Duquesne Light
435 Sixth Avenue
Pittsburgh, Pa.
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(412) 456-6000

October 15, 1979

Director of Nuclear Reactor Regulation
United States Nuclear Regulatory Commission
Attn: A. Schwencer, Chief
Operating Reactors Branch No. 1
Division of Operating Reactors
Washington, DC 20555

Reference: Beaver Valley Power Station, Unit No. 1
Docket No. 50-334
Response To Requests For Information On Station Service Bus Voltages

Gentlemen:

Enclosed are three (3) signed originals and thirty-seven (37) copies of the Duquesne Light Company response to your requests for information dated July 5, 1979, and August 8, 1979.

We are continuing to perform computer analyses to determine the station service bus voltage conditions that might exist during the relatively short periods of time required to start and accelerate to running speeds various combinations of motor driven station equipment. These studies should be completed within the next 60 days.

We are proceeding with the engineering and procurement required to install additional undervoltage relays on the Class IE 4160 volt and 480 volt busses. These relays will be set to operate at 90% of the rated bus voltage.

The proposed Technical Specifications associated with these new relays will be provided with the results of the motor inrush studies.

We plan to complete the installation of these relays during the refueling outage of the unit which is scheduled to commence during the month of November, 1979.

Very truly yours,

C N Dunn

C. N. Dunn
Vice President, Operations

cc: D. A. Beckman
Region I
King of Prussia, PA

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7910180365

(CORPORATE SEAL)

Attest:

H W Staas
H. W. Staas
Secretary

COMMONWEALTH OF PENNSYLVANIA)
) SS:
COUNTY OF ALLEGHENY)

On this 15th day of OCTOBER, 1979, before me, DONALD W. SHANNON, a Notary Public in and for said Commonwealth and County, personally appeared C. N. Dunn, who being duly sworn, deposed, and said that (1) he is Vice President of Duquesne Light, (2) he is duly authorized to execute and file the foregoing Submittal on behalf of said Company, and (3) the statements set forth in the Submittal are true and correct to the best of his knowledge, information and belief.

Donald W Shannon

DONALD W. SHANNON, NOTARY PUBLIC
PITTSBURGH, ALLEGHENY COUNTY
MY COMMISSION EXPIRES JUNE 7, 1983
Member, Pennsylvania Association of Notaries

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Beaver Valley P.S. - Unit #1
Duquesne Light Reply To NRC Letters
Dated July 5, 1979, and August 8, 1979

The following discussions refer to the statements and questions contained in the attachment to your July 5, 1979 letter:

Item 1 - Please refer to our revised proposal covered later.

Item 2 - The voltage drop data we sent you previously was based on a minimum system voltage of 132kV which was applicable in the year 1976. There have been a number of changes made to the high voltage system since that time; all tending to narrow the range of voltages on the Beaver Valley Substation high voltage busses.

The Duquesne Light Company System Planning Department has determined by load flow testing of various system conditions, involving not only a variety of outage situations, but also a varying number of simultaneous contingencies, the following maximum and minimum credible voltages that can occur on the Beaver Valley Substation busses:

	Bus Voltages	
A. Beaver Valley #1 in Service	138kV	345kV
a. Minimum Voltage	137,448V	347,760V
b. Maximum Voltage	143,382V	350,520V
B. Beaver Valley #1 Out of Service		
a. Minimum Voltage	134,964V	332,925V
b. Maximum Voltage	142,554V	350,175V

We have restudied the Beaver Valley Power Station bus voltages using the minimum voltage of 134,964 Volts. The study condition that produces minimum station service bus voltages is Containment Isolation Phase B (CIB) without loss of offsite power together with the normal station load expected for this condition, but with the main generator off.

For this worst condition the voltages, as obtained from the study, are as follows:

4160V Normal Bus	4160V Emergency Bus	480V Emergency Bus	**460V Emergency Motor Terminals
4029 Volts (96.9%)	4024 Volts (96.7%)	406V (88.3%)*	397V (86.2%)*

* 460V Base
** Based on Lead Drop of 2% of 480V

We recognize the resultant 480V system voltages are below those stated in ANSI Standard C84.1-1973. We will address this subject later.

