power Company, is more restrictive than that given in the model technical specifications in that the former makes no provision for removing an undervoltage relay from service without placing it in the tripped condition. This represents a more conservative mode of operation in terms of plant safety than that offered by the model specifications.

In addition, the LCO as requested by the Consumers Power Company, does not specify a time limit for a channel to be in the tripped position when it is removed from service. This specification is not required since a channel placed in the tripped position represents a more conservative mode of operation in terms of plant safety. Whenever a channel is removed from service and placed in the tripped condition, the DGVPS is converted from a three-out-of-three to a two-out-of-two coincidence logic for system actuation.

b. It is the opinion of the Consumers Power Company that since a three-out-of-three logic is utilized (instead of a more complicated two-out-of-three logic, for example), a monthly channel functional test should be conducted. This test is considered necessary since the ability of the DGVPS to perform its intended function is dependent on each of the three undervoltage relays to be operable. A channel functional test, conducted at a frequency of once per month, would allow logic system problems to be detected in a timely manner and yet would not result in excessive system testing which could significantly jeopardize plant availability.

Therefore, Paragraph 11.4.5.3.2(d) will be added to state the following:

"(d) Perform a channel functional test of the Degraded Grid Voltage Protection System."

c. It is the opinion of the Consumers Power Company that the DGVPS undervoltage relay setpoints, time delays and allowable limits (± tolerances) be called out in the Big Rock Point Plant Technical Specifications. Specifying these setpoints, time delays and tolerances will aid plant personnel in administering and performing effective surveillance and maintenance programs.

As a result, the following table will be added to Paragraph 11.4.5.3.A.1(i) (refer to letter dated February 3, 1981, DPHoffman to DMCrutchfield) as follows:

Functional Unit	Function	Setting	Tolerances
1. Degraded Grid Voltage Protection System Undervoltage Relay 127-10XY, XZ, YZ	1.1 Drop Out (Trip) 1.2 Time Delay 1.3 Pickup	1.1 107.1 V 1.2 0.5 Sec 1.3 109.2 V	1.1 109.2-107.1 V 1.2 0.5-0.6 sec 1.3 107.1-114V
2. Degraded Grid Voltage Protection Sys Aux Timer Relay 162-104	2. Timer	2. 10 Sec	2. 9.5-10.5 Sec

It should be noted that the DGVPS undervoltage relays are connected to the low voltage winding of a 2400/120 volt potential transformer. The high voltage winding of this transformer is connected directly to the 2400V main bus. Therefore, the relay dropout (trip) setpoint occurs at (107.1)(2400/120)V = 2142 volts. This corresponds to 39% of the rated bus voltage of 2400 volts.

ITEM 2

Describe the possible failure modes of the second-level undervoltage relay channel and components. Specifically, are there single failures that could negate the channel function?

RESPONSE TO ITEM 2

Bechtel Corporation Drawing E-105 (attached) provides a schematic representation of the DGVPS. As shown in the drawing, certain single-failure mechanisms do exist which could render the DGVPS inoperable. These single-failure mechanisms are listed below.

1. Either of the two 30-amp fuses, which are connected in the undervoltage control circuits immediately downstream of the breaker 1D43, could open rendering the DGVPS control circuit inoperable. It should be noted, however, that a local indicating light exists downstream of the fuses to provide a continuous display of the voltage available at the undervoltage control relays.

2. A failure of one undervoltage relay contact to close upon an actual undervoltage condition would also render the DGVPS inoperable. This single-failure is highly unlikely, however, since the relay operation is designed to be fail-safe. The design is such that the undervoltage relays are normally energized (relay contacts are open) during normal voltage levels and de-energize (contacts close) upon degraded grid voltage conditions. A failure of these relays would most probably cause the relay to de-energize thereby placing the relay in its safety-related mode of operation.

3. A failure of the DGVPS auxiliary timer relay (162-104) to energize and close its 1-2 contact in the #1136 ACB control circuits during degraded voltage conditions would also render the DGVPS inoperable. This condition could be considered more likely to occur than that described in Item 2 above.

4. In addition to single-failures, certain DGVPS misalignments could result in rendering the system inoperable. These misalignments are described below.

   4.1) 125 V d-c breaker 1D43 could inadvertently be opened and left open. Similar to Item 1 above, however, this condition would be locally displayed by the indicating light.

4.2) Either one of the four test switches (test switch #1-4) in the undervoltage control circuits could be misaligned such that the circuit containing the undervoltage relay (127-10) contacts and the auxiliary timer (162-104) coil would be permanently broken. This would result in relay 162-104 remaining de-energized even though a degraded voltage condition existed and was detected by the 127-10 relays.

4.3) Either one of the two test switches (test switch #5 or #6) in the #1136 breaker control circuits could be opened rendering the DGVPS inoperable. Opening either of these switches will prohibit the closure of timer relay contact 162-104/TDC from providing a breaker trip signal upon a degraded grid voltage condition.

Although single-failure mechanisms exist in the DGVPS channel, their presence does not significantly reduce the reliability of the system as a whole since only one diesel generator and associated circuitry and components exist to supply the emergency loads in the event of a degraded grid voltage condition concurrent with a design accident. Furthermore, the requested monthly channel functional test (refer to the response to Item 1) would detect system failures and misalignments in a timely manner resulting in a high level of confidence in the system's ability to perform its intended safety function.

ITEM 3

On DWG WD740 SH 1 you show a generator breaker. Is this device a load break switch or is it a breaker designed to interrupt the maximum generator and system fault currents? If this is a generator breaker supply the design criterion and testing used to qualify the breaker for this service. Will this breaker trip on a turbine trip and allow the 138 kV supply to automatically backfeed the station loads or is operator action required to make this source available as a delayed source of offsite power.

RESPONSE TO ITEM 3

The generator breaker shown on Drawing WD740, Sh 1 is designated as Breaker 116. This breaker is designed to interrupt the maximum fault of 629 MVA (this fault has been determined as maximum by Consumers Power Company calculation). This maximum fault represents the contribution of the generator only and would represent a fault between the breaker and the main transformer. This fault MVA is considered the maximum that could involve Breaker 116 since Consumers Power Company calculations show that the maximum MVA as seen by the breaker for a fault located between the generator and the breaker is less that 629 MVA. As can be seen in Drawings WD740, Sh 1 and the attached General Electric Specification Sheet #7040, Page 3, the breaker (type FK-339) is rated for at least 1500 MVA. Actual breaker qualification test data has been requested from the vendor. Although this data has not yet been received, it is expected to arrive in the next few weeks.

During plant operation, the normal lineup is such that the main generator breaker (#116) is closed, Breaker #1126 is closed to supply the plant auxiliaries from the main generator and Breaker #7726 is open. Upon turbine trip, the main turbine stop valve closure provides a trip to OCB 116. A trip of OCB 116 de-energizes the 2400V bus. Undervoltage relays connected to the 2400V bus de-energize to provide auto station power transfer by tripping Breaker #1126 and closing Breaker #7726. Closing Breaker #7726 allows the 46kV system to supply the plant auxiliaries through station power Transformer #7. The station power transfer (as revealed in the attached drawings #740-F19, Sh 4, M740-G19, Sh 2, E-107 and WD740, Sh 1) is fully automatic and requires no manual operator action.

ITEM 4

Supply the ratings for continuous operation of the Class 1E starters (nominal coil voltage, maximum and minimum coil voltages and transformer ratios).

RESPONSE TO ITEM 4

The motor starter for the reactor shutdown pump #1 (See Dwg E-112, attached) is typical of the Class 1E starters at the Big Rock Point Plant. Nameplate data taken from this specific starter showed the vendor to be General Electric. This data also showed that the nominal coil voltage is 120V a-c. Upon contacting the vendor, it was learned that minimum and maximum coil voltages are not normally specified for these starters. However, a letter from PVMartin (GE) to JDutta (Bechtel), dated January 6, 1977 (attached), indicates that the design standard for pick-up for motor starter coils is [illegible]% of the nominal coil voltage. Therefore, the Consumers Power Company considers the minimum voltage for the typical starter to be (120V a-c) (.85) or 102V a-c.

Regarding the coil's maximum voltage, the vendor's General Purpose Control Catalog (GEP 1206A) was used. According to Pages 24, 25 and 53 (attached), the maximum voltage rating for a CR106 type starter is 600 volts (according to nameplate data, the aforementioned starter type number is CR106D0). Since an instrument transformer with a ratio of 4:1 is used to supply 120 volts to the starter coil from the 480 volt circuit in which the starter contacts are connected, the Consumers Power Company expects the maximum coil voltage to be 600V/4 or 150 volts.

Regarding transformer ratios, drawing E-112 (attached) provides the transformation ratio of 4:1 for typical instrument transformers that supply power to the motor starters.

ITEM 5

Supply the voltage ratings (nominal, maximum and minimum) for the instruments and control systems connected to the Class 1E system. What is the maximum expected voltage for this equipment? CPCo has indicated that there may be occasions when this equipment is subjected to undervoltage conditions (4). Describe how these voltages will be improved.

RESPONSE TO ITEM 5

In a previous NRC request for information regarding the Station Electric Distribution System (refer to letter: DMCrutchfield to DPHoffman, dated January 27, 1981), the NRC asked the Consumers Power Company to supply calculated voltages and the voltage ratings for all low voltage a-c Class 1E equipment. In addition, the request asked Consumers to determine whether or not all the equipment is capable of sustaining the analyzed voltages without affecting the equipment's ability to perform the required function (refer to Item 1 of the referenced letter).

In response to the NRC requests, the Consumers Power Company analyzed the effects of low voltage on 120V a-c power supplies that supply the current loops of safety-related instrumentation. The rationale for selecting only these power supplies to be analyzed along with the results of the analysis were documented and forwarded to the NRC in a letter from DPHoffman to DMCrutchfield dated March 23, 1981.

Utilizing these same power supplies, the maximum expected voltage is compared to the voltage ratings (ie, nominal, maximum and minimum) for these supplies to determine if any ill-effects might result. The maximum expected voltage for these supplies is .9689 per unit (pu). This per unit voltage was calculated by the Consumers Power Company based on voltage readings as logged by plant personnel. This per unit voltage was calculated for 480 volt Bus 1A which provides power to a 4:1 instrument transformer which, in turn, feeds the power supplies. It should be noted that this voltage of .9689 pu represents the maximum expected Bus 1A voltage, since it was calculated from a study that assumed the plant auxiliaries had just been transferred to the reserve 46kV off-site supply as a result of low station power voltages. Maximum voltage is expected in this condition since the only significant loads may be two 200 hp condensate pumps. The .9689 per unit voltage calculation is documented in the attached letter: KEYeager to MRWade dated March 9, 1981. It should be noted that the referenced calculations assume that the 250kVA voltage regulator, installed between the 2400 volt transfer bus and breaker #1136 is not in service (see Dwg E-101).

Power Supply	Nominal Voltage	Minimum Voltage	Maximum Voltage	Maximum Expected Voltage (.9689 pu)
ES 8512A	115V	105V	125V	116.3
ES 8512B	115V	105V	125V	116.3
ES 2108	120V	107V	127V	116.3
ES 3171	115V	103.5V	126.5V	116.3
ES 2165	118V	106.2V	129.8V	116.3
ES 2160	115V	103.5V	126.5V	116.3
ES 2162	115V	103.5V	126.5V	116.3
ES 2161	115V	103.5V	126.5V	116.3
ES 2163	115V	103.5V	126.5V	116.3

In summary, it should be noted that utilizing the per unit voltage at the 480V bus is conservative for maximum voltage analysis since it represents a no-load condition. Obviously, during plant operation the power supplies serve as a load on the bus that will cause a voltage drop across the cable that connects to the supplies. As can be seen in the above table, the maximum expected voltage falls well within the range of each power supply's ratings even in the worst-case, no-load condition.

As previously mentioned, the Consumers Power Company conducted an undervoltage analysis on these power supplies and forwarded that analysis to the NRC in a letter from DPHoffman to DMCrutchfield, dated March 23, 1981. Although the analysis indicates that the power supply rated minimum voltage will be exceeded in the event of a minimum Bus 1A voltage condition of 0.85 per unit, it revealed a minimum available voltage at the input of a power supply to be only 4.4% below its minimum guaranteed rating. The analysis also investigated the effects of this low power supply input voltage and determined that no equipment maloperation or significant operator misinterpretation (which might result from a downscale reading on an indicator) would occur.

It should be noted, however, that the aforementioned analysis represents a worst-case condition in that no credit is taken for the 250kVA voltage regulator which is installed between the 2400V transfer bus and the 2400V circuit breaker #1136. This regulator maintains its output at 1.00 per unit for input voltage variations between 0.95 and 1.05 per unit. This regulator is always maintained in service. The regulator is removed from service for only two to three days per year for maintenance. As can be seen in the referenced drawing, the regulator serves to regulate the voltage at the 2400 volt reactor feed pump bus regardless of whether the plant auxiliaries are being supplies by the main generator or by the system grid.

Although it may be unreasonable to expect that this regulator would maintain 1.00 per unit voltage at its output should its input drop below 0.95 per unit, it is reasonable to expect that this regulator would require its input voltage to substantially decrease below 0.95 per unit to result in a per unit voltage of 0.85 at MCC 1A as assumed in the foregoing analysis. A recently completed Consumers Power Company study has shown that the voltage on the 138kV system grid must drop to 0.8200 per unit before the plant's DGVPS undervoltage relays, set to trip at a 2400 volt reactor feed pump bus voltage of 0.890 per unit, would trip to separate the plant auxiliaries from the system and start the diesel generator.

