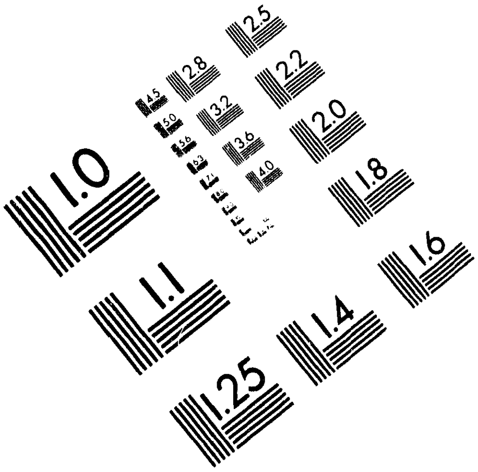

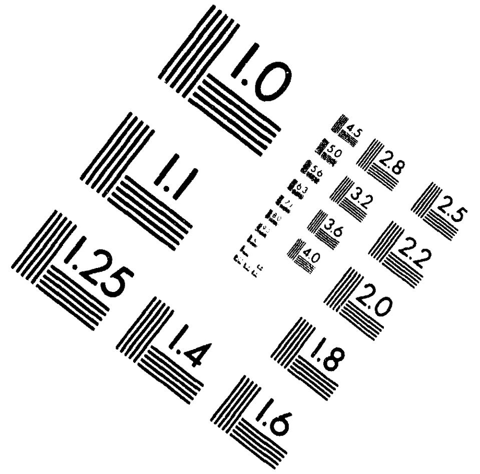

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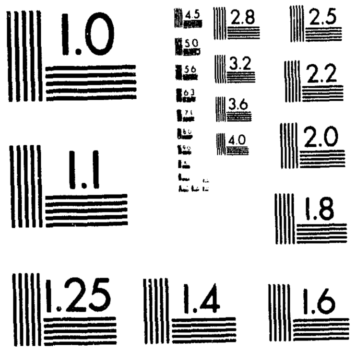

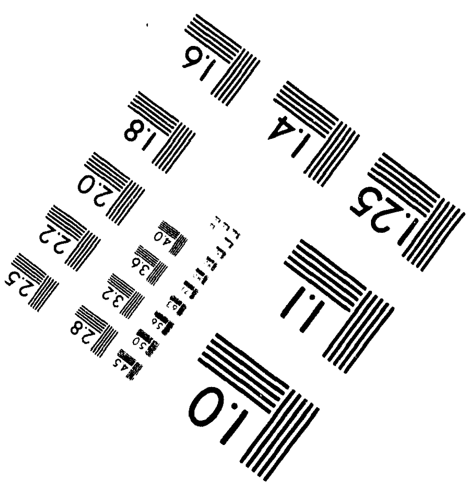

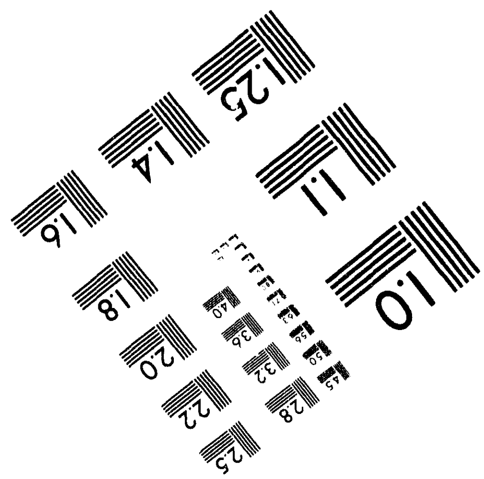

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D. L. Hirschel
1/10/69

DUN RECORDS DISPOSITION

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Destruction date until Reactor is abandoned
Authority 13-5-2

SECTION VII

REACTOR INCIDENT FILE

GENERAL INFORMATION

From 1945

By

Process Engineering Unit

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By Authority of W. A. Snyder 2-25-94
J. H. Wells 2-28-94
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DOUGLAS UNITED NUCLEAR, INC.

DISTRIBUTION:

RV Myers
RK Wahlen
File

DATE October 12, 1967

TO K. L. Hladek

FROM L. R. Monson

SUBJECT KW REACTOR SCRAM - 230KV, BREAKER #376 INTERRUPTION

At 11:13 am on 10-6-67, KW Reactor received a scram signal due to the interruption of breaker #376 on one of the 230KV feed lines.