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Item 3 - Please refer to our revised proposal covered later.

Item 4 - We will comply with your Position 2 of the letter dated June 3, 1977. Refer to our revised proposal covered later.

Item 5 - A Technical Specification change request will be made later.

Item 6 - We chose the normal bus as the sensing point for offsite voltage because it is the most representative location, without going outside of the station. In our initial opinion, the failure of these relays did not constitute a hazard to the health and safety of the public. However, we have reconsidered this application and we refer you to our revised proposal covered later.

The following discussions refer to the "Guidelines for Voltage Drop Calculations" attached to your letter of August 8, 1979:

Our studies considered all available connections to the offsite system.

The minimum expected value of grid voltage used as the basis for our studies occurs for the following system condition:

Beaver Valley Unit #1 off on dispatch and
Mansfield Unit #1 and #2 off on dispatch and
Beaver Valley-Sammis 345kV interconnection tripout

Mansfield Power Station (a Pennsylvania Power Company station) is located approximately one mile from the Beaver Valley Power Station and is electrically tied through a 345kV interconnection to the Beaver Valley Substation bus.

The above condition is referred to as East Central Area Reliability (ECAR) Criterion #1. The resultant Beaver Valley Switchyard bus voltages are 134, 964V on the 138kV busses and 332, 925V on the 345kV busses.

Using these minimum voltages, the Beaver Valley Station service bus voltages were studied under various accident and load conditions.

These conditions will be addressed in the next section.

The maximum credible voltages occurring on the high voltage busses at Beaver Valley Substation, used to study the no load condition on the station service busses are:

350, 175V on the 345kV busses and 142, 554V on the 138kV busses with Beaver Valley Unit #1 out of service. (Study Case 2-16)

The highest voltage will appear on the station service busses when they are supplied from the 138kV system busses. For a no load condition, the voltage profile is illustrated on the attached graph #2. This represents the maximum credible voltages the emergency busses will be subjected to. Under this condition the voltage does not exceed 110%. It must be remembered that since this is a no load condition, motors are not actually being subjected to this voltage until they are started, and then the no load condition no longer exists.

From these studies, we, therefore, conclude that the emergency equipment will not be subjected to overvoltages beyond the equipment's capabilities.

Accident and Load Conditions Studied

From our analyses, we found that our 4160V emergency busses are well within acceptable values of voltage, but we did find that for certain worse conditions the 480V emergency busses will drop below 90%.

Case 3 Loading Conditions

This study considered the Beaver Valley #1 unit on line with maximum station service load followed by loss of normal power and a unit trip condition. This causes transfer to the 138kV offsite source and results the minimum 4160V emergency bus voltage. The following voltages were calculated:

138kV Offsite Source	4160V Em. Bus	900 KVA Load 480V Em. Bus	460V Em. Motor Terminals
134,964V (97.8%)	3941V (94.7%)	417V (90.7%)*	407.4V (88.6%)*

*460V Base

Case 1 Loading Conditions

This study considered the unit off line with maximum station service load less two Steam Generator Feed Pumps but with a CIB loading that corresponds to complete loss of offsite power. The offsite source, however, is used in the calculation with a value of 134,964V. This case results in the minimum 480V emergency bus voltage. The following voltages calculated are:

138kV Offsite Source	4160V Em. Bus	1500 KVA Load 480V Em. Bus	460V Em. Motor Terminals
134,964V (97.8%)	4024V (96.7%)	406V (88.3%)*	396.4V (86.2%)*

*460V Base

Discussion of Case Studies

These two cases represent what we consider to be the worst cases. Both assume the Beaver Valley Unit off, simultaneous with two Mansfield Units off and a 345kV interconnection trip off. In addition, the Beaver Valley Station service busses are heavily loaded. A factor that should be considered is the loading of the 480V emergency bus. For case 1, the 1500 KVA load should only last for three (3) minutes before it is reduced to approximately 1350 KVA. Since the consideration addressed in your letters is sustained undervoltage, we could have used the lighter load in the studies but chose, for this analysis, to use the heavier load for conservatism.

