NRC FORM 195 (2-76)

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DESCRIPTION

Ltr notarized 11-17-76....trans the following in response to our 8-13-76 ltr.....

ENCLOSURE

Analyses of the effect of degraded grid voltage on the operability of safety related equipment.....

DO[illegible]VE

ACKNOWLEDGED

PLANT NAME: DC COOK #1

SAFETY — FOR ACTION/INFORMATION — ENVIRO 11-19-76 ehf

	ASSIGNED AD:		ASSIGNED AD:
✓	BRANCH CHIEF:	Ziemann (5)	BRANCH CHIEF:
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NRC FORM 195 (2-76)

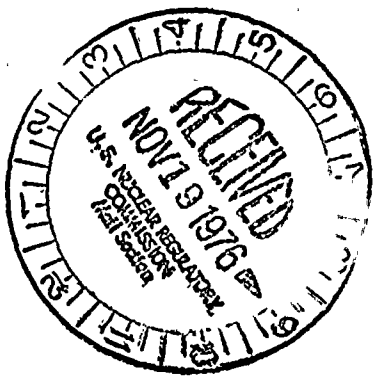
Regulatory Docket File

INDIANA & MICHIGAN POWER COMPANY

P. O. BOX 18
BOWLING GREEN STATION
NEW YORK, N. Y. 10004

November 17, 1976

Donald C. Cook Nuclear Plant Unit No. 1
Docket No. 50-315
DPR No. 58



Mr. Benard C. Rusche, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Rusche:

This letter transmits the results of analyses of the effect of degraded grid voltage on the operability of safety related equipment in response to Mr. Dennis L. Ziemann's request of August 13, 1976.

Due to the complexity of the analyses, on September 17, 1976 we requested a 60-day extension in order to provide all the necessary information. Enclosed please find 40 copies of Attachment A which addresses Enclosure 2 of Mr. Ziemann's letter of August 13, 1976.

Very truly yours,

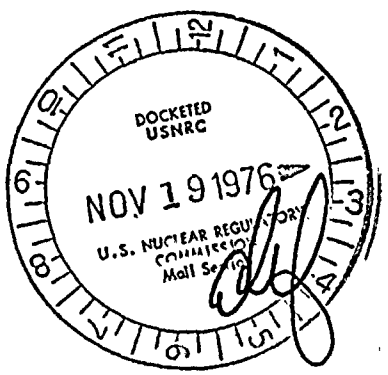
John Tillinghast
Vice President

JT:vp

Sworn and subscribed to before me
this 17th day of November 1976
in New York County, New York

Kathleen Barry
Notary Public
KATHLEEN BARRY
NOTARY PUBLIC, State of New York
No. 41-4606792
Qualified in Queens County
Certificate filed in New York County
Commission expires March 30, 1977

cc: (see next page)



11804

cc: G. Charnoff
P. W. Steketee
R. C. Callen
R. J. Vollen
R. Walsh
R. W. Jurgensen - Bridgman
R. S. Hunter

ATTACHMENT A

Evaluation of the Design of Cook Plant
Class IE Electrical Distribution System

An evaluation was made of the operability of safety related equipment, including associated control circuitry and instrumentation, as requested in your Enclosure 2.

The numbering below corresponds to Enclosure 2.

1a. Plant conditions under which the plant auxiliary systems (safety and non-safety related) will be supplied by offsite (reserve power) are the following: during startup; during shutdown; and during periods when auxiliary power supplied by unit generator (26/4 kV transformer (s)) is unavailable. Accordingly, it is estimated that for 2.3 percent of "normal plant operating time" the auxiliary buses will be powered from an offsite source (reserve power transformer(s)). In reaching this percentage figure the following definitions have been adopted:

a. Startup time: From reactor critical to transfer of auxiliary buses to auxiliary transformers after paralleling.

b. Shutdown time: From transfer of the auxiliary buses to the reserve source to the time when the reactor is not critical.

c. Auxiliary Transformer (s) unavailable: Cook Plant experience in this mode being zero, the following assumption was adopted: one auxiliary transformer out of service for 3 months during the entire life of the unit (40 years).

d. Total "normal plant operating time" equals total "reactor critical time".

1b. Normal operating range of grid system voltage is 355 kV ±3 kV. The corresponding voltage values at the safety related buses with the auxiliaries powered from the reserve source is as follows:

	345 kV	34.5 kV	4 kV	600 Volt
Max	358	35.5	4160	591
Min	352	35.0	4090	578

1c. With the generating unit out of service, the 345 kV system voltage is expected to be within the normal range of 352 to 358 kV. However, a combination of contingencies well beyond normal planning criteria and more severe than actual experience was chosen so as to produce a very extreme but highly unlikely range of network voltage levels.