At the time of the scram, the reactor was operating under an extended Critical "W" power condition (planned removal of electrical backup facilities during reactor operation). This power condition was placed in effect so that the updating modification of the 230KV transmission system could be accomplished. The planned duration of this condition was from 9-20-67 to 10-8-67. The wiring changes to breakers #376 and #372 had been completed and electricians were finishing their work on #372 (cleaning out cut leads and re-tieing wire bundles) when #376 opened. No wiring changes were being made at the time the relay opened. The relay was open for 4 seconds and then reclosed automatically. A thorough inspection of the system was performed in an effort to determine the cause of the interruption but no cause could be established.

Upon power loss, all the backup systems functioned as designed with the exception of Raw Water Valve #1. The breaker supplying power to this valve was found open; consequently, the valve did not close as it should have. This allowed water from the filter plant to drain back through this line to the river. This draining can take place only while the water level is above the filter plant inlet flume; therefore, total water loss could not occur due to the failure of the raw water valves to close. Apparently the breaker had not been closed after work had been performed on the system at some previous time. No tag was on the breaker and it had gone unnoticed until the scram occurred.

L. R. Monson
Process Engineer
Research and Engineering

LRM:cs

(Results of ~~further~~ checking
Recommendations?

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K W Reid

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October 11, [illegible]

[illegible]

At 11:14 a.m. on October [illegible], 1967, [illegible] was separated from BPA power when 230 kv OCB A-376 tripped. [illegible] in an extended critical power [illegible] condition with 230 kv OCB A-[illegible] opened and with both 230-13.8 kv primary transformers being supplied through OCB A-376. Power was restored in 4.3 seconds with the automatic reclosure of OCB A-376, however, [illegible] scrammed and stayed down for [illegible] hours and [illegible] minutes.

Investigation

There were no targets on any of the relays which can trip OCB A-376. Little checking was possible immediately following the trip-out of OCB A-376 because the other line breaker OCB A-372 was out of service for relay modification work (Project CAH [illegible] - Upgrading Protective Relaying).

On October 7, after OCB A-372 was restored to service, OCB A-376 was taken out for inspection. All of the wiring of the operating trip circuit was traced and checked satisfactory. There were no loose connections or broken conductors and no evidence of conducting material which might have come in contact with the terminals.

At the time of the incident, substation electricians were removing dead wiring from a de-energized panel (A-[illegible]) in the 230 kv substation control room. They are unaware of any actions which could have caused the trip.

Our analysis to date indicates three possible causes for the trip-out: (1) accidental bumping of the auxiliary relay in back of the electricians and across the aisle; (2) a dead wire shorting the trip bus to positive; (3) a short in the circuit from [illegible] to the auxiliary relay.

Conclusions

No cause for the breaker operation has been found. The investigation will be continued during a future scheduled reactor outage.

R. G. Ingersoll

R. G. Ingersoll, Manager
Electrical System Engineering

RGI:ds

cc: JH Dodd
RE Dunn
RT Hall
FJ Williams
OH [illegible]
LB

[redacted]
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RICHLAND, WASHINGTON

DOCUMENT NO.	SERIES AND COPY NO.	DATE
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TITLE

B-C Dual Area "Racoon" Scram
January 10, 1966

AUTHOR

ISSUING FILE

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DATE June 13, 1966

TO M. A. Clinton

FROM R. W. Wood

SUBJECT B-C DUAL AREA "RACOON" SCRAM, JANUARY 10, 1966

M A Clinton

Introduction

At 0308 hours on Monday, January 10, a racoon grounded the 13.8 kv C2-LS line which feeds the 182-B Building from the 151-B substation. B Reactor scrammed when an undervoltage condition caused a power failure trip. 190-B pumps 1 and/or 3 power failure relays opened and remained open for at least 26 cycles and tripped the PF and PFA relays. All steamers on automatic started due to the power failure relay trips. C Reactor scrammed when an undervoltage condition caused the PSR-PSRA relays to open. Trip identification display was "Pressure Monitor" and "Pressure Monitor Ground." all emergency backup systems functioned properly.
The export steamers at both 182-B and D came on within four minutes. The 182-B electric export pumps were restored to normal within nine minutes. One half of the 183-B filter plant lost power. The boilers at the 184-B Building responded normally to the minor increase in steam usage. All systems functioned properly.

Discussion

The C2-XS breaker, located at the 151-B substation, tripped at approximately 0308 hours on Monday, January 10, when a racoon grounded a 13.8 kv line between 151-B and 182-B. The C2-XS breaker feeds part of the 182-B, 183-B and 184-B Buildings. During a subsequent investigation by Process Engineering personnel, the information below was obtained and is summarized by building.