Although analytical studies have not yet been conducted which would determine precisely what minimum station grid voltage could be expected, the Consumers Power Company expects that this voltage may never drop below 0.95 per unit (138kV base). This expectation is based on the fact that standard plant design specifies that the off-site supply maintain its voltage between 0.950 and 1.050 per unit. Consumers Power Company calculations show, however, that should the station grid voltage drop to 0.90 per unit, the resulting voltage at the 2400 volt reactor feed pump bus would be 0.970 per unit and the voltage at Bus 1A would be 0.9200 per unit with the regulator in service. As described in the response to Item 6, the voltage at the input to the analyzed power supplies is within the power supply ratings when the voltage on Bus 1A is 0.9200 per unit. It is unlikely that Bus 1A would experience a voltage of 0.8500 per unit or less during normal plant operating conditions or during an accident with standby power available.

ITEM 6

Per telecon of June 4, 1981, the previously provided minimum expected grid voltage may be lower than needed to assure conservatism. Provide new analysis and justification for the new grid voltage as appropriate (see also Item 5).

RESPONSE TO ITEM 6

As described in the response to Item 5, the minimum voltage expected at Bus 1A is 0.9200 per unit. This voltage is expected to be minimum for conditions other than a loss of off-site power or perhaps some large horsepower motor starts. According to the attached calculations, the resulting voltages at the input of the analyzed power supplies is within the rated input voltage ranges for the power supplies when the 1A bus voltage is 0.9200 per unit. The table below summarizes these voltages.

Power Supply	Power Supply Voltage Ratings	Bus 1A Voltage (pu)	Voltage Drop Bus 1A to Power Supply (pu)	Available Voltage at Power Supply (pu/Volts)
ES 8512A & ES 8512B	105-125V a-c	0.9200	0.0264	0.8936/107.2
ES 2108	107-127V a-c	0.9200	0.0200	0.9000/108.0
ES 3171	103.5-126.5V a-c	0.9200	0.0113	0.9087/109.0
ES 2165	106.2-129.8V a-c	0.9200	0.0116	0.9084/109.0
ES 2160 & ES 2162	103.5-126.5V a-c	0.9200	0.0152	0.9048/108.6
ES 2161 & ES 2163	103.5-126.5V a-c	0.9200	0.0086	0.9114/109.4

It should be noted, however, that the foregoing analysis is based on Consumers Power Company expectations of minimum voltage conditions. In an attempt to precisely determine the minimum and maximum expected plant voltages during various operational modes, the Consumers Power Company plans to conduct an analytical study which, unlike the most recently calculated Big Rock Point Plant base case, will include the voltage regulator as being in service. The Consumers Power Company expects to complete this study by the end of this year. The results of this study will be used to determine whether or not plant/system modifications will be required.

ITEM 7

Supply the maximum expected grid voltages for the 138kV and for the 46kV grids.

RESPONSE TO ITEM 7

According to plant logs, the maximum expected voltages for the 138kV and the 46kV grids are 1.036 per unit (143kV) and 0.972 (44.7kV), respectively.

SEE

APERTURE

CARDS

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CARDS

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Types FK and FK-339

Framework Mounted

STANDARD BREAKER PRICES INCLUDE:

Three-pole, single-throw breaker.
Supporting framework.
*Six bushings, (noncapacitance Type L for high-current Type FK-339 breakers, and Type LC for all FK breakers except 69 KV, Type U for 69 KV).
*Six bushing current transformers (*relay-type*).
BCT terminal board in mechanism house.
Float-type oil level gage.
Three separating chambers.
Fill pipe, 1".
Drain valves, 1".
Sampling device, ⅜".
Oil (G.E. 10-C).
Operating mechanism (pneumatic or solenoid, per catalog number).
¶ Removable maintenance closing device and special tools as required.
Heaters for mechanism and housing, 230-volt, a-c.
Compressor motor, single-phase, 230-volt, 60-cycle, a-c (for pneumatic mechanism).
Fused knife switches (for control power).
Closing relay.
Auxiliary switch, 10-stage.
Operation counter.
Cut-off switches.
Latch-checking switches on solenoid operated only.
External manual trip device.
Provision for travel recorder.
Position indicating target.
★Bolted-type terminal connectors for 1200-ampere breakers: (Furnished only when specified on order.)
Ground terminal, for 1/0 to 300 mcm cable.

* For prices of breakers equipped with **meter-type** bushing current transformers, or for more than six (6) of either type, refer to High Voltage Switchgear Dept., Marketing Section, Phila. Five-lead bushing [illegible] transformers shall be furnished unless otherwise specified.

¶ One maintenance closing device shall be furnished for each five breakers or fraction thereof, shipped to any one destination, unless otherwise requested.

AUTOMATIC RECLOSING EQUIPMENT

See Section 7043.

RATINGS

Interrupting Time Rating—5 and 8 Cycles§. Reclosing Time Rating—20 Cycles♦

Breaker Type	Ratings			60-cycle Interrupting Rating†			Short-time Rating Amperes		Withstand Test Kv	
	Kv	Maximum Design Kv	Amp. at 60 Cycles‡	Mva	Rms Total Amperes At Rated Voltage	Rms Total Amperes Max Rating	Momentary	4-sec.	60-cycle Dry	Impulse
FK-14.4-1000	14.4	15.5	1200	1000	40000	48000	77000	48000	50	110
FK-339-14.4-1500	14.4	15.5	★3000	1500	60000	72000	115000	72000	50	110
FK-339-14.4-1500	14.4	15.5	4000							
FK-23-500	23	25.8	1200	500	12600	24000	38000	24000	60	150
FK-34.5-500	34.5	38	★1200	500	8400	12600	20000	12600	80	200
FK-34.5-1000	34.5	38	1200	1000	17000	25000	40000	25000	80	200
FK-34.5-1500	34.5	38	1200	1500	25000	38000	61000	38000	40	200
FK-339-34.5-2500	34.5	38	2000	2500	42000	60000	96000	60000	80	200
FK-46-500	46	48.3	★1200	500	6300	7200	12000	7200	105	250
FK-46-1500	46	48.3	1200	1500	19000	22000	35000	22000	105	250
FK-69-1000	69	72.5	★1200	1000	8400	9600	16000	9600	160	350
FK-69-1500	69	72.5	1200	1500	12600	14500	23000	14500	160	350
FK-69-2500	69	72.5	1200	2500	21000	24000	38000	24000	160	250

† For explanation, see Section 6615.
‡ For 25 cycles, see Section 6615.
♦ This rating applies only to pneumatically operated breakers rated 1200 amperes. Solenoid-operated breakers have a 45-cycle reclosing time. For reclosing time of breakers rated in excess of 1200 amp, refer to High Voltage Switchgear Dept., Marketing Section, Philadelphia.
§ 69-kv breakers are rated 5 cycles; all others are rated 8 cycles.

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CARDS

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GENERAL ELECTRIC

ELECTRIC UTILITY

SALES

DIVISION

GENERAL ELECTRIC COMPANY . . . ROOM 1510, 300 MADISON AVENUE
TOLEDO, OHIO 43604, Phone (419) XXXXXXX
241-5125

January 6, 1977

Bechtel Power Corporation
P.O. Box 1000
777 E. Eisenhower Pkwy.
Ann Arbor, Michigan 48104

Attention: Mr. ~~John~~ Chandan Dutta

Subject: Consumers Power Company
<u>Big Rock Nuclear Plant</u>

Dear Mr. Dutta:

You recently called requesting technical information on the motor control center equipment furnished by the General Electric Company for the subject plant. Specifically, you requested pick-up and drop out voltages for the motor starter coils.

The industry design standard for pick-up voltage is 85% of the nominal coil voltage rating. There is no industry standard as it relates to drop out voltage. There are a number of variables but we would expect our standard design units to drop out at some voltage below 65% of rated voltage.

Very truly yours,

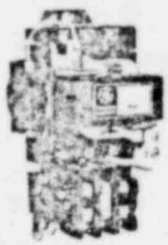
Paul V. Martin

Paul V. Martin
Sales Engineer

PVM:blm

FULL VOLTAGE NON-REVERSING MAGNETIC MOTOR STARTERS

200 Hp Max. NEMA Sizes 00-5 600 Volts Max. 60 Hertz Max.



Typical CR206 magnetic motor starter, open-type

Typical CR206 magnetic motor starter in enclosure with cover

ERING DIRECTIONS

pecify starter by complete CR num-er. Add coil suffix number in place f double asterisk as selected from oil suffix table on this page.

xample: CR206C102 is a size 1 starter ith 115 volt 60 Hz coil and in Type 1 eneral Purpose enclosure.

he final letter of the three-letter suf-x in CR number denotes extra auxili-ry contacts (sometimes referred to s auxiliary interlocks). Order the de-red extra auxiliary contacts by re-acing the final letter from first col-mn of auxiliary interlock table (see age 59).

ample: CR206C102AAB is size 1 starter ith one extra auxiliary contact, ormally open.

3. For continuous rated motors with a service factor of 1.15 to 1.25 select the heater with maximum motor amps equal to or immediately greater than the actual full load current taken directly from the nameplate of motor. Order heater by complete CR number from appropriate heater table on page 57 for 200-Line devices.
4. Order special features or forms not listed by complete description using a listed form as reference.

   Example: Similar to CR206C1** except with 460/115 volt control power transformer and red indicating light in cover.
5. Two-phase, four-wire forms are available. Contact your nearest GE Sales Office for pricing and ordering information.

SUFFIX

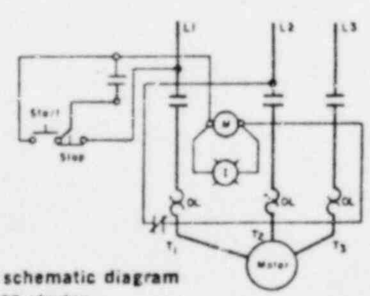
ates voltage and frequency of operating coils

ect catalog suffix number in accordance with line voltage using table below. (Do pply to forms with a control transformer.)

l Suffix Table (use where double asterisk appears in nomenclature.)

Frequency (Hertz)	115V	200/208V	230V	460V	575V	600V
60	02	23	03	04	05	06
Frequency (Hertz)	**110V**	**220V**	**380V**	**440V**	**550V**	**600V**
50	07	08	04	09	10	11

for dual-rated 120V, 60 Hz/110V, 50 Hz coil



Typical schematic diagram for CR206 starter

APPLICATION

General Electric's 200-Line of magnetic motor starters may be used for starting full voltage, non-reversing, single speed ac motors up to 200 horsepower, 600 volts maximum, providing protection to the motor against running or stalled overloads.

Their compact size and ease of wiring make them especially suitable for motor control centers, custom-type control panels, and switchgear equipment.

FEATURES

- New block-type overload relay gives greater application flexibility and meets NEC requirements for three-phase protection.
- Contactor and block-type overload relay mount on integral baseplate.
- Improved auxiliary contacts carry heavy pilot-duty ratings.
- Manual contact operation check is built into overload relay.
- Attractive, new split-case type enclosure has electrocoated, two-tone finish.
- Shrouded reset in cover.

ENCLOSURE ACCESSORY

Plastic insert cards for use in identification panel of NEMA Type 1 enclosure cover. CR number represents one package of 100 insert cards. Order by number of packages.

CR205X147A. . . . .
$20.00/pkg. of 100, GO-10G

REFERENCE:
GEA-8923

FULL VOLTAGE NON-REVERSING MAGNETIC MOTOR STARTERS

200 Hp Max. NEMA Sizes 00-5 600 Volts Max. 60 Hertz Max.

PRICING INFORMATION

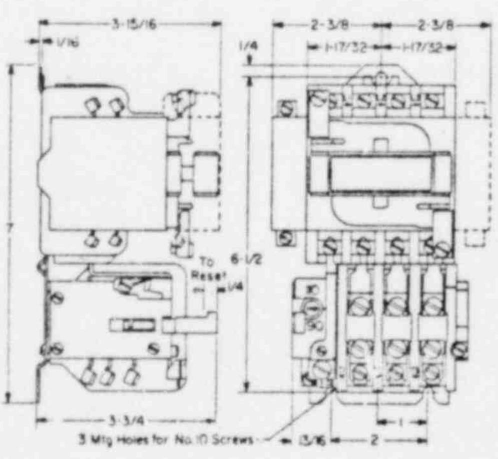
List price includes holding interlock but does not include overload heaters. Heaters should be specified and ordered as a separate item at **$3.00 ea. GO-10G.** Order one heater for 2-pole starters, and three heaters for 3-pole starters. Three pole, 200-Line starters, Sizes 00-5 provide 3-leg overload protection by installing the selected three heaters. Three pole, 100-Line starters, listed in table (Type 4 enclosed), are two overload forms; refer to note on page 58 for information on 3-leg protection.