The voltage profile at the safety related buses for the auxiliary full load and auxiliary minimum load conditions on the system (assuming this extreme range of grid voltage) with the auxiliaries powered from the reserve source is as follows:

	345 kV	34.5 kV	4 kV	600 Volt
1) Full Auxiliary Load & Min. Grid Voltage	322	31.9	3.66	510
2) Min. Auxiliary Load & Max. Grid Voltage	369	36.9	4.44	631

These were calculated using the transformer taps currently in use. The transformers which supply the auxiliary buses within the plant have five fixed taps which are set in such a manner as to provide the optimum voltage profile for the full range of anticipated operating conditions.

Case 1 represents "Hot Standby load" with the unit out of service and minimum grid voltage (322 kV). Case 2 represents "Cold Shutdown load" (minimum conceivable load) and maximum grid voltage (369 kV). Case 1 shows a 600 volt bus voltage of 510 volt, (.887 p.u. on a 575 volt base). Since it is proposed to operate all ESS equipment within the NEMA rating of ±10%, the ESS buses will be taken off the reserve source before this voltage level of 510 is reached. In Case 2 the 4 kV bus voltage of 4440 volt (1.11 p.u.) and the 600 volt bus voltage of 631 volts (1.09 p.u.) do not significantly exceed NEMA rating and are acceptable.

1d. Assuming auxiliary loads are being carried by the station generator, voltage profiles at the safety buses for grid voltage at the normal maximum value and the normal minimum value are as follows:

	345 kV	26 kV	4 kV	600 Volt
Grid Volt Norm Max. Value	358	25.5	4.10	573
Grid Volt Norm. Min. Value	352	26.7	4.32	613

If the generator terminal voltage is brought as low as .95 p.u. (24.7 kV) the ESS buses*voltage levels are still satisfactory, that is, .989 p.u. (3960 volt) at the 4 kV buses and .927 p.u. (577 volt) at 600 volt buses.

Safety Buses Voltage Profile When Grid Voltage is at Degraded Conditions which would require generator trip

Automatic generator trip for degraded grid voltage conditions is not provided. Under these conditions unit output would be reduced to obtain additional reactive capability to sustain generator terminal voltage. When operating the generator at its reactive capability limits and terminal voltage below 95%, operation would continue while monitoring generator temperatures and the auxiliary buses voltage limits. See Paragraph "4a". However, we know of no system condition that would require this type of operation.

1e. The undervoltage sensors (G.E. NGV relays) will sense a voltage failure, disconnect the emergency buses from the offsite power source and start the diesel generators. These undervoltage sensors are listed in Table 1 below. The trip setpoint for Cook Plant loss of offsite power is set at 60% (2400 volt) voltage. The reason for the selection of such a low value is that it is voltage failure that is being monitored and not abnormal voltage. There is no undervoltage trip at present. See Paragraph "4b" for proposed new scheme.

Table I

Undervoltage Relay (G.E. NGV's) Locations

4 kV Bus monitored	Undervoltage Relay Designation	Electrical Location
T11A	27-T11A	ϕ1-ϕ2
T11A	27-1-T11A	ϕ2-ϕ3
T11B	27-T11B	ϕ1-ϕ2
T11B	27-1-T11B	ϕ2-ϕ3
T11C	27-T11C	ϕ1-ϕ2
T11C	27-1-T11C	ϕ2-ϕ3
T11D	27-T11D	ϕ1-ϕ2
T11D	27-1-T11D	ϕ2-ϕ3

*Engineered Safeguards System Buses. Also referred to as safety related buses.

1f. Assuming operation on offsite power and degradation of the grid system voltage:

a. The voltage value at the safety related buses corresponding to the maximum value of grid voltage is as follows:

345 kV	34.5 kV	4 kV	600 Volt
369	36.9	4.44	631

b. The degraded grid voltage corresponding to the undervoltage trip setpoint proposed (see Paragraph "4b") is 327 kV. The profile is given below:

345 kV	34.5 kV	4 kV	600 Volt
327	32.4	3.74	518

1g. The voltage range over which the safety and non-safety related components can start and operate continuously in the performance of their designed functions is as follows:

	NEMA Rating ±10%	
	4000 Volt Class	600 Volt Class
Safety Related Loads	4400-3600	632.5-517.5*

*Safety related equipment rating is 4000 volts and 575 volts, therefore 90% and 110% values are based on 4000 volt and 575 volt, respectively.