151-B

The operator at 151 substation heard the ground annunciator when the C2-XS breaker opened and he started to reset each breaker. The #8 breaker reset. Total time elapsed - less than one minute. The 74 breaker did not open.

105-C

The reactor scrammed at 0308 hours when a low voltage condition caused the PSR and PSRA relays to open (the "fail safe" condition). The trip identification display was "Pressure Monitor" and "Pressure Monitor Ground" detection. All HCR annunciators were received except the supply and #14. The #6 supply

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fan stopped operating. The thermal shield and riser pressure charts, as well as the power level and process flow charts, showed no unusual observations. The thermal shield flow had a blip at 0308 which is similar to the blips obtained when backwashing the 183-C filters. The blip as a single blip (-√‾), while the backwash blips are usually multiple (-√√‾).

The gas flow at C was erratic and abnormal and is summarized in the table below:

Time Interval	Minutes	Gas Flow (CFM)
0308	Scram	255
0308 - 0328	20	15
0328 - 0343	15	9
0343 - 0348	5	4.5
0348 - 0450	62	0
0450	Normal	300

The operator at 115-B reported that C Reactor did have gas flow during this time. No explanation for this condition has been found.

The bulk outlet temperature recorder showed no blip. On the control console extended range recorder, a blip was noted of about a magnitude that would correspond to 1.1 power level units.

190-C

All systems indicated normal conditions. The process water pressure was spiked as expected and decreased normally.

183-C

The systems investigated indicated normal conditions. The basin flows varied somewhat from each other. The south side flow was at 63.5, spiked to 64.2 and then decreased to 63.0. The north side flow was at 63.5 and just decreased to 62.0. It was not determined whether or not, a low voltage condition occurred at 183-C, supposedly, it did not.

105-B

The reactor scrammed at 0308 when a power failure indication greater than ~~26~~ 17 cycles caused the PF and PFA relays to open and the trip identification read "power failure." The 190 pumps 1 and/or 3 power failure relays opened causing the scram. All steamers on automatic came on immediately. The 190-B pumps Nos. 1 and 3 did not trip off; therefore, the underpower relays were open more than ~~26~~ 17 cycles, but less than 42 cycles since some 190 pumps would have been lost if the power failure was greater than 42 cycles. The 115-B gas pressure

[redacted]

[redacted]

for B Reactor fluctuated. Reactor outlet dew points increased 39 units. The outlet gas pressure fluctuated and averaged 2.0 inches of water. The inlet gas pressure fluctuated and averaged 2.8 inches of water. The gas flow remained relatively constant. Total reactor flow decreased normally. No power level abnormality was noted. The TORP increased 10 psi and remained there for 10 minutes. The loop header had been fluctuating, before the scram, and therefore, no data were analyzed.

190-B

The #1 and/or 3 pump power failure relay opened due to an undervoltage condition and caused B Reactor scram. All steamers on automatic came up immediately. All pumps were stable. The power failure relay is set at ~~22~~ 17 cycles. The diesel pumps at 182 were not affected. The TORP increased an indicated 10 psi. The charts at 190-B indicated that the export system pressure was at 226, decreased to 107, then increased to 300, and was finally stabilized at 265.

182-B

Three electric export pumps were on the line. Two of the pumps were affected by the racoon grounding the line; the third pump was on a different transformer. The indicated export pressure from 182-B charts decreased from 226 to 53 psi, remained there for about 5 minutes, increased to 122 psi for a few minutes and finally increased to a stable 241 psi. The pumps were put back on the line by the normal operating procedure, that is, using the rotocheck valves. These valves slowly open reducing any pressure surges. The surge suppressers did cycle.

183-B

The B-C crosstie was normal. The flume level had a blip of 0.3 feet. Four of the seven 183-B pumps (#1, 2, 3, 7) were lost.

184-B

The deaerator fluctuated for 7 minutes. The air pressure and feedwater temperature were normal. The steam pressure was fluctuating for 7 minutes. Heating steam pressure was normal. The following table shows variations in boiler paramenters.

	Boiler 1	Boiler 2	Boiler 3	Boiler 4
Air Flow (MPPH)	37.5-60	50	38-66	40-68
Steam Flow (MPPH)	30-50	10	27-50	26-49
Gas Temperature (F)	450-540	317	440-460	445-465
Feedwater Flow (MPPH)	13-40	20*	1-68	15-42
Feedwater Drum Level (Feet)	0-2.5	no data	5-.3	-.5-1

* Slight Blip

[redacted]

[redacted]

102-D

An indicated pressure reduction was noted at 0308 and the D steamers were started within 4 minutes. Although on manual start, these pumps can be placed on automatic and will start within 4 to 10 minutes. Electrics from B-3 came on the line and produced full flow with 9 minutes of trip.