For factory installed modifications refer to page 55

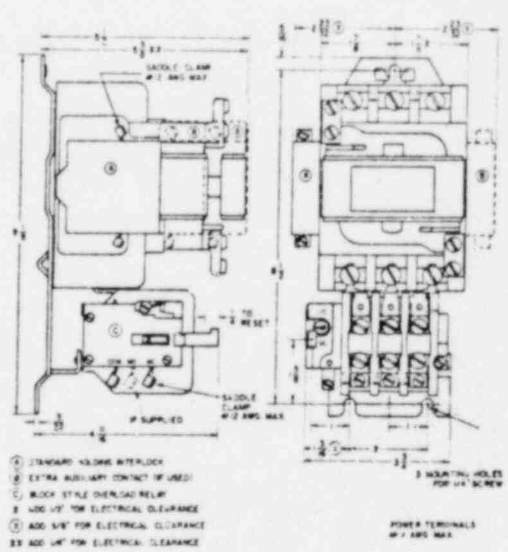
SINGLE-PHASE, 2-POLE (Price does not include heater)														
00	½	....	1	...	H0**	$54	H1**	$58	....	.....	....	....	....	....
0	1	....	2	...	J0**	61	J1**	65	J4**	$135	J4**BKA	$135	J2**	$89
1	2	....	3	...	K0**	71	K1**	75	K4**	147	K4**BSA	147	K2**	99
1P	3	....	5	...	K0**BMA	93	K1**BKA	97	K4**BKA	169	....	....	K2**BKA	121
2	3	....	7½	...	L0**	129	L1**	149	L4**	293	....	....	L2**	193
THREE-PHASE, 3-POLE (Price does not include heaters)														
00	...	1½	1½	2	A0**	$54	A1**	$58	— USE NEMA SIZE O —				....	....
0	...	3	3	5	B0**	68	B1**	72△	B4**	$142	B4**BJA	$142	B2**	$96
1	...	7½	7½	10	C0**	78	C1**	82△	C4**	154	C4**CBA	154	C2**	106
2	...	10	15	25	D0**	142	D1**	162	D4**	306	D4**ASA	306	D2**	206
3	...	25	30	50	E0**	230	E1**	270	E4**	474	E4**BAA	474	E2**	322
4	...	40	50	100	F0**	526	F1**	610	F4**	958	F4**BAA	958	F2**	782
5‡	...	75	100	200	G0**	1285	G1**	1439	G4**	1802	G4**BAA	1802	G2**	1879

† Motor full-load current should not exceed ampere rating of enclosed contactor listed by NEMA size on page 20.
**See coil suffix table, page 24.
‡ Size 5 nomenclature shown applies to 60 or 50 hertz forms only.
§ External reset not included on standard listed forms.
¶ Refer to page 62 for 380 volt 50 hertz ratings.
△Units with 230V 60 Hz coil are individually boxed and "Poly-Packed" six per carton as standard.

DIMENSIONS (For estimating only)



CR206 NEMA Sizes 00-1 open type, Shipping wt, 3¾ lbs.



CR206 NEMA Size 2, Open type Shipping wt, 8 lbs.

REPLACEMENT DEVICES — MAGNETIC CONTACTORS, STARTERS AND CONTROLLERS

List Price, GO-10G includes holding interlock, but does not include overload heaters. Heaters for the starters and controllers listed in tables may be ordered at **$3.00 each GO-10G.** Order one heater for single-phase starters, two for polyphase starters and four heaters for multi-speed controllers. See listings of factory and/or field installed modifications listed on pages 55 and 60.

GENERAL PURPOSE MAGNETIC CONTACTORS—CR105 FORMS

A0**	$ 46	A1**	$ 52	....	.....
B0**	58	B1**	64	B2**	$ 89
C0**	68	C1**	74	C2**	99
D0**	124	D1**	149	D2**	194
E0**	200	E1**	249	E2**	302
F0**	480	F1**	283	F2**	760
G0**	1046	G1**	1246	G2**	1694
J0**	52	J1**	58	J2**	83
J0**ADA	46	J1**ADA	52	....	.....
K0**	62	K1**	68	K2**	93
K0**ADA	56	K1**ADA	62	....	.....
L0**	116	L1**	141	L2**	186
M0**	184	M1**	233	M2**	286
N0**	444	N1**	549	N2**	724
P0**	962	P1**	1162	P2**	1610
R0**AEA	74	R1**AEA	80	R2**AEA	105
R0**AEB	96	....	.....	....	.....
S0**AEA	84	S1**AEA	90	S2**AEA	115
S0**AEB	106	....	.....	....	.....
T0**	160	T1**	185	T2**	230
T0**AEA	240	....	.....	....	.....
U0**	256	U1**	305	U2**	358
U0**AEA	384	....	.....	....	.....
W0**	668	W1**	773	W2**	1008
W0**AEA	924	....	.....	....	.....
Z0**	1922	Z1**	2276	Z2**	2768
Z0**AEA	2614	....	.....	....	.....

FULL VOLTAGE NON-REVERSING MAGNETIC STARTERS—CR106 FORMS

A0**	$ 54	A1**	$ 60	....	.....
B0**	68	B1**	74	B2**	$ 99
C0**	78	C1**	84	C2**	109
D0**	142	D1**	167	D2**	212
E0**	230	E1**	279	E2**	332
F0**	526	F1**	631	F2**	806
G0**	1208	G1**	1408	G2**	1856
H0**	54	H1**	60	....	.....
J0**	61	J1**	67	J2**	92
K0**	71	K1**	77	K2**	102
K0**BMA	93	K1**BKA	99	K2**BKA	124
L0**	129	L1**	154	L2**	199

FULL VOLTAGE NON-REVERSING COMBINATION MAGNETIC STARTERS—CR107 FORMS

....	.....	B1**AAA	$ 201	B2**AAA	$ 250
....	.....	B1**BAA	201	B2**AWA	250
....	.....	B1**FAA	259	B2**BAA	250
....	.....	B1**GAA	259	B2**BWA	250
....	.....	C1**DAA	211	B2**FAA	307
....	.....	C1**EAA	211	B2**FWA	307
....	.....	C1**GAA	269	B2**GAA	307
....	.....	C1**HAA	269	B2**GWA	307
....	.....	C1**JAA	269	C2**DAA	260
....	.....	D1**EAA	324	C2**DYA1	260
....	.....	D1**GAA	414	C2**EAA	260
....	.....	D1**LAA	382	C2**EYA1	260
....	.....	D1**MAA	382	C2**GAA	318
....	.....	D1**NAA	414	C2**GYA1	318
....	.....	E1**BDA	768	C2**HAA	318
....	.....	E1**CAA	558	C2**HYA1	318
....	.....	E1**EAA	558	C2**JAA	318
....	.....	E1**FAA	558	C2**JYA1	318
....	.....	F1**BAA	1228	D2**EAA	396
....	.....	F1**CAA	1228	D2**EMA	396
....	.....	F1**EAA	1228	D2**GAA	486
....	.....	G1**AAA	2767	D2**GMA	486
....	.....	G1**BAA	2767	D2**LAA	454
....	.....	G1**CAA	2767	D2**LMA	454

FULL VOLTAGE NON-REVERSING COMBINATION MAGNETIC STARTERS—CR107 FORMS—Continued

....	.....	....	.....	D2**MAA	$454
....	.....	....	.....	D2**MMA	454
....	.....	....	.....	D2**NAA	486
....	.....	....	.....	D2**NMA	486
....	.....	....	.....	E2**CAA	652
....	.....	....	.....	E2**CJA	652
....	.....	....	.....	E2**BDA	862
....	.....	....	.....	E2**EAA	652
....	.....	....	.....	E2**EJA	652
....	.....	....	.....	E2**FAA	652
....	.....	....	.....	E2**FJA	652
....	.....	....	.....	F2**BAA	1483
....	.....	....	.....	F2**BYA17	1483
....	.....	....	.....	F2**CAA	1483
....	.....	....	.....	F2**CYA17	1483
....	.....	....	.....	F2**EAA	1483
....	.....	....	.....	F2**EYA17	1483
....	.....	....	.....	G2**AAA	3236
....	.....	....	.....	G2**AEA	3236
....	.....	....	.....	G2**BAA	3236
....	.....	....	.....	G2**BEA	3236
....	.....	....	.....	G2**CAA	3236
....	.....	....	.....	G2**CEA	3236

FULL VOLTAGE NON-REVERSING COMBINATION MAGNETIC STARTERS—CR108 FORMS

....	.....	B1**AAA	$ 187	B2**AAA	$ 236
....	.....	B1**BAA	193	B2**AEA	236
....	.....	B1**DAA	197	B2**BAA	242
....	.....	C1**AAA	207	B2**BEA	242
....	.....	C1**BAA	203	B2**DAA	246
....	.....	C1**CAA	207	B2**DEA	246
....	.....	C1**DAA	207	C2**AAA	246
....	.....	C1**EAA	211	C2**AMA	246
....	.....	D1**AAA	312	C2**BAA	252
....	.....	D1**BAA	320	C2**BMA	252
....	.....	D1**CAA	344	C2**CAA	256
....	.....	D1**DAA	368	C2**CMA	256
....	.....	D1**EAA	326	C2**DAA	256
....	.....	D1**FAA	348	C2**DMA	256
....	.....	E1**AAA	520	C2**EAA	260
....	.....	E1**CAA	584	C2**EMA	260
....	.....	E1**DAA	676	D2**AAA	384
....	.....	E1**EAA	550	D2**AHA	384
....	.....	E1**FAA	592	D2**BAA	392
....	.....	F1**AAA	1010	D2**BHA	392
....	.....	F1**CAA	1142	D2**CAA	416
....	.....	F1**DAA	1052	D2**CHA	416
....	.....	F1**EAA	1158	D2**DAA	440
....	.....	G1**AAA	2189	D2**DHA	440
....	.....	G1**CAA	2459	D2**EAA	398
....	.....	G1**FAA	2261	D2**EHA	398
....	.....	G1**GAA	2543	D2**FAA	420
....	.....	....	.....	D2**FHA	420
....	.....	....	.....	E2**AAA	614
....	.....	....	.....	E2**AMA	614
....	.....	....	.....	E2**CAA	678
....	.....	....	.....	E2**CMA	678
....	.....	....	.....	E2**DAA	770
....	.....	....	.....	E2**DMA	770
....	.....	....	.....	E2**EAA	644
....	.....	....	.....	E2**EMA	644
....	.....	....	.....	E2**FAA	686
....	.....	....	.....	E2**FMA	686
....	.....	....	.....	F2**AAA	1265
....	.....	....	.....	F2**ALA	1265

To MRWade, P-24-406

KEY

From KEYeager, P-26-200

Date March 9, 1981

Subject RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION ON ADEQUACY OF STATION ELECTRIC DISTRIBUTION VOLTAGES - BIG ROCK

Consumers Power Company

Internal Correspondence

CC

References

A. CP Co letter, K E Yeager to M R Wade, "Big Rock Point Plant - Voltage Studies for Undervoltage Protection Modification," March 13, 1980.

B. CP Co letter, K E Yeager to M R Wade, "Response to NRC Request - Verification of Analytical Models for Nuclear Power Plants - Big Rock," July 7, 1980.

C. NRC letter, D M Crutchfield to D P Hoffman, "Request for Additional Information on Adequacy of Station Electric Distribution System Voltages," January 27, 1981.

The following items are in response to the recent NRC requests (Reference C) for additional information on the adequacy of station distribution voltages - Big Rock Point Plant.

Item 1: Provide in percent of maximum bus loading, the loading of the buses as measured in your test verification.

Table A summarizes the actual running bus loads and total connected bus loads based on the ampere and watt feeder readings taken during the verification test (Reference B).

Item 2: Are the voltages supplied in your response derived from the same computer simulation (P1161) that your testing verified? If they are not, provide a steady-state voltage analysis that has been verified by test. In either case, describe the loads for the analyzed conditions.

The first analysis and response (Reference A) concerning the adequacy of station electric distribution voltages were performed with the same P1161 computer program as the test verification. However, additional feeder readings obtained during the verification test (Reference B) provided information for a new P1161 load flow base case simulating peak plant operations. A transcription of the base case is provided in Figure 1. The remaining steady-state voltage analyses with the new base case are provided in Items 3 and 4.

Item 3: Are the analyzed cases for MCC 2A feeding Class 1E MCC 2B worse than MCC 1A feeding MCC 2B? If not, provide the required analyses for the alternate (MCC 1A) feed.

The alternative MCC 1A feed will result in slightly higher voltage drops than the MCC 2A feed due to the additional 16 feet of 3-1/C 350 MCM cable from MCC 1A to MCC 2B and the additional 6 feet of 3-1/C 350 MCM cable from LC #1 to MCC 1A. The loading on LC #1 is also slightly higher (approximately 12%; see transcription of base case) than the loading on LC #2 which will also result in higher voltage drops. The motor starting cases reflecting these additional voltage drops were rerun with the new base case described in Item 2 and are summarized in Table B. (These voltages assume both reactor feed pumps and recirculating water pumps are off when fed from the 46 kV supply. Previous cases did not include this load reduction. Therefore the voltages are higher than those provided in Reference A.)

Item 4: Your response provides two analyses, one for starting a reactor feed pump with the 138 kV source, the other for starting a fire pump with the 46 kV source. Is each the worst case for that source? If not, supply the worst case analysis for the source. Identify the duration of these transient conditions.

Starting a 1500 HP reactor feed pump off the 138 kV supply is the worst case for that source. Prestart and instantaneous starting bus voltages calculated with the new P1161 base case as described in Item 2 are summarized in Table C. The analytical transient analyses cannot be performed until the additional motor and pump inertia data and pump speed torque curve are received from GE. Once this data is received, the motor acceleration calculations and the review of the 10-second delay setting on the undervoltage relay can be completed within two to three days.

Starting the 100 HP fire pump and the emergency motor operated valves on MCC 2B is the worst case for that bus for the Class 1E equipment but is not the worst case for the off-site 46 kV supply. Transfer to the off-site 46 kV supply due to low station power voltages may require the simultaneously starting of two 440 V 200 HP condensate pumps. This results in the worst case motor starting conditions for the 46 kV off-site supply. Prestart and instantaneous starting bus voltages are provided in Table D. A transient analysis does not appear warranted at this time, however, since the 2400 V bus voltage does not drop below .89 PU (the second level undervoltage relay drop-out voltage) and will not initiate the 10-second delay timer.