If all the above simultaneous conditions are taken into account the terminal voltage at the emergency equipment appears to be maintained at approximately 90% for all reasonable conditions.

Improvement of Bus Voltage

We are, however, proceeding with additional studies and investigations to improve the bus voltages. We are looking at two methods: (1) Adding another 480V transformer to each emergency system so the load on any one transformer can be reduced and thereby develop higher voltage on the 480V bus, or (2) Add 4160V capacitors to the station service system to increase voltage during sustained undervoltage conditions.

The attached graphs illustrate the results of these two approaches. These studies are incomplete only in that physical placement of the equipment needs further analysis. We will advise you of the results of our investigation.

Discussion of Attached Voltage Profile Graphs

Two graphs are attached. One illustrates the voltage profile when supplied from the 22kV lead banks (GRAPH #1). The other illustrates the profile when supplied from the 138kV banks (GRAPH #2).

As illustrated by curve #1 in both graphs, the voltages do not exceed 110%.

We stated previously that the minimum voltage occurs when the busses are supplied from the 138kV system. This is illustrated by curve #2 on graph #2.

Curve #4 on both graphs shows the results that would be obtained by adding capacitors to the normal busses.

Curve #3 of graph #2 shows the results of adding a third 480V transformer to the emergency system.

Both the addition of the capacitors and the third transformer are still under study.

Motor Starting Conditions

In 1973, we ran a number of bus transfer and motor starting studies. These studies were run on the Westinghouse Electric Corp. computer. One case assumed offsite source voltage at 95%, and all motors running except a reactor coolant pump (RCP) motor. (This motor is 6000 HP and has a flywheel. It is our largest motor.) The reactor coolant pump motor was then started and studied. The results of the study indicate the motor continues to accelerate through 30 seconds, the time length of the study. The study lists slip and voltage at 0.5 second increments. We can extrapolate that the motor will be at full speed in under 50 seconds. (Ref. Study 5/15/73, case 1A, Bus 210, pg. 803-1976 Condition)

On February 26, 1975 oscillograph records were taken during the start of this RCP. The initial 4160V bus voltage prior to start was 97%. During start (approximately 30 seconds) the bus voltage was depressed to 79%. The motor started.

Manufacturers starting curves for this motor indicate that at 80% terminal voltage, the motor will start and accelerate within 40 seconds.

We present this information to illustrate that the largest motor will start for a bus voltage similar to that calculated in cases 1 and 3.

Revised Proposal to Meet Staff Positions

The proposal described below relates to busses 1AE, 1N and 1N1, but with the understanding that busses 1DF, 1P and 1P1 will be made similar. (Please refer to attached diagram.)

1. We will provide two (2) single phase undervoltage relays connected to potential transformers presently on 4160V bus 1AE. We will also provide two (2) single phase undervoltage relays connected to potential transformers on the secondary of transformer 1-8N. These relays will meet the requirements of IEEE 279-1971.

2. The contacts of the two relays on the 4160V bus 1AE will be connected in series (coincident logic). The contacts of the two relays on the secondary of transformer 1-8N will be connected similarly.

3. The two series circuits of (2.) above will operate a timing relay set for 90 seconds time delay on pickup. The timing relay will initiate trip of breakers 1E7 and 1A10. This will remove the offsite source from the emergency busses. With reference to the stipulation that time delays not exceed FSAR time limitations, the accident conditions addressed in the FSAR are based on complete loss of offsite power. For these conditions, existing undervoltage protection will not exceed the limits imposed for reactor safety. The Design Basis Accident (29 in. double ended rupture and loss of offsite power) requires the following equipment available in the times noted:

Equipment	Time After DBA
Two Charging Pumps	25 sec
Two Low Head S.I. Pumps	25 sec
Two Quench Spray Pumps	60 sec after CIB signal
Four Recirculating Pumps	5 min. after CIB signal

On a loss of offsite power signal, existing undervoltage relays will isolate the emergency equipment within a revised time setting of one (1) second. The diesel generator start is initiated in 12 cycles after detection of the undervoltage condition. Automatic loading will begin within 10 seconds. The required availability time for the above equipment is programmed in the loading sequence of the diesel generator.