Conclusion

It is concluded that the steam backup system functioned normally and gave adequate protection in this instance.

RW Wood	HI Burton	GL Smith

[redacted]

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CGJ:LB
LB

DATE January 17, 1966

TO A. R. Maguire, Manager
B-C Reactor Subsection
Manufacturing Section

FROM C. G. Jenkins, 1704-B, 100-B, 2-4367

SUBJECT POWER OUTAGE 100-B-C AREA

At 0308 on January 10, 1966, both B and C Reactors "scrammed" due to an electrical fault on Line C2-L8 caused by a raccoon coming in contact with the 13.8 KV line on top of transformer No. 2 at 182-B Building. Line C2-L8 relayed out at the 151-B Building. Details of the occurrences at 151-B are covered in the attachment.

C-Reactor scrammed due to reduced voltage on the pressure monitor system. The reduction in voltage caused the auxiliary relays of the pressure monitor ground detector to open, de-energizing the end result relays PSR and PSRA. The safety circuit trip identification system displayed "Pressure Monitor" and "Pressure Monitor Ground Detector".

B-Reactor scrammed by a power failure signal from 190-B Building. The power failure relays for pump numbers 1 and 3 opened due to these pumps contributing power to the fault. The power failure relays at 190-B remained open long enough for the end result relays PF and PFA to open. Since these relays are timed delayed, 0.26 seconds, the power failure relays must have remained open at least that long.

At the 190-B Building the steam turbines started due to the power failure relays for pump numbers 1 and 3 opening. The main process pumps remained stable and continued to supply normal flow to the reactor.

Pumps were tripped from the line at 182-B and 183-B Buildings. The surge suppressors cycled normally and the turbine export pumps started as a result of low export line pressure. No power equipment was affected in C Area.

This report was compiled from reports by G. Fiorelli, B-Processing; D. G. Winston, C-Processing; C. E. Harkins, B - C Power; and F. J. Mollerus, Facilities Engineering.

Any questions arising from this report may be directed to the author.

Concurred by:

F. J. Mollerus
Principal Electrical Engineer

C G Jenkins

C. G. Jenkins, Engineer
Plant Engineering, Mechanical
Manufacturing Engineering

CGJ:alz

Attachment

HANFORD UTILITIES AND PURCHASING OPERATION

GENERAL ELECTRIC

RICHLAND, WASHINGTON

99352

January 12, 1966

cc: FJ Mollerus
CJ Weeks
LB-File

JAN 1 . 1966

A. R. Maguire, Manager
B C Reactors
Douglas United Nuclear

INVESTIGATION REPORT
POWER INTERRUPTION - 100-B AREA

At 3:08 a.m. on January 10, 1966, a raccoon traveled along the aerial conduit pipes into substation C2S2 and onto the cable terminals of the No. 2 transformer serving 182-B. The resulting phase-to-phase and phase-to-ground faults caused voltage fluctuations, and sensing devices scrammed the 105-B and 105-C reactors. The reactors did not recover and were down an estimated thirty hours.

Description

Apparently the raccoon climbed the conduit wooden support structure to the pipes and then down between the 2.4 kv A and B phase bushings. The shock threw him diagonally across the transformer top onto or between the 13.8 kv B and C phase bushings. All bushings, connectors, and the transformer tank (ground) show considerable evidence of arcing.

There was a ground annunciation at the 151-B substation, followed by a breaker-trip annunciation when the relay tripped breaker C2X8 supplying 182-B and other loads. The substation operator reclosed the breaker in approximately one minute.

Comments and Recommendations

The incident was unique in that it was a double fault, successively involving two voltage levels, and varying impedances. On the low-side, the current magnitude remained below the instantaneous relay setting and the fault duration did not reach the overcurrent relay's minimum setting of 72 cycles. It is estimated that the 13.8 kv fault existed between 12 and 42 cycles.

The Utility is investigating the possibility of enclosing the transformer bushings with hoods, and will check with other utilities who experience similar animal problems. The access route which the raccoon used in this instance can be blocked, however, there are numerous alternate routes in this and other substations which cannot be eliminated. We understand that 100-B has a large population of raccoons living on waste scraps and basin fish. It is recommended that the Area landlord take steps to eliminate the food supply or have the State Wildlife Service trap out the animals.

C. M. Salina
Manager
Electrical Utility Operation

CM Salina:ag

PAT: PLEASE T/F COPIES FOR RS BELL & R.W. REID FOR INFORMATION. THANKS RD

DOUGLAS UNITED NUCLEAR, INC.