Item 5: It is not clear from Figure 1 (Big Rock single-line diagram provided by Power Resources and System Planning) whether Transformer No 77 is a possible source of power to the 2400 V switchgear bus or a load on that bus. If this is a possible power source, provide the required analyses. If this is not a source, are the effects of this connection reflected in your analyses for the 46 kV source?

Figure 1 was provided for the identification of the buses described in the load flow cases and was not intended to be used as a registered electrical drawing of the Big Rock Point Plant. The No 77 transformer was not included in the analyses for the 46 kV source provided in Reference A, since the 50 kVA transformer and associated load will have an insignificant effect on the studies. However, the voltage analyses on the 46 kV supply provided in this response includes the 50 kVA transformer at an assumed static loading of 25 kVA (50% diversity). All future studies will also include this load.

If you have any questions or need further studies, please let me know.

fz

Summary of Bus Loads

Bus	Actual Running Bus Load (KVA)	Total Connected Load (KVA)	% Actual / Total Connec
* 2400 V Bus	2988	3275	91.24
* LC #1	328	363	90.36
MCC 1A	56	355	15.78
MCC 1C	60	151	39.74
MCC 1F	0	0	0
MCC 1D	100	157	63.69
MCC 1E	0	199	0
MCC 1P	40	251	15.94
* LC #2	320	363	88.15
* MCC 2A	87	419	20.76
* MCC 2B	9	144	6.25
MCC 2C	60	69	86.96
MCC 2D	40	103	38.83
MCC 2E	0	243	0
MCC 2F	0	0	0
MCC 2P	23	202	11.39

*(Based on actual measurements taken during verification test (Ref B) - all other loads based on assumed diversity calculations & discussion with plant personnel)

KEY 3/4

Fire Pump + Emergency MOV Startups

Summary of Bus Voltages

Case	2400V Bus (2.4 KV)	LC#1 (480V)	LC#2 (480V)	Bus 1A (480V)	Bus 2B (480V)	Fire Pump (480V)	MOV 7071 (480V)	MOV 7070 (480V)	MOV 7069 (480V)	MOV 7[illegible] (480[illegible]
Generator @ 1.0 PU Prestart	.9941	.9459	.9516	.9449	.9448	.9448	.9448	.9448	.9448	.944[illegible]
Generator @ 1.0 PU Startup	.9863	.8622	.9434	.8557	.8494	.7975	.8475	.8475	.8475	.849[illegible]
Generator @ .95 PU Prestart	.9411	.8894	.8956	.8883	.8882	.8882	.8882	.8882	.8882	.888[illegible]
Generator @ .95 PU Startup	.9336	.8098	.8877	.8035	.7976	.7489	.7958	.7958	.7958	.797[illegible]
46 KV Swing Bus @ .972 PU, Prestart	.9981	.9501	.9558	.9491	.9490	.9490	.9490	.9490	.9490	.94[illegible]
46 KV Swing Bus @ .972 PU, Startup	.9832	.8591	.9401	.8526	.8464	.7947	.8444	.8444	.8444	.84[illegible]
46 KV Swing Bus @ .95 PU, Prestart	.9743	.9248	.9307	.9238	.9237	.9237	.9237	.9237	.9237	.92[illegible]
46 KV Swing Bus @ .95 PU, Startup	.9597	.8358	.9154	.8294	.8233	.7730	.8215	.8215	.8215	.8[illegible]

KEY 3/6/81

Reactor Feed Pump Startups

Summary of Bus Voltages

Case	Gen Term (13.5 KV)	2400V Bus (2.4 KV)	RFP #1 (2.4 KV)	RFP #2 (2.4 KV)	LC #1 (480V)	LC #2 (480V)	Bus 1A-2B (480V)	Bus 2A (480V)
Generator Down, 138 KV Swing Bus @ 1.036 PU, Prestart of First Reactor Feed Pump	.9829	.9920	.9920	.9920	.9437	.9494	.9427	.9486
Generator Down, 138 KV Swing Bus @ 1.036 PU, Starting First Reactor Feed Pump	.9597	.8709	.8661	.8709	.8138	.8208	.8126	.8198
Generator Down, 138 KV Swing Bus @ 1.00 PU, Prestart of First Reactor Feed Pump	.9485	.9562	.9562	.9562	.9056	.9117	.9045	.9108
Generator Down, 138 KV Swing Bus ~ 1.00 PU, Starting First Reactor Feed Pump	.9261	.8392	.8345	.8392	.7791	.7865	.7778	.7855
Generator Down, 138 KV Swing Bus @ .95 PU, Prestart of First Reactor Feed Pump	.9007	.9063	.9063	.9063	.8521	.8587	.8510	.8578
Generator Down, 138 KV Swing Bus @ .95 PU, Starting First First Reactor Feed Pump	.8793	.7949	.7905	.7949	.7300	.7382	.7287	.7372
Gen. @ 1.0 PU, Prestart of 2nd Reactor Feed Pump	1.00	1.0021	1.0015	1.0021	.9544	.9600	.9533	.9592
Gen @ 1.0 PU, Starting 2nd Reactor	1.00	.9008	.9001	.8862	.8462	.8528	.8450	.8519

Condensate Pump Startups*

Summary of Bus Voltages

Case	2400 V Bus (2.4 KV)	LC #1 (480 V)	LC #2 (480 V)	Cond #1 (480 V)	Cond #2 (480 V)	Bus 1A - 2B (480 V)	Bus 2A (480 V)	Bus 1F (480 V)
46 KV Swing Bus @ .972 Prestart	1.0053	.9699	.9783	.9699	.97[illegible]3	.9689	.9775	.9683
46 KV Swing Bus @ .972 Starting Both Cond Pumps	.9625	.8144	.8237	.7723	.7826	.8132	.8228	.8125
46 KV Swing Bus @ .95 Prestart	.9817	.9454	.9540	.9454	.9540	.9443	.9532	.9437
46 KV Swing Bus @ .95 Starting Both Cond Pumps	.9399	.7932	.8028	.7522	.7628	.7920	.8019	.7912

* {Assumes Simultaneous Starting of Both 440V 200HP Condensate Pumps - Transfer to Offsite Power Source Due to Undervoltage Relay Operation + Load Shed.}

KEY 3/6/81

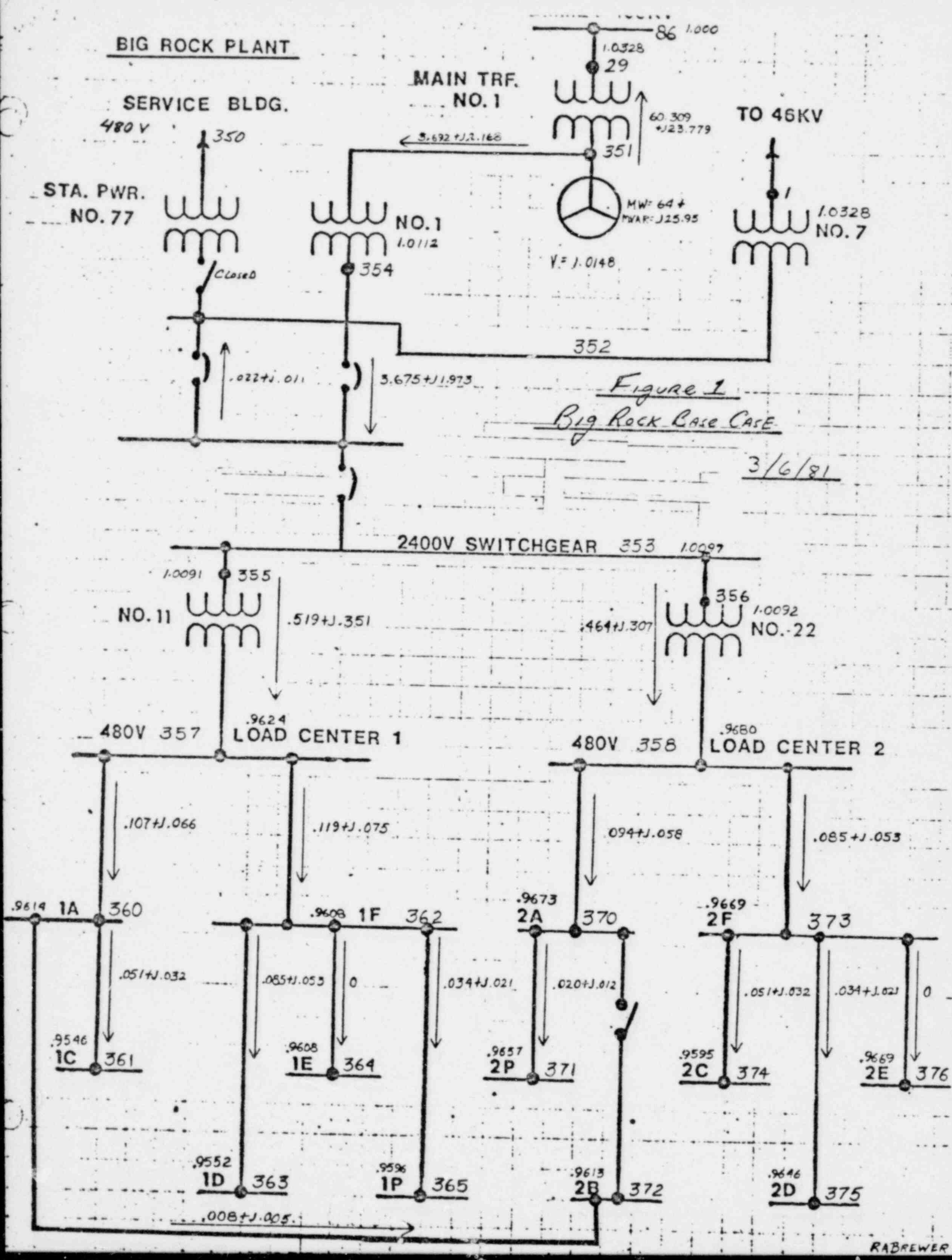


Figure 1
Big Rock Base Case
3/6/81

SEE

APERTURE

CARDS

APERTURE CARD NO# 8109020251

AVAILABILITY ✓ PDR ______ CF ______ HOLD ______

NUMBERS OF PAGES. 1 page

Form 2953

TONR 53-81

EA - AIR-A-NA-81-126
Sheet 1 of 14

CONSUMERS POWER COMPANY
Nuclear Plant
ENGINEERING ANALYSIS WORKSHEET

Title: RESPONSE TO AIR-A-NA-81-126 "ADEQUACY OF STATION ELECTRIC DISTRIBUTION SYSTEM VOLTAGES AND DEGRADED GRID PROTECTION - BIG ROCK POINT PLANT

Performed by: KA Toner Date: 8/17/81

References: SEE SHEETS 12, 13 + 14

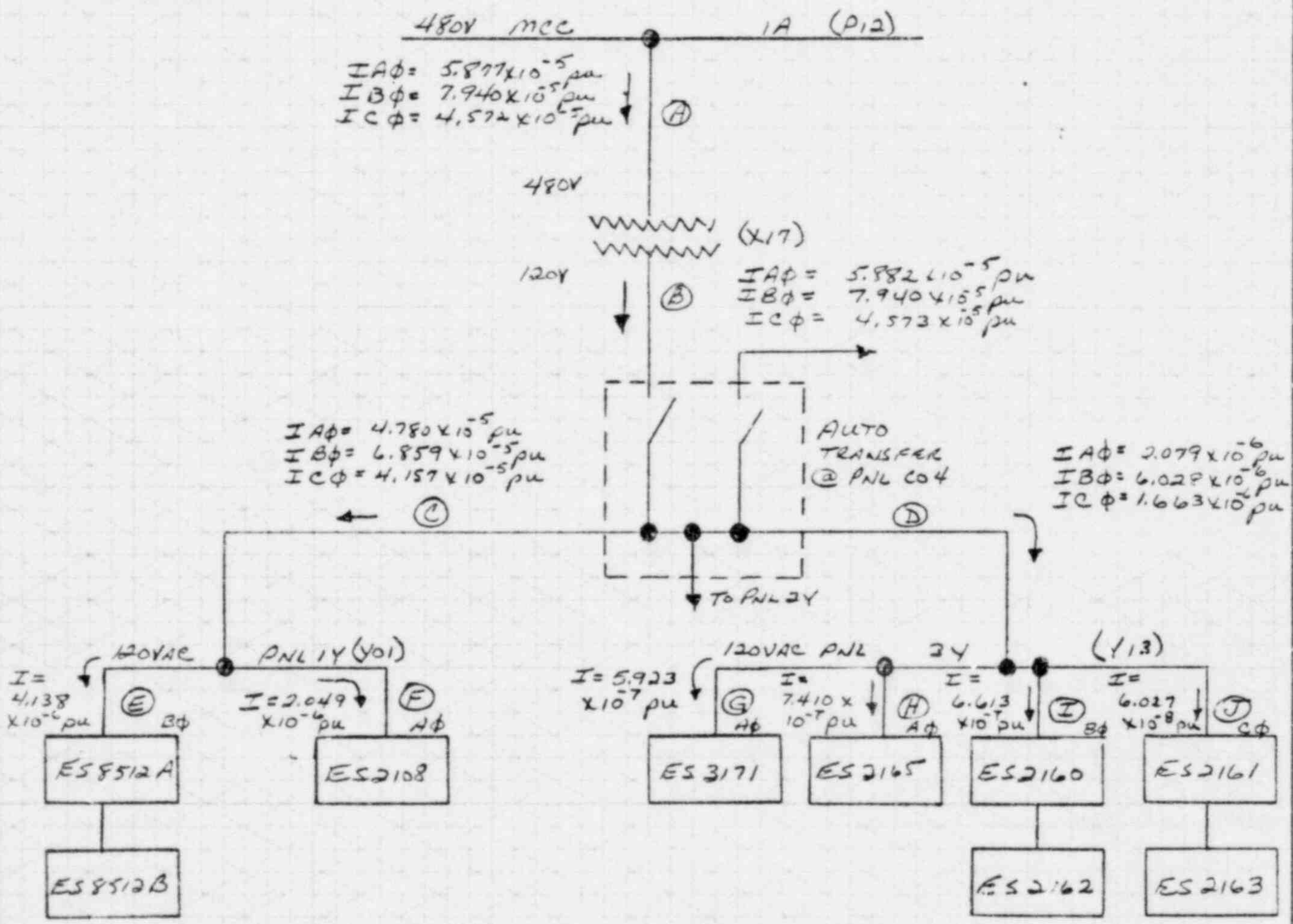
Review Method by: Alternate Calcs [ ] Detailed Review [✓] Qualification Test [ ]

MRWade 8/17/81
Review by: Date

CALCULATIONS TO DETERMINE:

1) VOLTAGE DROPS FROM BUS 1A TO THE INSTRUMENT POWER SUPPLIES
2) VOLTAGE AVAILABLE AT POWER SUPPLIES CONSIDERING THE VOLTAGE DROPS DETERMINED IN 1.) ABOVE AND A BUS 1A VOLTAGE OF 0.9200 PER UNIT.