4. We will remove the tripping function of breaker 1A10 and 1E7 from our normal bus 1A undervoltage protection since these are not to be considered safety related relays.

5. The load shedding relay presently on the 4160V 1AE emergency bus, trips the 4160V and 480V emergency loads. It does not trip the offsite source from the bus. We will add tripping of breakers 1A10 and 1E7 to the function of this protective scheme. This will remove the offsite source from the 4160V bus 1AE on loss of voltage in one (1) second.

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6. Load shedding protection related to the loss of voltage on the 4160V and 480V emergency busses will be disabled when these busses are being supplied from the onsite source. The load shedding feature will be reinstated when these busses are supplied from the offsite source.

7. The requirements of staff position 3 relating to the testing of the undervoltage protection will be met.

We will proceed to modify our undervoltage protection on the basis of this proposal.

Discussion of Undervoltage Relay Response

The following discussion will be on the basis of our present system, using relays mentioned in our revised proposal.

With the sustained minimum voltage of 134, 964V on the 138kV system, full station service load, the Beaver Valley #1 unit off line and a CIB signal, the 4160V emergency bus relays associated with degraded grid voltage will not operate since they will be set for 90% voltage and the bus voltage will not degrade below this set point.

The 480V emergency bus degraded grid voltage relays will, however, operate. After a 90 second time delay, breakers 1E7 and 1A10 will be tripped. The emergency bus load shedding relays will operate at 75% voltage and will trip all 4160V and 480V emergency motors in one (1) second. When this function is performed, the load shedding relays will be disabled. The diesel generator will start, both by the undervoltage signal and by the opening of breakers 1E7 or 1A10. The diesel generator and the emergency loads will be sequenced on automatically.

For the same sustained minimum system voltage, normal loads and no accident condition, as for the startup of the main unit for example, the maximum voltage transient expected is the starting of a reactor coolant pump motor. (Ordinarily this motor is started as one of the first on the bus, but for the purpose of analysis, consider it starts last.) The 4160V emergency bus voltage will drop to approximately 79%. The degraded grid voltage relays on both the 4160V and 480V emergency busses will operate and begin timing. The RCP will be up to speed and the voltage transient subsided within 50 seconds. The degraded grid voltage timing relay, being set for 90 seconds, will not time out. There will be no spurious trip of the offsite source. The diesel generator will start, due to a voltage drop below its set point of 83%. It will not be placed on the bus, and it will be manually shutdown when the transient subsides.

Either under normal or accident conditions, none of the emergency equipment will be subjected to less than 90% voltage for longer than 90 seconds.

ANSI Standard C84.1-1973

With regard to your reference to this standard, we question its applicability for the following reasons:

1. The standard does not address the voltage range capabilities of the electrical components. For example, ANSI C57 specifies the maximum voltage for a transformer in an unloaded condition is 110%. Also, NEMA MG-1 relating to motors permits plus or minus 10% of rated voltage. Further, NEMA Part 2 covering motor control centers indicates a permissable voltage range of 85 to 110% of rated voltage.

2. The standard relates to electrical supply system ranges for sustained voltages rather than component capabilities.

We, therefore, feel the standards for the individual components should apply in reference to sustained voltage variations rather than ANSI Standard C84.1.

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FORM D 23-31112

Duquesne Light Company

SHEET ___ OF ___

JOB TITLE *Beaver Valley P.S. – Unit #1*

FILE NO. / O.F.E. NO. *Graph #1*

LOCATION

C.O./J.O.