DISTRIBUTION:

RG Clough
RV Myers
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LB

DATE January 6, 1966

TO R. E. Dunn

FROM J. C. McLaughlin

SUBJECT FAILURE OF NO. 2 DIESEL AT 182 BUILDING

During a routine startup of the three diesels at 182 in conjunction with an EMS being conducted at 105-KW, the No. 2 diesel started and ran for a short period and stopped. The duration or period of time that the unit ran is unknown; however, it is the writer's opinion that it was less than one minute. We were busy checking other equipment and operations in conjunction with the diesels, primarily the opening of the check valve on No. 3 diesel pump discharge which opened in a satisfactory manner at this time. Continued attempts to start the No. 2 diesel, which I would estimate at six or eight attempts, finally resulted in the unit starting and running. The unit continued to operate in a satisfactory manner.

While in operation, it was noted that diesel fuel oil was leaking quite noticeably from both ends of the fuel supply strainers on this engine. We advised Transportation of the leak and requested the assistance of a diesel mechanic.

The unit was in continuous operation for approximately one hour while we flushed the crosstie line both to KE and to KW. After completion of the flushing and restarting the No. 2 unit three times, initiating signals from different remote locations, the unit started and operated satisfactorily in each case.

The diesel mechanic arrived at 1:00 p.m. He repaired the leaks, which were in the valves on the inlet and outlet of the strainers, and it was his opinion that this leakage resulted in a loss of an undetermined amount of fuel oil from the strainer and/or fuel lines to the cylinders from the strainers. Loss of the fuel oil from the lines resulted in air in the fuel oil lines to the cylinders. The attempts to restart the No. 2 diesel finally exhausted the air in the fuel line after which the engine fired and operated satisfactorily as described above.

Since the repair of the leak by the mechanic, two remotely initiated starts of this engine have been completed satisfactorily. We concur with the mechanic's diagnosis of the engine's failure to operate after starting due to air in the fuel line as previously described, and we are quite certain that this was the root of the trouble.

After witnessing the above described incident and subsequent startups of the engine since the incident, I am of the opinion that the trouble has been eliminated.

Bob

Please return for ~~History~~ → Memo.

Interesting to note #3 was the pump which recently lost the motor

DOUGLAS UNITED NUCLEAR, INC.

DISTRIBUTION:

DATE November 22, 1965

TO Distribution

FROM R. W. Hooper - R. W. Wood

SUBJECT <u>RAW WATER TRIP - C REACTOR</u>
<u>MAY 10, 1965 - ADDENDUM</u>

Ref "Raw Water Trip - C Reactor, May 10, 1965," R. W. Hooper and R. W. Wood, dated 5-26-65 (Confidential Undocumented)

Since the date of issuance of the above referenced document, additional facts have been presented. In light of these facts, referenced statements in the parent document are revised to read as follows:

<u>OBSERVATION 2 - PAGE 2</u>

The schedule called for valving off the crossunder to allow blanking of the crossunder valve to permit downcomer repairs. Although the front face specialist was new to Supplemental Crews (vacation relief) and was not familiar with C Reactor procedures, this is still a standard procedure at all reactors to notify the control room when valving is to take place during this critical period and to request them to relay this information to the 190 control room. In this case, communications procedures failed to give adequate coolant backup.

<u>OBSERVATION 4 - PAGE 2</u>

A 190-C operator saw the TORP dropping. Since he had been informed by Instrument Technicians that they were going to take the gauges out of service, he assumed that the reduction was caused by the Instrument Technicians behind the control panel valving off the TORP pressure gauges. This assumption was erroneous, although reasonable, and could have been verified.

<u>OBSERVATION 9 - PAGE 3</u>

The reactor was being supplied by three throttled electric pumps. Normal for coming off the crossunder is five electric pumps. However, had the 190 Chief Operator been informed of conditions according to procedures, this incident could have been avoided.

<u>RECOMMENDATIONS 3 - PAGE 4</u>

An extension handle should be installed above the high tank valve pit to allow easier opening and closing of the valve during high velocity flushes. The present valve, located inside the high tank valve pit, is located such that it is a safety hazard to operate the valve. An extension valve would also allow flow to be shut off faster than is now possible; thus, the high tanks will not drain as far and - if needed - more water would be available sooner in an emergency.