DIAGRAM:



Form 2953

EA - AIR-A-NA-81-126
Sheet 2 of 14

CONSUMERS POWER COMPANY
Nuclear Plant
ENGINEERING ANALYSIS WORKSHEET

Title: RESPONSE TO AIR-A-NA-81-126

Performed by: KA Lower   Date: 8/17/81

References: SEE SHEETS 12, 13 + 14

Review Method by: Alternate Calcs ☐ Detailed Review ☑ Qualification Test ☐

MRWade   8/17/81
Review by: Date

1) LINE SEGMENT (REFER TO DRAWING) CURRENTS:

1a) DIVERSITY FACTOR (DF), USED TO APPROXIMATE ACTUAL POWER SUPPLY INPUT AMPS

$$DF = \frac{\text{ACTUAL MEASURED AMPS ON PHASE FEEDER (SEE REF. \#5)}}{\text{TOTAL CONNECTED AMPS ON PHASE FEEDER (SEE REF. \#6)}}$$

DF PNL 1Y (Y01):

- DWG 0740A30009 SH21 GIVES ϕ VA OF: 10502 VA FOR Aϕ, 4305 VA FOR Bϕ, 3982 VA FOR Cϕ

∴ ϕ TOTAL CONNECTED AMPS IS:

$A\phi$ = 10502VA/120V = 87.5A

$B\phi$ = 4305VA/120V = 35.9A

$C\phi$ = 3982VA/120V = 33.2A

- REFERENCE #5 DATA SHEETS GIVE MEASURED READINGS:

$A\phi$ = 23 A

$B\phi$ = 33 A

$C\phi$ = 20 A

∴ DF $A\phi$ = 23/87.5 = 0.263

DF $B\phi$ = 33/35.9 = 0.919

DF $C\phi$ = 20/33.2 = 0.602

DF PNL 3Y (Y13):

- DWG 0740A30009 SH29 GIVES ϕ VA OF: 140 VA FOR Aϕ, 730 VA FOR Bϕ, 2180 VA FOR Cϕ

∴ ϕ TOTAL CONNECTED AMPS IS:

$A\phi$ = 140VA/120V = 1.17A

$B\phi$ = 730VA/120V = 6.08A

$C\phi$ = 2180VA/120V = 18.2A

Form 2953

EA - AIR-A-NA-81-126
Sheet 3 of 14

CONSUMERS POWER COMPANY
Nuclear Plant
ENGINEERING ANALYSIS WORKSHEET

Title: RESPONSE TO AIR-A-NA-81-126

Performed by: KA Toner Date: 8/17/81

References:
SEE SHEETS 12,13+14

Review Method by: Alternate Calcs ☐
Detailed Review ☑
Qualification Test ☐

Review by: MRWolfe Date 8/17/81

- REFERENCE #5 DATA SHEETS GIVE MEASURED READINGS:

$A\phi = 1A$

$B\phi = 2.9A$

$C\phi = 0.8A$

$\therefore$ DF $A\phi = 1A/1.17A = 0.855$

DF $B\phi = 2.9A/6.08A = 0.477$

DF $C\phi = 0.8/18.2A = 0.044$

1b.) SEGMENT Ⓔ ($B\phi$)

VA (ES8512A + ES8512B) = 260VA = TOTAL CONNECTED LOAD

Ⓔ TOTAL CONNECTED CURRENT = 260VA/120V = 2.167 A

Ⓔ ACTUAL CURRENT = (TOTAL CONNECTED CURRENT) DF $B\phi$

= (2.167A)(0.919) = 1.991 A

Ⓔ ACTUAL CURRENT PER UNIT = ACTUAL CURRENT / 120V BASE CURRENT
(AS SUPPLIED BY WP WALLEBY, SYSTEMS PROTECTION, 8/14/81)

$= 1.991A/481140 = 4.138 \times 10^{-6}$ pu ✓

1c.) SEGMENT Ⓕ ($A\phi$)

VA (ES2108) = 450VA

Ⓕ TOTAL CONNECTED CURRENT (TCC) = 450VA/120V = 3.75A

Ⓕ ACTUAL CURRENT (AC) = (") (DF $A\phi$) = (3.75A)(0.263) = 0.986 A

Ⓕ AC pu = .986/481,140 = 2.049×10^{-6} pu ✓

1d) SEGMENT Ⓖ ($A\phi$)

VA (ES 2171) = 40VA

Ⓖ TCC = 40VA/120V = 0.333 A

Ⓖ AC = (TCC)(DF $A\phi$) = 0.33A(0.855) = 0.285A

Ⓖ AC pu = .285/481140 = 5.923×10^{-7} pu ✓

CONSUMERS POWER COMPANY
Nuclear Plant
ENGINEERING ANALYSIS WORKSHEET

Title: RESPONSE TO AIR-A-NA-81-126

Performed by: Ka Toner Date: 8/17/81

References:
SEE SHEETS 12, 13 + 14

Review Method by: Alternate Calcs [ ]
Detailed Review [✓]
Qualification Test [ ]

Review by: MRWade Date 8/17/81

1e) SEGMENT (H) (Aϕ)

VA (ES 2165) = 50VA

(H) TCC = 50VA/120V = 0.417A.

(H) AC = (TCC) (DF Aϕ) = (0.417A) (0.855) = 0.356A

(H) AC pu = .356/481140 = 7.410×10^{-7} pu ✓

1f) SEGMENT (I) (Bϕ)

VA (ES 2160 + ES 2162) = 80VA

(I) TCC = 80VA/120V = 0.667A

(I) AC = (TCC)(DF Bϕ) = (0.667)(0.477) = 0.318 A

(I) AC pu = .318/481140 = 6.613×10^{-7} pu
6.609

1g) SEGMENT (J) (Cϕ)

VA (ES 2161 + ES 2163) = 80VA

(J) TCC = 80VA/120V = 0.667 A

(J) AC = (TCC) (DF Cϕ) = (0.667A) (0.044) = 0.029 A

(J) AC pu = .029/481140 = 6.027×10^{-8} ✓

1h) SEGMENT (C) - FROM PLANT READINGS (SEE REF # 5), THE ACTUAL CURRENT ALONG LINK SEGMENT (C) IS:

Aϕ = 23A

Bϕ = 33A

Cϕ = 20A

IN PER UNIT, THESE CURRENTS ARE:

Aϕ pu = 23/481140 = 4.780×10^{-5} pu ✓

Bϕ pu = 33/481140 = 6.859×10^{-5} pu ✓

Cϕ pu = 20/481140 = 4.157×10^{-5} pu ✓

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EA - AIR-A-NA-81-126
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CONSUMERS POWER COMPANY
Nuclear Plant
ENGINEERING ANALYSIS WORKSHEET

Title: RESPONSE TO AIR-A-NA-81-126

Performed by: [signature] Date: 8/17/81

References: SEE SHEETS 12, 13 + 14

Review Method by: Alternate Calcs ☐ Detailed Review ☑ Qualification Test ☐

Review by: [signature] Date 8/17/81

1i) SEGMENT (D) - FROM PLANT READINGS (SEE REF #5), THE ACTUAL CURRENT ALONG LINK SEGMENT (D) IS:

$A\phi - 1.0A$

$B\phi = 2.9A$

$C\phi = 0.8A$

IN PER UNIT, THESE CURRENTS ARE:

$A\phi\ pu = 1.0/481104 = 2.079\times10^{-6}$ pu ✓

$B\phi\ pu = 2.9/481104 = 6.028\times10^{-6}$ pu ✓

$C\phi\ pu = 0.8/481104 = 1.663\times10^{-6}$ pu ✓

1j) SEGMENT (B) - THE CURRENT IN SEGMENT (B) IS THE SUM OF THE CURRENTS IN SEGMENTS (C) AND (D) AND THE CURRENT TO PNL 2Y.

PANEL 2Y CURRENTS IN PER UNIT USING MEASURED VALUES (SEE REFERENCE #5):

$A\phi\ pu = 4.3/481104 = 8.938\times10^{-6}$ pu ✓

$B\phi\ pu = 2.3/481104 = 4.781\times10^{-6}$ pu ✓

$C\phi\ pu = 1.2/481104 = 2.494\times10^{-6}$ pu

(B) CURRENTS ARE THE SUM OF THE (C), (D) AND 2Y CURRENTS OR:

$A\phi\ pu = 4.780\times10^{-5}\ pu + 2.079\times10^{-6}\ pu + 8.938\times10^{-6}\ pu$
$= 5.882\times10^{-5}$ pu ✓

$B\phi\ pu = 6.859\times10^{-5}\ pu + 6.028\times10^{-6}\ pu + 4.781\times10^{-6}\ pu$
$= 7.940\times10^{-5}$ pu ✓

$C\phi\ pu = 4.157\times10^{-5}\ pu + 1.663\times10^{-6}\ pu + 2.494\times10^{-6}\ pu$
$= 4.573\times10^{-5}$ pu ✓

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CONSUMERS POWER COMPANY
Nuclear Plant
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Title: RESPONSE TO AIR-A-NA-81-126

Performed by: KA Toner Date: 8/17/81

References: SEE SHEETS 12, 13 + 14

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Review by: MRWade Date: 8/17/81

1k) SEGMENT Ⓐ: THE SEGMENT Ⓐ CURRENTS ARE THE SEGMENT Ⓑ CURRENTS (AS MEASURED, SEE REFERENCE #5) DIVIDED BY THE TRANSFORMER TURNS RATIO:

Ⓐ $A\phi$ = Ⓑ $A\phi/4 = (23A + 4.3 + 1.0A)/4 = 7.07A$

Ⓐ $B\phi$ = Ⓑ $B\phi/4 = (33A + 2.3A + 2.9A)/4 = 9.55A$

Ⓐ $C\phi$ = Ⓑ $C\phi/4 = (20A + 1.2A + 0.8A)/4 = 5.50A$

THESE CURRENTS, IN PER UNIT ARE:

$A\phi\ pu = \dfrac{7.07}{\text{BASE CURRENT}} = 7.07/120285 = 5.877 \times 10^{-5}\ pu$ ✓

(BASE CURRENT FOR 480V SYSTEM (AS SUPPLIED BY WP WAUDBY, SYSTEMS PROTECTION, 8/14/81)

$B\phi\ pu = 9.55/120285 = 7.940 \times 10^{-5}\ pu$ ✓

$C\phi\ pu = 5.50/120285 = 4.572 \times 10^{-5}\ pu$ ✓

2.) VOLTAGE DROPS:

2.1 LINE SEGMENTS:

THE FOLLOWING CABLE IMPEDANCE VALUES WERE PROVIDED BY WP WAUDBY, SYSTEMS PROTECTION, 8/14/81. THEY ARE USED TO CALCULATE THE VOLTAGE DROPS ACROSS THE LINE SEGMENTS:

#14 CABLE - Z/1000' IS 3.065 Ω
#12 CABLE - Z/1000' IS 1.932 Ω
#6 CABLE - Z/1000' IS 0.4906 Ω
#1/0 CABLE - Z/1000' IS 0.1289 Ω

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CONSUMERS POWER COMPANY
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Title: RESPONSE TO AIR-A-NA-81-126

Performed by: KA Toner Date: 8/17/81

References: SEE SHEETS 12, 13 + 14

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Review by: MRWolc Date 8/17/81

LINE SEGMENT (E):

CABLE IS 55' OF #14 AWG (SEE REFERENCE #3)

$\therefore Z = 3.065(55/1000) = 0.1686\,\Omega$ ✓

$Z_{BASE}\,\Omega$ AS SUPPLIED BY SYSTEMS PROTECTION IS $\frac{(KV)^2}{100\,MVA}$

$= \frac{0.120^2}{100} = 0.000144$

$\therefore Z_{pu} = Z_\Omega / Z_{BASE\,\Omega} = 0.1686/0.000144 = 1170.83\ pu$