SUBJECT *Voltage Study*

COMPILED BY: *[initials]*

DATE: *10/8/79*

DEPARTMENT

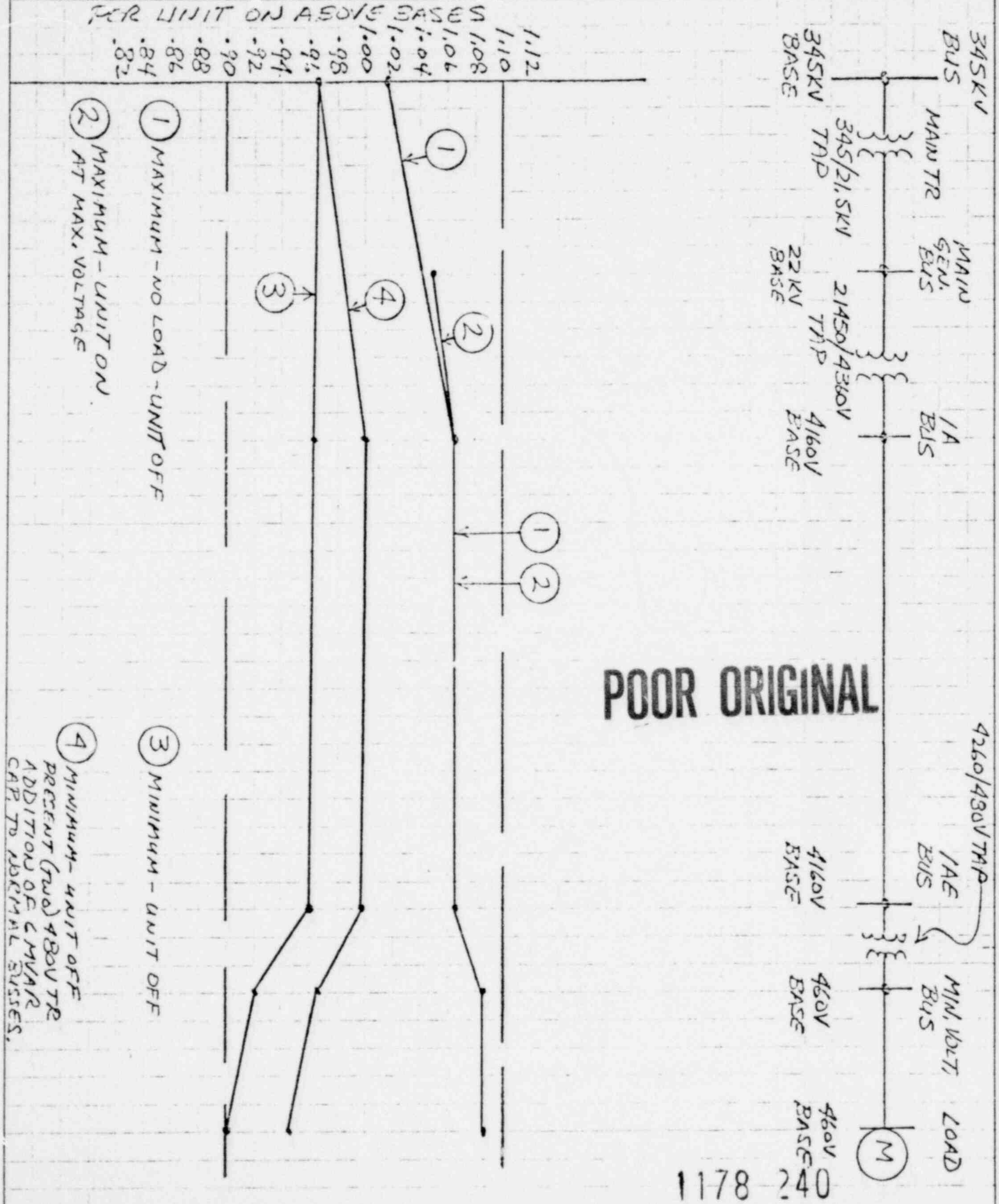
CHECKED BY:

DATE:

DIVISION

REVISED BY:

DATE:



POOR ORIGINAL

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FORM D 23-31112

Duquesne Light Company

SHEET ___ OF ___

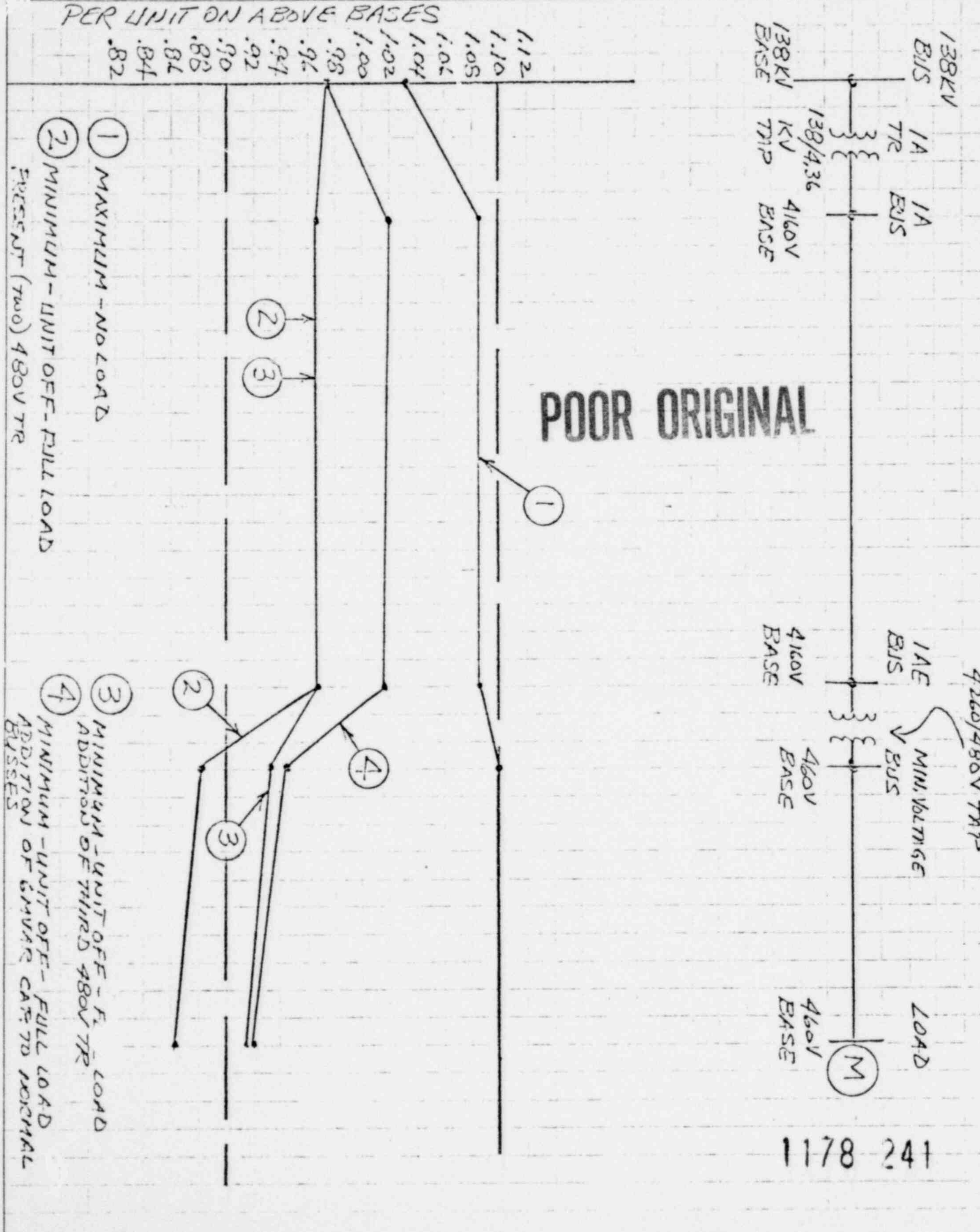
JOB TITLE BEAVER VALLEY P.S.-UNIT #1 | FILE NO. O.F.E. NO. GRAPH # 2

LOCATION | C.O./J.O.