RW Wood:dl

RAW WATER TRIP - C REACTOR
MAY 10, 1965
ADDENDUM

J. W. Baker	1704-B	100-B	D-UN
R. S. Bell	1704-H	100-H	D-UN
R. G. Clough	1704-K	100-K	D-UN
R. E. Dunn	1704-K	100-K	D-UN
E. J. Filip	105-C	100-B	D-UN
C. N. Gross	1704-D	100-D	D-UN
C. E. Harkins	1704-B	100-B	D-UN
A. R. Maguire	1704-B	100-B	D-UN
R. V. Myers	1704-K	100-K	D-UN
J. R. Pierce	105-C	100-B	D-UN
R. W. Reid	1704-D	100-D	D-UN
R. W. Wood	105-C	100-B	D-UN
M. A. Clinton	1704-D	100-D	D-UN

IRRADIATION PROCESSING DEPARTMENT

GENERAL ELECTRIC

RICHLAND WASHINGTON

Incident File

October 25, 1965

R. S. Bell
Manager, Manufacturing

NO. 3 165-KE TURBOGENERATOR FAILURE OF OCTOBER 9, 1965

Summary

At 12:30 p.m. on October 9, 1965, an oil leak from the auxiliary oil pressure regulating valve supplying bearing lubricating oil to No. 3 turbogenerator at 165-KE was observed. Nos. 1 and 3 turbogenerators supplied by Nos. 2 and 3 boilers respectively were in service supplying 1000 kw's each to the 4160 volt buses at the time. The Power Supervisor called Maintenance for assistance and instructed his operators to prepare No. 2 turbogenerator for service and to place it in service if the leak could not be stopped. At 1:48 p.m., shortly after the weep hole on the regulating valve was blocked to stop the oil leak, the loading to No. 3 turbogenerator dropped off. Three to four minutes later the generator breaker opened. The Power Supervisor returned to the boiler room from 183-KE when notified of the failure and called the Processing Supervisor at 1:55 p.m. denoting the abnormal condition. No. 2 turbogenerator was placed in service at 1000 kw loading at 2:04 p.m.

Description:

At 12:30 p.m. on October 9 an oil leak was observed in the pressure regulating valve No. 17 supplying bearing lubricating oil to No. 3 turbogenerator at 165-KE. The Power Supervisor believed the oil leak to be due to a leaking diaphragm flange on the regulating valve. Maintenance was requested to stop the oil leak if possible and the two boiler room operators were instructed to prepare No. 2 turbogenerator for pre-start operation and to place this unit in service in the event Maintenance was unable to stop the oil leak. The supervisor then proceeded to 183-KE Building. He returned to the 165-KE boiler room when notified by the 165-KE Chief Control Operator of the generator failure. The Power Supervisor notified the Processing Supervisor of the failure at 1:55 p.m.

Maintenance personnel investigated the leaking oil pressure regulating valve and found the discharge to be from the valve top exhaust port rather than the diaphragm flange. Maintenance then proceeded to install gasket material secured by hose clamps over the leaking discharge port. At 1:48 p.m., shortly after the valve discharge port was covered, these events occurred:

1. 165-KE Control Room

   Chief Control Operator observed the loading on No. 3 turbogenerator to drop off. He attempted to pick up the load by increasing the turbine speed. In approximately three to four minutes the generator breaker opened.

GENERAL ELECTRIC

2. 165-KE Boiler Room

The Chief Operator was in the vicinity of No. 1 turbogenerator unit when an annunciator sounded on No. 3 turbogenerator control panel. Upon investigation, the annunciator for low turbine vacuum had activated and the generator load was zero. No annunciation was received that would denote low lube oil pressure or turbine trip and throttle valve (T&T Valve) closure.

The sudden loss of steam load caused unstable conditions in No. 3 boiler. Both Fireye systems, with accompanying annunciation, were cycling from one burner to the other.

The two operators concentrated on correcting No. 3 boiler problems before attempting to restart No. 3 turbogenerator or place the stand-by unit in service.

The Chief Operator then proceeded to No. 3 turbogenerator control station and noted that the turbine first stage steam pressure and vacuum were zero. He believed the trip and throttle valve to be tripped, but when he closed the manual screwed stem, an annunciator alarm was received indicating the generator breaker had opened. Approximately three to four minutes had expired since the initial annunciation. Two electrical limit switches are provided on the trip and throttle valve to: (1) open the generator breaker and activate an annunciator, and (2) activate electrical circuitry in the steam turbine pump starting medium. The trip and throttle valve must be in the closed position for these systems to be activated.

No. 2 turbogenerator was then placed in service at normal load at 2:04 p.m.

Observations

1. Following the return of conditions to normal, No. 3 turbogenerator was started in an attempt to diagnose the cause of the failure. When the turbine speed had attained 3000 rpm, normal is 3600 rpm, the governor relay valve oil pressure had exceeded 120 psig (normally 80 psig at 3600 rpm) and the auxiliary oil pump had not shut down. This would indicate low oil pressure in the supply line to the oil regulating valve because low pressure causes the auxiliary oil pump to operate.