VOLTAGE DROP $= I_{pu} Z_{pu} = (4.138\times10^{-6})(1170.83) = \underline{0.0048\ pu}$ ✓

LINE SEGMENT (F)

CABLE IS 99' OF #14 AWG (SEE REFERENCE #3)

$\therefore Z = 3.065(99/1000) = 0.3034\,\Omega$

$Z_{pu} = 0.3034/.000144 = 2106.94\ pu$

VOLTAGE DROP $= I_{pu} Z_{pu} = (2.049\times10^{-6})(2106.94) = \underline{0.0043\ pu}$ ✓

LINE SEGMENT (G)

CABLE IS 20' OF #12 AWG (SEE REF #3)

$\therefore Z = 1.932(20/1000) = 0.0386\,\Omega$

$Z_{pu} = 0.0386/.000144 = 268.05\ pu$

VOLTAGE DROP $= I_{pu} Z_{pu} = (5.923\times10^{-7})(268.05) = \underline{0.00016\ pu}$ ✓

LINE SEGMENT (H)

CABLE IS 50' OF #12 AWG (SEE REF #3)

$\therefore Z = 1.932(50/1000) = 0.0966$

$Z_{pu} = 0.0966/.000144 = 670.83\ pu$

VOLTAGE DROP $= I_{pu} Z_{pu} = (7.410\times10^{-7})(670.83) = \underline{0.00050\ pu}$ ✓

CONSUMERS POWER COMPANY
Nuclear Plant
ENGINEERING ANALYSIS WORKSHEET

Title: RESPONSE TO AIR-A-NA-81-126

Performed by: [signature] Date: 8/17/81

References: SEE SHEETS 12, 13 + 14

Review Method by: Alternate Calcs ☐ Detailed Review ☑ Qualification Test ☐

Review by: MRWolfe [signature] Date 7/17/81

LINE SEGMENT (I)

CABLE IS 20' OF #12AWG (SEE REF #3)

$\therefore Z = 1.932(20/1000) = 0.0386\,\Omega$

$Z_{pu} = (.0386)/.000144 = 268.05$

VOLTAGE DROP = $I_{pu} Z_{pu} = (6.613\times10^{-7})(268.05) =$ 0.00018 pu ✓

LINE SEGMENT (J)

CABLE IS 20' OF #12AWG (SEE REF #3)

$\therefore Z = 1.932(20/1000) = 0.0386\,\Omega$

$Z_{pu} = (.0386)/.000144 = 268.05$

VOLTAGE DROP = $I_{pu} Z_{pu} = (6.027\times10^{-8})(268.05) =$ 0.000016 pu ✓

LINE SEGMENT (C)

CABLE IS 109' OF 1/0 AWG. (SEE REF #3)

$\therefore Z = .1289(109/1000) = 0.0140\,\Omega$

$Z_{pu} = .0140/.000144 = 97.22$ pu

VOLTAGE DROPS:

$A\phi = IA\phi pu\, Z_{pu} = (4.780\times10^{-5})(97.22) =$ 0.0046 pu ✓

$B\phi = IB\phi pu\, Z_{pu} = (6.859\times10^{-5})(97.22) =$ 0.0067 pu ✓

$C\phi = IC\phi pu\, Z_{pu} = (4.157\times10^{-5})(97.22) =$ 0.0040 pu ✓

LINE SEGMENT (D)

CABLE IS 10' OF 1/0 (SEE REF #3)

$\therefore Z$ IS $.1289(10/1000) = 0.0013\,\Omega$

$Z_{pu} = .0013/.000144 = 9.028$ pu

VOLTAGE DROPS:

$A\phi = IA\phi pu\, Z_{pu} = (2.079\times10^{-6})(9.028) =$ 0.00002 pu ✓

$B\phi = IB\phi pu\, Z_{pu} = (6.028\times10^{-6})(9.028) =$ 0.00005 pu ✓

$C\phi = IC\phi pu\, Z_{pu} = (1.663\times10^{-6})(9.028) =$ 0.00001 pu

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CONSUMERS POWER COMPANY
Nuclear Plant
ENGINEERING ANALYSIS WORKSHEET

Title: RESPONSE TO AIR-A-NA-81-126

Performed by: KA Tower Date: 8/17/81

References: SEE SHEETS 12, 13 + 14

Review Method by: Alternate Calcs [ ] Detailed Review [✓] Qualification Test [ ]

Review by: MRWade Date 8/17/81

LINE SEGMENT (B)

CABLE IS 20' OF 1/0 (SEE REF #3)

$\therefore Z$ IS $(.1289)(20/1000) = 0.0026\,\Omega$

$Z_{pu} = .0026/.000144 = 18.06\ pu$

VOLTAGE DROPS:

$A\phi = IA\phi_{pu} Z_{pu} = (5.882\times10^{-5})(18.06) = \underline{0.0011\ pu}$ ✓

$B\phi = IB\phi_{pu} Z_{pu} = (7.940\times10^{-5})(18.06) = \underline{0.0014\ pu}$ ✓

$C\phi = IC\phi_{pu} Z_{pu} = (4.573\times10^{-5})(18.06) = \underline{0.0008\ pu}$

LINE SEGMENT (A)

CABLE IS 31' OF #6 AWG

$\therefore Z$ IS $(0.4906)(31/1000) = 0.0152\,\Omega$

$Z_{pu} = \dfrac{0.0152}{Z_{BASE}\text{ FOR 480 Volt SYSTEM}} = \dfrac{0.0152}{(.48^2/100)} = \dfrac{0.0152}{0.002304} = 6.60\ pu$

VOLTAGE DROPS:

$A\phi = IA\phi_{pu} Z_{pu} = (5.877\times10^{-5})(6.60) = \underline{0.00039\ pu}$

$B\phi = IB\phi_{pu} Z_{pu} = (7.940\times10^{-5})(6.60) = \underline{0.00053\ pu}$

$C\phi = IC\phi_{pu} Z_{pu} = (4.572\times10^{-5})(6.60) = \underline{0.00030\ pu}$ ✓

2.2 TRANSFORMER X17:

TRANSFORMER % Z IS 4.9 (SEE REFERENCE #4) AND RATED AT 30KVA

BASE Z AT 100 MVA IS $.049\,(100\text{MVA}/30\text{KVA}) = 163.33\ pu$

VOLTAGE DROPS:

$A\phi = IA\phi_{pu} Z_{pu} = (5.88\times10^{-5})(163.33) = \underline{0.0096\ pu}$ ✓

$B\phi = IB\phi_{pu} Z_{pu} = (7.940\times10^{-5})(163.33) = \underline{0.0130\ pu}$ ✓

$C\phi = IC\phi_{pu} Z_{pu} = (4.573\times10^{-5})(163.33) = \underline{0.0075\ pu}$ ✓

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CONSUMERS POWER COMPANY
Nuclear Plant
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Title: RESPONSE TO AIR-A-NA-81-126

Performed by: KA Toner Date: 8/17/81

References:
SEE SHEETS 12, 13 + 14

Review Method by: Alternate Calcs ☐ Detailed Review ☑ Qualification Test ☐

Review by: MRWade Date: 8/17/81

4.3 TOTAL VOLTAGE DROPS (IN PU) FOR POWER SUPPLIES:

ES 8512A + ES 8512B:

TOTAL DROP = ΣBφ DROP IN SEGMENTS Ⓔ, Ⓒ, Ⓑ, Ⓐ + X17
= (0.0048 + 0.0067 + 0.0014 + 0.00053 + 0.0130) pu
= 0.0264 pu ✓

ES 2108:

TOTAL DROP = ΣAφ DROP IN SEGMENTS Ⓕ, Ⓒ, Ⓑ, Ⓐ + X17
= (0.0043 + 0.0046 + 0.0011 + 1.00039 + 0.0096) pu
= 0.0200 pu ✓

ES 3171:

TOTAL DROP = ΣAφ DROP IN SEGMENTS Ⓖ, Ⓓ, Ⓑ, Ⓐ + X17
= (0.00016 + 0.00002 + 0.0011 + 0.00039 + 0.0096) pu
= 0.0113 pu ✓

ES 2165:

TOTAL DROP = ΣAφ DROP IN SEGMENTS Ⓗ, Ⓓ, Ⓑ, Ⓐ + X17
= (0.00050 + 0.00002 + 0.0011 + 0.00039 + 0.0096) pu
= 0.0116 pu ✓

ES 2160 + ES 2162:

TOTAL DROP = ΣBφ DROP IN SEGMENTS Ⓘ, Ⓓ, Ⓑ, Ⓐ + X17
= (0.00018 + 0.00005 + 0.0014 + 0.00053 + 0.0130) pu
= 0.0152 pu ✓

ES 2161 + 2163:

TOTAL DROP = ΣCφ DROP IN SEGMENTS Ⓙ, Ⓓ, Ⓑ, Ⓐ + X17
= (0.000016 + 0.00001 + 0.0008 + 0.00030 + 0.0075) pu
= 0.0086 pu ✓

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CONSUMERS POWER COMPANY
Nuclear Plant
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Title: RESPONSE TO AIR-A-NA-81-126

Performed by: KA Gower Date: 8/17/81

References: SEE SHEETS 12,13 & 14

Review Method by: Alternate Calcs [ ] Detailed Review [✓] Qualification Test [ ]

Review by: MRWade Date: 8/17/81

3.0 VOLTAGE AVAILABLE AT POWER SUPPLIES:

POWER SUPPLY	POWER SUPPLY VOLTAGE RATINGS	BUS 1A VOLTAGE (P.U.)	VOLTAGE DROP BUS 1A TO PWR SUPPLY (P.U.)	AVAILABLE VOLTAGE AT PWR SUPPLY (P.U. / VOLTS)
ES8512A & ES8512B	105-125 VAC	0.9200	0.0264	0.8936 / 107.2
ES2108	107-127 VAC	0.9200	0.0200	0.9000 / 108.0
ES3171	103.5-126.5 VAC	0.9200	0.0113	0.9087 / 109.0
ES2165	106.2-129.8 VAC	0.9200	0.0116	0.9084 / 109.0
ES2160 & ES2162	103.5-126.5 VAC	0.9200	0.0152	0.9048 / 108.6
ES2161 & ES2163	103.5-126.5 VAC	0.9200	0.0086	0.9114 / 109.4

CONCLUSION: AT A BUS 1A VOLTAGE OF 0.9200, THE RESULTING VOLTAGE AT THE INPUT OF EACH OF THE ABOVE POWER SUPPLIES IS WITHIN THE POWER SUPPLY VOLTAGE RATING.

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EA - AIR-A-NA-81-126
Sheet 12 of 14

CONSUMERS POWER COMPANY
Nuclear Plant
ENGINEERING ANALYSIS WORKSHEET

Title: RESPONSE TO AIR-A-NA-81-126
ASSUMPTIONS AND REFERENCES - PG 1 OF 3

Performed by: [signature] Date: 8/17/81

References:

Review Method by: Alternate Calcs ☐ Detailed Review ☑ Qualification Test ☐

Review by: [signature] Date: 8/17/81

ASSUMPTIONS

CABLE SIZES AND LENGTHS (SEE REFERENCE #3)

SYMBOL (SEE PG 1)	CABLE	SIZE	LENGTH
Ⓐ	P12 - X17	6	31'
Ⓑ	C04 - X17	1/0	20'
Ⓒ	C04 - Y01	1/0	109'
Ⓓ	C04 - Y13	1/0	10' (est.)
Ⓔ	C02 - Y01	14	55'
Ⓕ	C02 - Y01	14	99'
Ⓖ	ES3171 - Y13	12	20'
Ⓗ	ES2165	12	50'
Ⓘ	ES2160 - Y13	12	20'
Ⓙ	ES2161 - Y13	12	20'

1) THE AC INSTRUMENT TRANSFORMER #1A IMPEDANCE IS 4.9% (SEE REF. #4).

2) THE FOLLOWING CURRENT READINGS TAKEN AT THE PLANT ARE TYPICAL (SEE REF. #5):

C04 - Y01	C04 - Y02	C04 - Y13
φ1 - 23a	φ1 - 4.2a	φ1 - 1.0a
φ2 - 33a	φ2 - 2.3a	φ2 - 2.9a
φ3 - 20a	φ3 - 1.2a	φ3 - 0.8a

3) POWER SUPPLY CONNECTED LOADS ARE (SEE REFERENCE #6)

ES 8512A AND ES 8512B	- 260 VA
ES 2108	- 450 VA
ES 3171	- 40 VA
ES 2165	- 50 VA
ES 2160 AND ES 2162	- 80 VA
ES 2161 AND ES 2163	- 80 VA

4) RATED VOLTAGE RANGES OF POWER SUPPLIES (SEE REFERENCE #7):

POWER SUPPLY	MFR/TYPE	RATED VOLTAGE RANGE (INPUT)
ES 8512A + B	ROSEMOUNT / SPS 2102	105 - 125 VAC
ES 2108	BRISTOL / 2007-10B-100	107 - 127 VAC
ES 2160, ES 2161, ES 2162, ES 2163, ES 3171	ITT BARTON / 297	103.5 - 126.5 VAC
ES2165	FOXBORO / 610AT-OH	106.2 - 129.8 VAC

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EA - AIR-A-NA-81-126
Sheet 13 of 14

CONSUMERS POWER COMPANY
Nuclear Plant
ENGINEERING ANALYSIS WORKSHEET

Title: RESPONSE TO AIR-A-NA-81-126
ASSUMPTIONS AND REFERENCES PG 2 OF 3

Performed by: KA Tower Date: 8/17/81

References:

Review Method by: Alternate Calcs [ ] Detailed Review [✓] Qualification Test [ ]

Review by: MR Wade Date: 8/17/81

ASSUMPTIONS CONT'D.

