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July 21, 1983

Mr. Nicholas S. Fioravante
Auxiliary Systems Branch
Division of Systems Investigation
Office of Nuclear Regulatory Research
M/S P-1022
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Nick:

In our previous work on alternative safe shutdown with the Auxiliary System Division, we ended with one unresolved technical issue. The concern in brief is that a fire could cause the secondary leads of a current transformer to open and bring about possible adverse effects on alternative safe shutdown. A telephone conference call was held on October 25, 1982 between NRC and BNL personnel concerned. A telephone memorandum was written at that time by Max Wertheim. This memorandum is Attachment 1 of this report.

We have given a more detailed description of the problem in Attachment 2 to this letter and would appreciate a review of this issue by the NRC staff. Since we still have this concern, and since we want to be consistant in our inspections, we intend to raise the issue in the upcoming field inspection.

If we can give further clarification to the problem please contact me.

Very truly yours,

E. A. MacDougall, Task Leader
Engineering Analysis and
Human Factors Group

EAM/smm
Attachments
cc: R. E. Hall
J. H. Taylor
W. J. Luckas, Jr.
File

Attachment 1

BROOKHAVEN NATIONAL LABORATORY

MEMORANDUM

DATE: October 25, 1982

TO: Post-Fire Safe Shutdown Group

FROM: M. Wertheim

SUBJECT: Generic Issue, Current Transformer (CT) Protection.

Background

On October 22, 1982, a telecon was held between BNL personnel and NRC staff concerning current transformers. Participating in the call were:

NRC	BNL
K. Knight (PSB)	R. Hall
E. Rossi (ICCB)	W. Luckas, Jr.
V. Panciera (ASD)	E. A. MacDougall
N. Fioravante (ASD)	M. Wertheim
P Guild (PSB)	

BNL had brought to NRC's attention that licensees may not be preventing CT secondary circuits from generating very high voltage transients caused by opening said circuits due to fire damage. These high voltages will be coupled to the primary circuit, causing further damage. The high voltages could ultimately destroy the CT, and may, in that process, start another fire, either in the cabling or in the transformer. Protection can be implemented in a number of ways, among which are:

- Voltage clamps or transient suppressor/absorbers
- High speed detection and shorting equipment.

Any method used must be able to handle the energy supplied by the primary power source.

The above applies to CTs used to monitor current flow and read out remotely as in the control room. The secondary cables thus can run through one or more fire zones between the CT location and control room readout. The most likely primary source components to be damaged will be the circuit breaker. If the CTs are those used to monitor diesel-generator power, the risk is run of losing a major on-site power supply. If the CTs are ones used to monitor a pump motor, the risk is run of losing an important safe shutdown component.

Telecon Results

The initial reaction of PSB's personnel was that there was no problem. However, after some questions addressed to technical matters, NRC staff personnel agreed there was some uncertainty. ASB personnel then stated that all plants currently under review, or about to start review, and for which reports had not been written could be questioned on this matter.

Suggested Question

Are all current transformers used to monitor electrical parameters in the control room, or other location remote from the power source or motor load, protected from the effects of fire damage causing open secondary circuit(s)?

MW/smm

cc: A. Coppola
S. Karimian
R. Hall
V. Lettieri
W. Luckas, Jr.
E. MacDougall
R. Smith
J. Taylor
H. Thomas
File