   Maintenance's inspection of the oil system revealed the following:

   a. The diaphragm in regulating valve had ruptured, thereby permitting oil to flow into the top valve section and out the escape port (port previously blocked by Maintenance).

   b. The 80 psig pressure regulating valve, a valve ahead of the regulating valve that leaked, was found to be worn such that a malfunction could have occurred, thereby creating the high oil pressure (120 psig at 3000 rpm).

2. Examination of the pressure regulating valve revealed a diaphragm failure. The diaphragm was not original equipment but was one that had been cut

from a sheet of diaphragm material. We have no record of this diaphragm ever having been replaced and suspect that it may have been done during construction. This is the first trouble we have had on any of these regulators in the ten years they have been in service. They are checked periodically to see that they are maintaining the proper pressure but no other P.M. is done on them.

Since this failure, we have checked the diaphragm in the No. 2 KW turbogenerator lube-oil regulating valve, which was the only one available. It appeared to be in good condition but was replaced on the basis of its ten years of service.

3. Examination of the 80 psig regulating valve showed the valve to be worn but no other abnormality was detected.

4. No annunciations were received at No. 3 turbogenerator control panel of low lube oil pressure that would activate the trip and throttle valve.

5. Generator failure occurred at 1:48 p.m.; however, 105-KE Processing was not notified of the incident until 1:55 p.m.

6. Power Supervisor was not present when the failure occurred although he was aware of unusual conditions.

7. The turbogenerator trip and throttle valve closes automatically only on low bearing oil pressure (5 psig), turbine overspeed, or generator breaker trip.

8. The Processing Supervisor went to 165-KE when notified of the failure to determine firsthand if he would have to shut the reactor down. Process Standards permit reactor operation for up to 10 minutes with only one turbogenerator on line. Specific instructions were given to the Reactor Specialist to remain in the 105 control room to receive messages from 165 control room.

9. Persons directly involved included:

   F. L. Nacke, Supervisor, Power
   C. L. Stairet, Supervisor, Processing
   T. A. Huske, Chief Control Operator
   J. R. Miller, Chief Operator
   O. B. Godwin, Journeyman Operator
   G. N. James, Supervisor, Maintenance
   G. M. Byerly, Pipefitter

Probable Cause of Failure

Oil system pressure probably cycled momentarily after the regulating valve weep hole was blocked, tripping the "trip and throttle" valve. The "trip and throttle" valve failed to close sufficiently to engage the limit switches. Manual closing of the "trip and throttle" valve tripped the breaker, isolating the generator from the bus.

GENERAL ELECTRIC

Corrective Action Taken or Planned

1. Power Supervisors and the 165 Chief Control Operators were instructed to inform the Processing Supervisor immediately of any failure of emergency systems.

2. Regulating valve diaphragms on other units will be replaced as the units become available.

3. The 80 psig oil pressure regulating valves will be given Class A overhauls as they become available.

4. Power Supervisors have been instructed to be present during abnormal situations involving emergency backup facilities insofar as practicable.

5. Thorough inspections of all turbine "trip and throttle" valves will be made as units are available.

6. Manufacturing Engineering was requested to review the design of turbine "trip and throttle" valve limit switches.

7. The Processing Supervisor was cautioned on leaving the 105-KE Building.

8. "Certification" of Power Supervisors as a longer range program will be pushed.

9. Manufacturing Engineering will be requested to review EMS's and PM programs affecting turbogenerators in light of this failure.

Roy E. Dunn

Manager, KE-KW Reactor

Roy E. Dunn:r

cc: RG Clough
JW Frymier
SM Graves
JC McLaughlin
EJ O'Black
RJ Pyzel-RV Myers
RW Reid
EE Weyerts
File
LB

October 14, 1965

EMERGENCY GENERATOR LOSS - 165-KE

At about 12:30 a.m., on October 9, leakage was noticed in the lube oil system of #3 turbo-generator, which was on the line supplying backup power along with #1 turbo-generator. It was decided at that time to bring #2 turbo-generator on the line and take #3 off for maintenance, and so Power operations started warming #2 up prior to its being put in service. At 1:54 a.m., #3 turbo-generator tripped off the line due to low lube oil pressure. At about 2:04 a.m., #2 turbo-generator was placed on the line, thus returning the secondary backup system to normal.