5) VOLTAGE AVAILABLE AT THE 480V BUS 1A IS 0.9200pu. THIS pu VOLTAGE REPRESENTS THE MINIMUM EXPECTED AT THE BUS. THIS VOLTAGE WAS CALCULATED AND DOCUMENTED IN LETTER: KE YEAGER TO MR WADE, DATED 3/9/81.

BLANK

Form 2953

CONSUMERS POWER COMPANY
Nuclear Plant
ENGINEERING ANALYSIS WORKSHEET

Title: RESPONSE TO AIR-A-NA-81-126 ASSUMPTIONS AND REFERENCES

Performed by: KA Toner   Date: 8/17/81

References: ______

Review Method by: Alternate Calcs [ ] Detailed Review [✓] Qualification Test [ ]

Review by: MR Wade   Date: 8/17/81

REFERENCES

1.) THESE POWER SUPPLIES ARE REFERENCED IN LETTER: DP HOFFMAN TO DM CRUTCHFIELD (USNRC) DATED 3/23/81. IN THIS LETTER THE EFFECTS OF UNDERVOLTAGE ON THE LOW-VOLTAGE CLASS 1E EQUIPMENT WAS ANALYZED.

2.) PLANT DRAWINGS WD 740-1, 11, 12, 13 AND 0740G30114 WERE USED TO IDENTIFY THE POWER SUPPLIES AND THEIR CONNECTION TO THE BUSES

3.) CABLE REFERENCES

CABLE SYMBOL (SEE PAGE 2)	REFERENCES
(A)	DWG. 0740B30167-73
(B)	DWG. 0740B30167-71
(C)	DWG. 0740B30167-71
(D)	LENGTH ESTIMATED AS 10' SINCE Y13 IS MOUNTED ON NORTH WALL OF THE STATION POWER ROOM (DWG. 740A-30009) BENEATH THE AUTO TRANSFER SWITCH C14 (DWG 0740A30220-2). SIZE USED IS 1/0 TO BE CONSISTENT WITH CABLE (C).
(E)	DWG. 0740B30167-38 + 0740G30114-2
(F)	DWG. 0740B30167-37, 38 + 0740A30238-4, 11, 13, 14, 16 + 18,
(G)	DWG. 0740B-0167-85A
(H)	LENGTH ESTIMATED AT 50', ES2165 LOCATED IN CONTROL ROOM PANEL C02 DIRECTLY ABOVE ROOM WHICH HOUSES PNL 3Y. SIZE USED IS #12 TO BE CONSISTENT WITH CBLS (G) + (J)
(I)	DWG 0740B30167-85A
(J)	DWG 0740B30167-85A

4.) GE (DON NULING) HAS GIVEN THIS VALUE OF IMPEDANCE, REFER TO RECORD OF TELECON #119. (ATTACHED)

5.) REFER TO P.I.R.I.T DATA SHEETS DATED 2/19/81 (ATTACHED)

6.) REFER TO DWGS 0740A3009-21 + 29.

7.) REFER TO ATTACHED DATA SHEETS AND RECORD OF TELECON #120.

ATTACHMENT

RECORD OF TELECON

Sheet No 119

Date: 8/5/81 Time: 1500 Hrs By: KA Losee

Who Talked To: Don Hulings His (Her) Dept: Sales

Company: General Electric Co Phone: AC____ No 787 0351

1 Midwest Centre Ext ____

Suite 310, Jackson, MI 49201

Subject: % Impedance of I&C Power Transformer 1A @ Big Rock Point.

Topics Discussed:

According to Don, the impedance of the subject transformer is 4.9%. To determine this value, Don was given the following transformer information:

GE 480-120/208 3Φ

Model #9T23Y3522

30KVA, 150°C rise

dry, indoor, Class AA-NP 18365

Fort Wayne, Indiana

DATE 2/19/81

EA-AIR-A-NA-81-126
ATTACHMENT

DATA SHEET

1). OBTAIN MWe OUTPUT OF PLANT. 59.8 MW

2). OBTAIN 480V GRID VOLTAGE 480 V.

3). DETERMINE BREAKER SIZE OF BREAKER 20 OF THE TURBINE BLDG. INSTR. AND CONTROL POWER PANEL "1Y" 70 AMP. BKR.

4). LIST THE TYPE, SIZE AND CABLE NUMBER OF EACH CABLE ATTACHED TO THE BREAKER DESCRIBED IN ITEM 3 ABOVE. ~~6505-401-201-1~~
6519-401-C05-1-X
#8 WIRE 600V PE

5). TAKE CURRENT AND VOLTAGE READINGS AT EACH OF THE FOLLOWING LOCATIONS.

a). AT THE AUTO. THROW-OVER PANEL (C.04) LOCATED ON THE NORTH WALL OF THE AIR COMPRESSOR RM TAKE CURRENT AND VOLTAGE READING ON THE FOLLOWING CABLES.

Cable		Phase	Current		Voltage	
C04 – Y01/1 1503 (1Y)	Z	A	23 ✓	AMP	122	V
	X	B	33 ✓	"	122	V
	Y	C	20 ✓	"	122	V
C04 – Y02/1 1504 (2Y)	T2	A	4,3	AMP	122	V
	T3	B	2,3	"	122	V
	T1	C	1,2	"	122	V
C04 – Y13/ (3Y)	T2	A	1 ✓	AMP	122	V
	T3	B	2.0 ✓	AMP	122	V
	T1	C	.8 ✓	AMP	122	V
C02 – D02/11 6607 @72-1D22 BKR IN D02		WIRE 201	(1.7)	AMP	115	V

5). CONT.

C05 — Y01/1 6514 ___2___ AMP ___121___ V
1Y PNL BKR#20

ITT BARTON

PRODUCT/BULLETIN 297-1

Model 297, 298, 299, 300, 378 Power Supplies

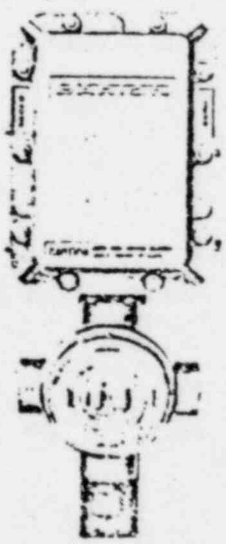
EA-AFL-A-NA-81-12C
ATTACHMENT

PRODUCT DESCRIPTION

ITT Barton manufactures five power supplies for use with Barton Electronic Pressure and Temperature Transmitters.
The Power Supplies are available in either single or multiple output channel design, for 4-20 mA and 10-50 mA electronic transmitter output applications.

Depending on application and area of installation, the Power Supplies are available in a NEMA-IV case or an explosion-proof conduiet which meets the requirements for hazardous location Class 1, Group D, Division 1 Service. One model is available as a circuit board-mounted component for installation inside a weatherproof or NEMA-IV electronic transmitter case.

All five Barton Power Supply models operate on an AC input of 115 or 230 volts, 50-60 Hz. They are shortcircuit protected and designed to operate in a temperature environment between −40°F and +160°F.



Models 297, 299 In Condulet Attached to Transmitter Case

Models 298, 300 NEMA-IV Case

MODELS 297 and 299

These Power Supplies are of the single-output channel design, housed in an explosion-proof condulet. The condulet is close-coupled to an explosion-proof electronic transmitter case.

Model 297 provides a 43 volt DC output of up to 25 mA for use in a 4-20 mA electronic transmitter output application.

Model 299 provides a 68 volt DC output of up to 60 mA for use in a 10-50 mA electronic transmitter output application.

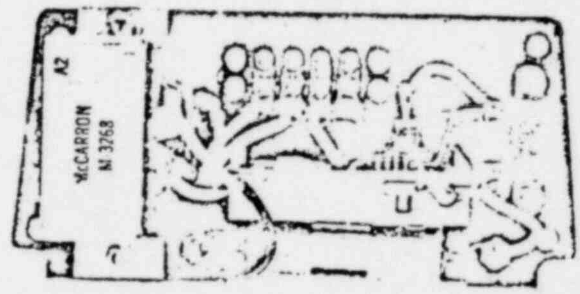
MODELS 298 and 300

These Power Supplies offer multiple, 1 to 10, output channels and are housed in NEMA-IV cases with an external power-on signal light and provisions for wall, pipe or panel mounting.

Model 298 provides a 43 volt DC output of up to 225 mA to operate one to ten 4-20 mA output electronic transmitters as long as the load current does not exceed 225 mA.

Model 300 provides a 68 volt DC output of up to 550 mA to operate one to ten 10-50 mA output electronic transmitters as long as the load current does not exceed 550 mA.

EA-AIR-A-NA-81-126
ATTACHMENT



Model 378 Circuit Board-Mounted Power Supply

MODEL 378

This Power Supply is of the single-channel output configuration. Mounted on a circuit board, it is designed for installation inside the ITT Barton 300 Series weatherproof or NEMA-IV electronic transmitter cases. This model is available for either 4-20 mA or 10-50 mA output electronic transmitter operation and provides a 75 volt DC output of up to 60 mA, depending on electronic transmitter output requirement.

SPECIFICATIONS

	Model 297	Model 298	Model 299	Model 300	Model 378
Transmitter Application	4-20 mA	4-20 mA	10-50 mA	10-50 mA	4-20 or 10-50 mA
Channels	1	10	1	10	1
Input Voltage AC	115 or 230 V ±10% 50-60 Hz	115 or 230 V ± 10% 50-60 Hz	115 or 230 V ± 10% 50-60 Hz	115 or 230 V ± 10% 50-60 Hz	115 or 230 V ± 10% 50-60 Hz
Output Voltage DC	43 V ± 5%	43 V ± 1%	68 V ± 5%	68 V ± 1%	75V ± 5%
Maximum Output Current	25 mA	225 mA	60 mA	550 mA	60 mA
Regulation (load or line)	≦ 3%	≦ 1%	≦ 3%	≦ 1%	3%
Ripple	≦ 1%	≦ .5%	≦ 1%	≦ .5%	≦ 10%
Short Circuit Protection	Yes	Yes	Yes	Yes	Yes
Housing	Explosion-Proof	Nema IV	Explosion-proof	Nema IV	None
Weight	–	6 lbs.	3 lbs.	14 lbs.	2 lbs.

YOUR LOCAL REPRESENTATIVE

ITT
BARTON

PROCESS INSTRUMENTS AND CONTROLS
900 S. TURNBULL CANYON RD.
BOX 1882, CITY OF INDUSTRY, CA. 91749
Telephone (213) 961-2547 TELEX 67-7475

GJ06M Litho in U.S.A.

BRISTOL

instruction manual B2742-1

MASTER FILE
DOCUMENT CONTROL

ES-2108
~~ES-7804~~

METATRONIC*

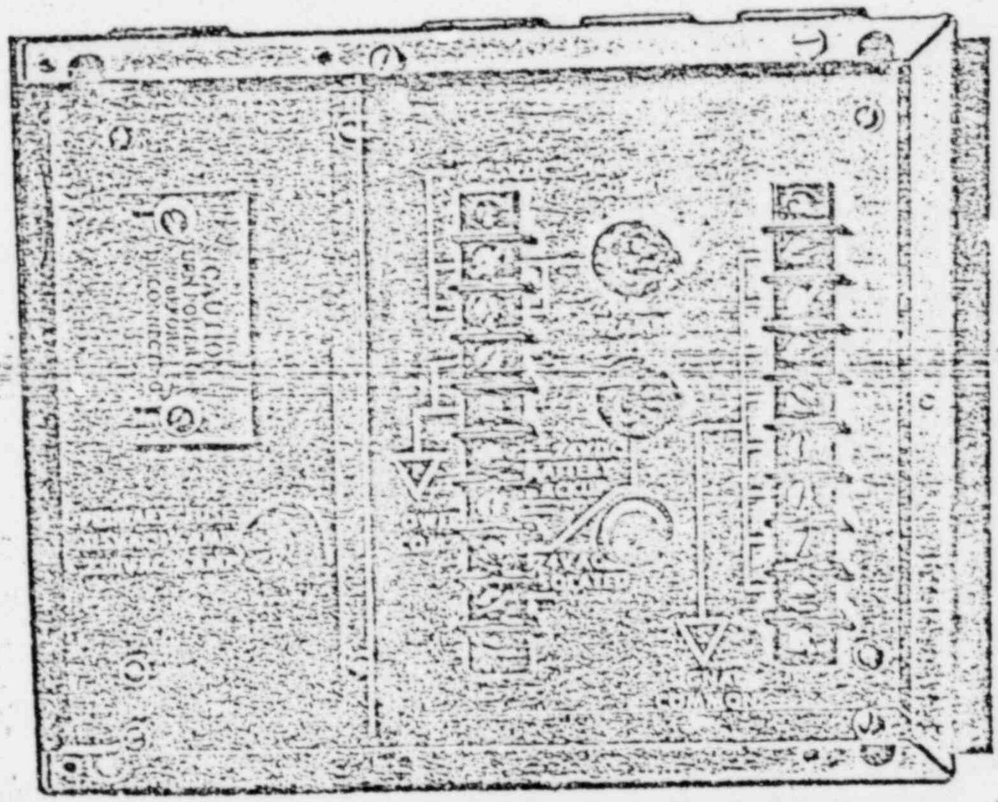
EA-AIR-A-NR-81-126
ATTACHMENT

50—WATT POWER SUPPLIES

24 VOLTS DC
FROM 110

MODELS 2007—10B & 2007—20B

2007-10B-100



REAR OF 50-WATT POWER SUPPLY

0497 74

AMERICAN CHAIN & CABLE COMPANY, INC.