The above voltages apply for power requirements for all motor sizes. For motor sizes larger than 100 hp, controls operate from the 250 V DC batteries. Battery chargers are subject to no derating for source voltage variation of ±10%. Reactor instrumentation and protection equipment are also fed from 250 V DC through inverters and are not affected by degradation of the grid voltage. Control power for motor sizes less than 100 hp comes from AC control transformers installed within the MCC's. Voltage level ranges required for the control of these smaller motors is as follows:

	From	To
Motor Starter Size 1	460 volts	632.5 volts
" " " 2	512	"
" " " 3	542**	"
" " " 4	533**	"

**Review and analysis of control circuits for size 3 and 4 starters demonstrated that for bus voltages below 542 and 533 volts respectively reliable contactor operation on energizing could not be assured. As these voltages are above the 518 volt minimum for the 600 volt bus voltage listed in response to question "1f", we propose to modify these starters (see paragraph 4d) to enable them to operate for voltages as low as 480 volts (80% of rated).

1h. The bus voltage monitoring and abnormal voltage alarms available in the control room are as follows:

Table II

(a) List of Bus Voltage Monitoring in the Control Room (Voltmeters)

Bus Monitored	Voltmeter Location
4 kV buses 1A and 1B	Station Auxiliary Panel "SA"
4 kV buses T11A and T11B	" " " "
4 kV buses 1C and 1D	" " " "
4 kV buses T11C and T11D	" " " "
600 V buses 11A and 11B	" " " "
600 V buses 11C and 11D	" " " "
345 kV bus 1	Generator Panel "G"

(b) Currently, there are no undervoltage alarms available in the control room (see Paragraph "4a" for alarms to be added).

2. Description of load shedding feature at Cook Plant. On undervoltage trip, the logic initiates the following actions:

a. The auxiliary bus source is disconnected from the emergency power system.

b. Existing loads are shed from the 4 kV emergency buses.

c. Onsite emergency power sources (diesel generators) are started.

d. Sequencing of the emergency loads is initiated.

At present the load shedding feature is retained after the diesel generators are connected to the emergency buses. Retention of the load shedding function after the diesel generators are connected to the emergency buses is based on the following: Voltage failure ($V \leq 60\%$) causes the load shedding relays to be energized and the load shedding function activated. At such a low voltage the system cannot operate; removal of the load shedding function was not considered. However as a result of this analysis we are proposing to revise our load shedding scheme as outlined in Paragraph "4c" below.

3. Operating limits are given by the generator capability curve. As indicated in the PSAR, the D. C. Cook Unit No. 1 has no operating constraints imposed by transient stability performance considerations. With the unit operating at full load, steady state stability considerations limit the underexcited reactive power to approximately 350 MVAR's. The overexcited reactive power output at full load is limited to approximately 600 MVAR's by generator thermal design considerations. Note that the Unit operates at its overexcitation reactive power limit of 600 MVAR's when the D. C. Cook 345 kV bus voltage is at normal minimum of 352 kV or at the lowest credible voltage of 337 kV. Similarly the unit operates at its underexcitation reactive power limit of 350 MVAR's for the conditions when the D. C. Cook 345 kV voltage is at normal maximum of 358 kV or at the highest credible voltage of 369 kV.

The generator capability curve applies for voltages between 95% and 105% of rated generator terminal voltage.

For frequencies between 58 and 59 HZ the operator is instructed to load reject the unit within 30 min. If frequency decreases to 58 HZ the operator is instructed to load reject the unit immediately. For voltage below 95% operation would be as described in Paragraph (1d).

4. As a result of the analysis performed in response to Items 1-3 above, the following modifications are proposed at Cook Plant.

a. Addition of low voltage alarms on the 600 volt

and 4 kV ESS buses. Issuance of operating instructions to be used for operation of the generator at voltages other than rated.

b. Addition of automatic circuitry to insure that the ESS bus loads cannot be disabled by a degraded offsite power supply. This will be accomplished by:

1. Installation of potential transformers and under voltage relays on the reserve source (34.5 kV).

2. Interlocking will be installed to initiate ESS bus load shed and Diesel Generator start for 34.5 kV voltage less than 94% (32.4 kV) when the 4 kV reserve bus feeders are closed. This circuit will have a two second time delay to avoid spurious operation due to grid transient conditions.

c. Revision of the Diesel Generator load shedding circuit to remove the recycle capability now inherent in the circuit. The new revision will insure that no load shedding can take place once ESS load has been transferred to the Diesel Generator.

d. Modification of the control circuitry for motor starter sizes 3 and 4. It is proposed to equip these contactors with 600 volt rated starter coils. An interposing relay will be used for energization of the starter coil, and allow reliable starter operation well below the 518 volt bus limit.