Attachment 2

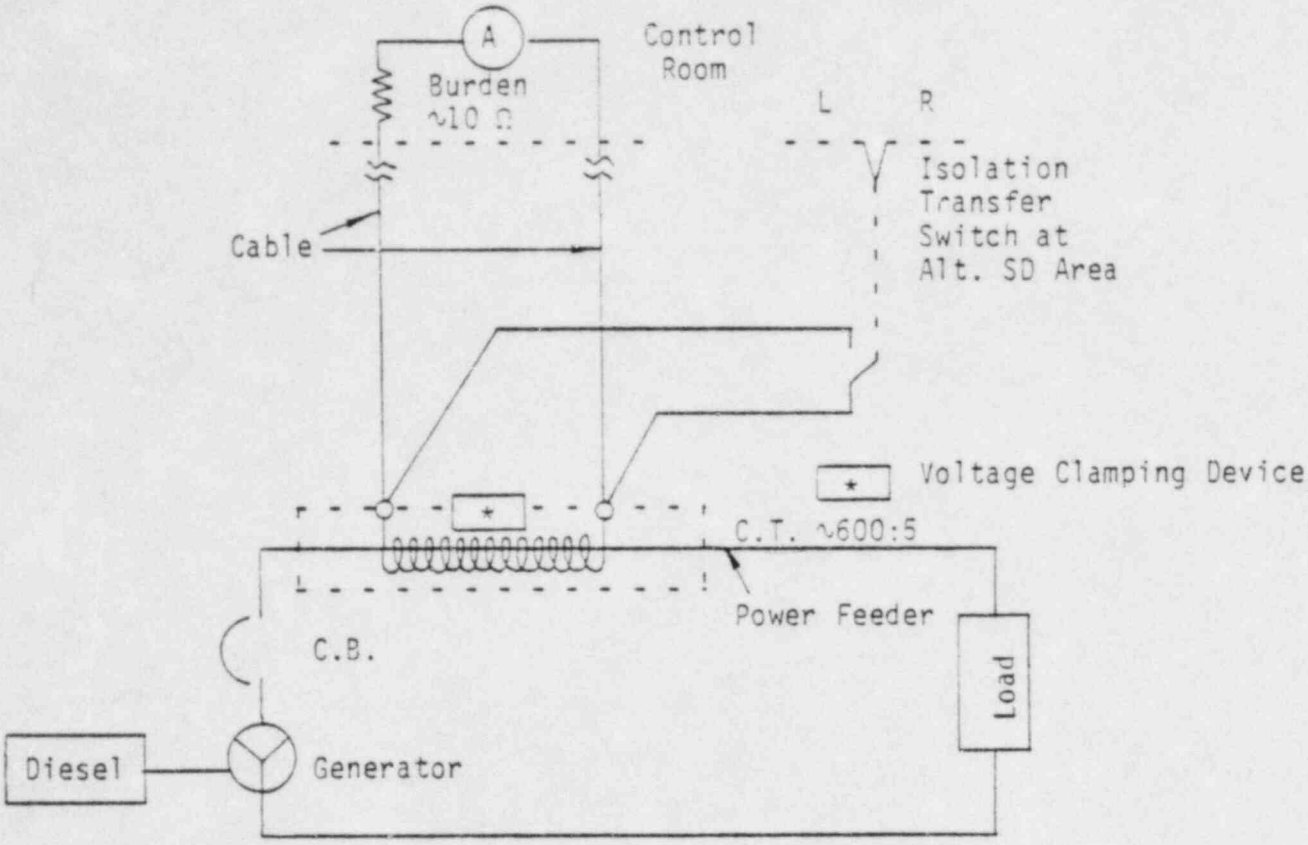

Figure 1.

Problem: Current Transformer (CT) secondary leads routed in cable through cable spreading room to control room. Fire damage could cause secondary circuit to open and the resulting transient could trip circuit breaker if CT does not first destroy itself. Furthermore, it could destroy breaker contacts and break down power feeder insulation, causing second fire. CT will probably destroy itself sooner or later. All of this could happen before an operator can reach isolation switch whose contact shorts secondary.

Background: If diesel generator is loaded to approximately full load (555-600 amps for Oyster Creek), secondary circuit will carry 4.6-5 amps due to law of equal amp-turns. If burden impedance is approximately 10Ω, maximum secondary voltage will be 10 x 5 = 50 V rms. Given a typical transformer ratio of 600:5 (120:1), the maximum primary (power feeder) voltage due to the transformer is then 50/120 = 0.42 V rms

which in negligible compared to generator voltage of 4160 V. However, if the secondary circuit opens, the circuit load can go to 10^8 Ω ±, driving the secondary voltage toward 5×10^8 V, and the reflected primary voltage toward 4.2×10^6 V. This is because primary (power feeder) current still flows. The reflected voltage appears between the power feeder and ground.

Damage Analysis: Unless the secondary is shorted within 1 cycle (approximately 16 ms), or unless there exists a voltage clamping device at the secondary terminals, the current transformer will ultimately self-destruct. However, a current transformer for a 4160 V system could have insulation rated for at least 11 kV, and industrial insulation usually has very large safety margins. Thus, it will take a few seconds to be destroyed by short circuit.

With the onset of the transient, the breaker's OV protection circuit starts to act. If this succeeds in tripping the breaker before the CT self-shorts, the breaker contacts will open at the transient voltage level present. This could severely damage or destroy the contact material due to the high voltage arc (the breaker, too, is rated for 4160 V service).

The diesel generator winding and the load will also see the transient, and either or both could be damaged depending upon their sensitivity and the time necessary for breaker trip and/or CT self-short. The isolation switch contact will also see the secondary transient and could break over--ultimate damage unknown.

Any event above can occur either on transient value (level) or on rate-of-rise (dv/dt) exceeding component-specific critical values.

There is also the possiblility of insulation breakdown of the power feeder cable or the secondary feeder.

Results: An unclamped or unshorted (external) CT circuit opened by fire damage could cause the following:

1. Self-destruction of the CT--a second fire may be part of this.

2. Destruction of the circuit breaker supplying the generator or other critical load with a resultant loss in that load.

3. Opening of a circuit breaker on a needed power circuit.

4. Power feeder breakdown--possible second fire.

5. Destruction of other sections of the secondary cable (upstream towards the CT) due to voltage breakdown.