SUBJECT VOLTAGE STUDY | COMPILED BY: [illegible] | DATE: 10/3/79

DEPARTMENT | CHECKED BY: | DATE:

DIVISION | REVISED BY: | DATE:



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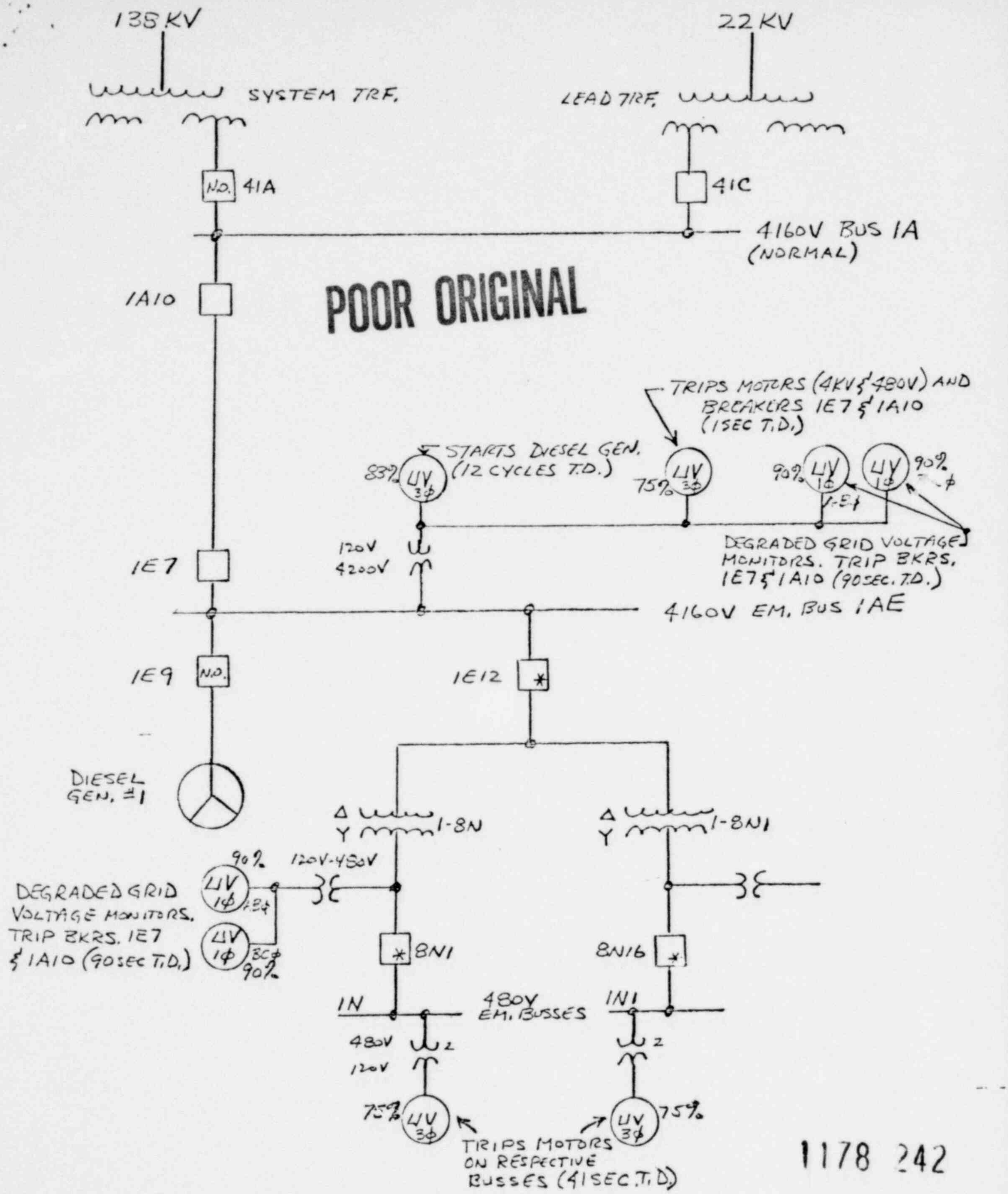

POOR ORIGINAL

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NOTES: UV = UNDERVOLTAGE RELAYS

BUS 1D, 1DF, 1P & 1P1 ARE SIMILAR

* = NOT TRIPPED ON UV

BEAVER VALLEY P.S.
UNIT #1
PROPOSED UNDERVOLTAGE PROT.
10-8-79