ACCO BRISTOL DIVISION
WATERBURY, CONNECTICUT 06720

* A Trademark of the American Chain & Cable Co., Inc.

PRINTED IN U.S.A.

A. Specifications

1. Line Voltage:

   107 to 127 vac, 120 vac nominal or
   214 to 254 vac, 240 vac nominal

2. Line Frequency:

   48 to 62 Hz, 60 Hz nominal

3. Power Rating:

   90 watts max. @ 115 vac with full load at output.

4. Supply Outputs:

   24.5 vdc isolated @ 2 amps max.
   24 vac isolated @ .5 amp. max.

   (Total output power cannot exceed 50 watts)

5. Output Accuracy:

   24.5 vdc, ±.1 vdc @ 1 amp.
   24 vac, ±2 vac @ .25 amp.

6. D-C Regulation:

   24.5 vdc with 0-1 amp. load change and 107 to 125 vac (or 214 to 254 vac) line change.

7. D-C Ripple:

   60 mv p-p at 24.5 vdc (±.5 vdc) with 2.0 amps. load and 107 vac (or 214 vac) line input.

8. Ambient Temperature:

   Operating = +40° to +120°F
   Storage = -40° to +160°F

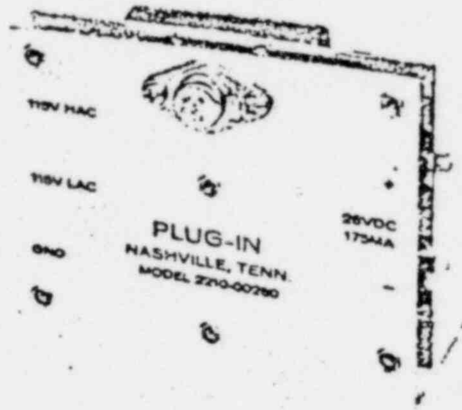
9. Humidity:
   10% to 90% RH (40° to 120°F)
   10% to 50% RH (40° to 100°F)

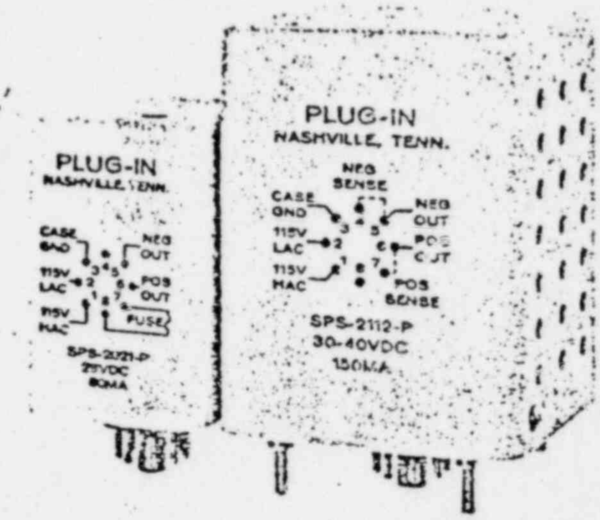
049776

[redacted]

EA-AIR-A-NA-81-126
ATTACHMENT

PLUG-IN™ REGULATED DC POWER SUPPLIES





1 to 40 volt outputs
Adjustable voltage
Overcurrent protection
(Automatic or external fuse)

GENERAL

Rosemount regulated Plug-In DC power supplies provide highly stable and isolated DC voltage for various industrial, medical, laboratory, ground support and other applications. These models are ideally suited for industrial transducer excitation, current transmitter applications as well as for laboratory use.

The Plug-In types are transistorized and compact, but are repairable. A mating 8-pin octal receptacle for conventional chassis mounting is shipped with each unit. However, the optional screw-down socket with molded barrier strips offers extra convenience and fast installation.

The open construction 2210 series is equally convenient in use and installation. This economical unit is of solid state design, and offers automatic momentary short circuit protection. The line and load regulation and the ripple specifications are less stringent (see ordering table) than for the enclosed models. However, these units are especially designed for low-cost applications where a large number of isolated voltages are required and where electrical specifications are not critical.

Power supplies are available with narrow slot range and with wide range voltage adjustments. Any voltage between 1 and 40 volts is available from at least one Rosemount standard power supply. The table below shows the model numbers for the most popular voltage ranges between 1 and 40 volts. After determining applicable models, refer to the "Style" table on page 2 for electrical specifications. Duplications exist in some voltage ranges for your selection based on economy, current ratings or electrical specifications.

VOLTAGE/MODEL TABLE

	VOLTAGE									
STYLE	1–6.5	5–9	10	12	15	18	20	24	28	30–40
2210				2210	2210	2210		2210	2210	
A			SPS-2077	SPS-2077	SPS-2078					
B			SPS-2014	SPS-2010	SPS-2018			SPS-2011	SPS-2021	
D	SPS-2055 •	SPS-2056	SPS-2057 SPS-2052	SPS-2057 SPS-2052 SPS-2073-D	SPS-2058 SPS-2074-D	SPS-2054	SPS-2054 SPS-2101	SPS-2060 SPS-2101	SPS-2101	SPS-2102
F	SPS-2062	SPS-2063	SPS-2110	SPS-2110 SPS-2120-D	SPS-2110 SPS-2121-D	SPS-2110	SPS-2111	SPS-2111	SPS-2111	SPS-2112

Rosemount

ORDERING INFORMATION

2210

OPEN CIRCUIT CONSTRUCTION

MODEL	DC OUTPUT RATING		REGULATION (mV DC)		RIPPLE (mV RMS)	OUTPUT ADJUST
	VOLTS	CURRENT (mA)	LINE	LOAD		
2210-00280	28	175	±10	20	10	±5%
2210-00240	24	225	±10	20	10	±5%
2210-00180	18	250	±10	20	10	±5%
2210-00150	15	300	±10	20	10	±5%
2210-00120	12	400	±10	20	10	±5%

STYLE "A"

ULTRA COMPACT 0.6 WATT PLUG-IN

MODEL	DC OUTPUT RATING		REGULATION (mV DC)		RIPPLE (mV RMS)	TEMP. COEFF. (%/°F)
	VOLTS	CURRENT (mA)	LINE	LOAD		
SPS-2077-P	9-12.5	0-50	3	6	1.5	0.02
SPS-2078-P	13-16	0-40	3	6	1.5	0.02

STYLE "B"

ECONOMICAL 2 WATT PLUG-IN

MODEL	DC OUTPUT RATING		REGULATION (mV DC)		RIPPLE (mV RMS)	TEMP. COEFF. (%/°F)
	VOLTS	CURRENT (mA)	LINE	LOAD		
SPS-2014-P	10	0-175	±4.5	± 9	1	0.03
SPS-2010-P	12	0-175	±6	±12	1	0.03
SPS-2018-P	15	0-125	±6	±12	1	0.03
SPS-2011-P	24	0-90	±5	±12	1	0.025
SPS-2021-P	28	0-80	±6	±14	1	0.025

STYLE "D"

3 WATT PLUG-IN OR SOLDER-HEADER MOUNTING

	MODEL	DC OUTPUT RATING		REGULATION (mV DC)		RIPPLE (mV RMS)	TEMP. COEFF. (%/°F)	MOUNTING STYLE
		VOLTS	CURRENT (mA)	LINE	LOAD			
NARROW ADJUSTMENT RANGE	SPS-2055-P SPS-2055-S	1-6.5	0-300	15	5	1.5	0.03	Plug-In Solder-Header
	SPS-2056-P	5-9	0-250	15	5	1.5	0.03	Plug-In
	SPS-2057-P	9-13	0-200	2	5	0.5	0.02	Plug-In
	SPS-2058-P	13-17	0-175	2	5	0.5	0.02	Plug-In
	SPS-2052-P SPS-2052-S	9-13	0-200	2	5	0.5	0.01	Plug-In Solder-Header
	SPS-2054-P	[illegible]-21	0-150	2	5	0.5	0.01	Plug-In
WIDE ADJUSTMENT RANGE	SPS-2101-P	20-30	0-100	10	15	1	0.02	Plug-In
	SPS-2102-P	30-40	0-75	10	15	1	0.02	Plug-In
DUAL VOLTAGE OUTPUT	SPS-2073D-P SPS-2073D-S	±12	0-75	3	6	1	0.02	Plug-In Solder-Header
	SPS-2074D-P SPS-2074D-S	±15	0-65	3	6	1	0.02	Plug-In Solder-Header

STYLE "F"

4.5 WATT PLUG-IN OR SOLDER-HEADER MOUNTING

	MODEL	DC OUTPUT RATING		REGULATION (mV DC)		RIPPLE (mV RMS)	TEMP. COEFF. (%/°F)	MOUNTING STYLE
		VOLTS	CURRENT (mA)	LINE	LOAD			
NARROW ADJUSTMENT RANGE	SPS-2062-P SPS-2062-S	1-6.5	0-600 0-800	15	10	1.5	0.03	Plug-In Solder-Header
	SPS-2063-P SPS-2063-S	5-9	0-450 0-600	15	10	1.5	0.03	Plug-In Solder-Header
WIDE ADJUSTMENT RANGE	SPS-2110-P	10-20	0-200	15	15	1	0.02	Plug-In
	SPS-2111-P	20-30	0-175	15	15	1	0.02	Plug-In
	SPS-2112-P	30-40	0-150	15	15	1	0.02	Plug-In
DUAL VOLTAGE OUTPUT	SPS-2120-P SPS-2120-S	±12	0-175	5	10	1.5	0.02	Plug-In Solder-Header
	SPS-2121-P SPS-2121-S	±15	0-150	5	10	1.5	0.02	Plug-In Solder-Header

GENERAL SPECIFICATIONS

Input Voltage
105 to 125 VAC at 50–400 Hz.

Adjustable Output
Voltage adjust potentiometer at the top of all power supplies. (If range is not specified, adjustment is ±5%.)

Floating Output
Positive or negative, output can be grounded, isolated from case and AC line.

DC Isolation
Greater than 100 megohm with 200 VDC applied between output and case.

AC Isolation
Typically 20 picofarad – shield between primary and secondary transformer.

Line Regulation (output voltage variation as input line voltage changes from 105 to 125 VAC)
See ordering table on opposite page.

Load Regulation (output voltage variation due to a change from no load to full rated load current)
See ordering table on opposite page.

Output Impedance
Less than 0.1 ohms (DC to 1KC).

Reverse Current
Fully protected against an application of reverse current.

Remote Sensing
Styles "D" and "F" models have provisions for remoting the point of regulation to the load.

Short Circuit Protection
Electronic protection against accidental short-circuit and temporary overloads. (The style "B" has provision for external fusing.)

Transient Response
250 mV peak to peak, for a step load change of 10 to 100% for less than 50 millisecond duration. (Not specified for 2210.)

Temperature Range
The temperature effect over the usable range of 20°F to 125°F is less than 0.03%/°F. Do not exceed 150°F maximum temperature on base of solder-header styles or premanent damage may result. (Not specified for 2210.)

Stability
Long term stability is better than ±0.1% of rated voltage at fixed conditions. Stability is ±0.2% for Style "B" and other models when operating below 9 volts.

PRICING AND DISCOUNTS

The applicable price list is P50000. All models listed on the current price list are stocked at our Nashville plant. Most styles delivered from stock in quantities to 25 pieces F.O.B., Nashville, Tennessee. Prices and specifications on all models are subject to change without notice. When ordering, specify model number and quantity of each item.

Quantity discount schedule follows:

DISCOUNT	QUANTITY
1–9	Base Price
10–24	Base Price Times 0.96
25–49	Base Price Times 0.92
50–99	Base Price Times 0.88
100–199	Base Price Times 0.84

WARRANTY

Rosemount Nashville, Inc. warrants its power supplies to be free from defects in workmanship and/or material and to function satisfactorily when properly installed, operated and maintained in accordance with instructions and specifications for a period of 6 months. The warranty becomes effective on the date of shipment.

This warranty does not extend to any of our products which have been subject to misuse, neglect, accident, or improper installation or application; nor shall it extend to units which have been repaired or substantially altered by persons other than authorized personnel.

Rosemount Nashville, Inc. will in no way, be liable for damage to other equipment caused by failure or malfunction of equipment built by Rosemount Nashville, Inc.

REPAIR POLICY

The warranty obligation is limited to repairing or adjusting of the power supply or parts thereof upon authorized return to the factory, transportation prepaid. Repair or replacement of such equipment, which upon examination proves to be defective due to materials or workmanship, will be completed at no charge and reshipped F.O.B. Nashville. Any power supply returned beyond the time limit warranty, or due to misuse, etc., will be repaired (repair price is approximately half price) or if not repairable, can be replaced at the current price.

ATTACHMENT

RECORD OF TELECON

Sheet No 120

Date: 8/6/81 Time: 0945 Hrs By: K Q Joxer

Who Talked To: Gene Drenth His (Her) Dept: I&C Supv.

Company: CP Co Phone: AC — No 137

Big Rock Point Ext 126

Subject: Power Supply ES2165 Information

Topics Discussed:

Gene provided the following power supply information for ES2165:

mfr: Foxboro

model #: 610AT-OH

S/N: 3099692C

supply voltage: 118V ±10%

power: 12VA