S A Wood

Process Engineering Unit

SA Wood:md

cc: MA Clinton ←
KE Incident File

IRRADIATION PROCESSING DEPARTMENT
GENERAL ELECTRIC
RICHLAND, WASHINGTON
99352

ACCENT ON VALUE

July 26, 1965

RS Bell
ML Faught
SM Graves
JW Green
CN Gross
JW Hedges
AR Maguire
FJ Mollerus
EJ O'Black
OC Schroeder
FF Vlacil

July 22

POWER INTERRUPTION JULY 21, 1965 AT 100-D

At approximately 9:15 a.m. July 21, 1965, a power interruption to two 220/13.8 KV transformers (Nos. 1 and 3) caused power to be removed from buses 1, 3, and 4 at 100-D Area, resulting in the loss of all but two 4500 HP pumps and scram of the 105-D Reactor. A recovery attempt by D Reactor was successful.

A critical W power condition was set for Electric Utilities to perform maintenance work on the 220 KV system. The bypass around feeder breakers A-342 and A-346 and bus-tie breaker A-344 was closed. Breaker A-342 was open, and breakers A-344 and A-346 were closed. Transformer #2 was being fed through breaker A-346, and transformers #1 and #3 were being fed through breakers A-346 and the bus-tie A-344. When an attempt was made to close A-342 during the performance of the work, it failed to close and bus-tie A-344 opened. This removed power from transformers #1 and #3 and tripped off all but two of the 4500 hp pump motors, causing D Reactor to scram. The emergency generator at 184-D came on as it should. The supply fans and dampers at 105-D operated properly, and the trip indicator in the 105-D Control Room indicated the proper readout. The operating status of D-Reactor allowed 1 1/2 hours for scram recovery which was sufficient time to return all power to normal and recover from the scram using cold start-up procedures. No improper equipment operation was reported. The cause of the breaker malfunction has not as yet been determined. More investigation of the problem will be made by Electrical Utilities when D Reactor goes down for at least a minimum outage.

inspection

on after completion

Engineer,
Plant Engineering-Electrical

G. Kestell/rca

cc: Letterbook
File

July 23, 1965

G. W. Wells, Manager
D Reactor Power
1704-D Building, 100-D Area

PRELIMINARY REPORT
POWER INTERRUPTION - 100-D AREA

On July 22, 1965, at 9:16 a.m. a three minute partial electrical outage occurred at 100-D, interrupting two-thirds of the power to the Area and scramming 105-D.

Utility electricians were making the annual routine check scheduled for 230 kv oil circuit breaker No. 342 and had electrically isolated the unit from the 230 kv system. When the electrician operated the control switch on the breaker in order to check its closing, he heard the adjacent breaker, No. 344, trip open. This removed two primary transformers from service, leaving only one to supply the Area.

The attendant substation operator took immediate steps to restore all power by 9:19 a.m., and the reactor subsequently recovered.

An investigation found there had been no human operational error, however, an odor of smoke was detected in OCB No. 342. Electrical checks of circuits found they were normal. The situation, prior to the incident, was then re-established, the operation simulated, and no misoperation of No. 344 occurred when No. 342 was closed.

The Area's system arrangement was returned to normal, and no switching operations for routine maintenance will be performed until after a complete investigation when the reactor is on shutdown. At that time, tests will be made on high voltage insulation and control wiring.

Manager
Electrical Utility

CM Salinas:ag

cc: FJ Mollerus
CW Weeks
LB - File

8/2/65

Recap of Boiler Loss Event

All information below should be treated as preliminary and subject to modification and/or deletion when the final report of this incident is released.

Operating Reactor at time of Incident was KW with KE down, Been shutdown since 1005 on 7/30/65

Date of Incident – 7/31/65

Summary of Events – At approximately 0815 (the man in charge of that power shift stated the event described probably occurred between 0810 and 0815) on the above date a power operator noted less than normal brightness coming from the front viewing ports on #3 boiler. His first action was to increase the firing rate via the boiler controls which was unsuccessful. At some point in time, and I assume it was here, the operator notified the shift supervisor he had lost the fire on #3 boiler and the supervisor started out to the boiler room. The next action reported was to ignite a torch to manually start the fire since the automatic restart mechanism had failed to restart the fire. The torch was inserted but was blown out or snuffed out presumably because of excess air. The controls were adjusted to decrease the forced draft fan speed. The lighted torch was inserted again and it is reported that flame and soot blew out of the manual igniting port but, the burners were ignited and steam pressure (which by this time had decreased to 280 psig) was raised to about 400 psig. It was at this time the shaft on the forced draft fan failed; whereupon the Power shift supervisor notified the 105 specialist that a reactor shutdown might be required. The specialist relayed this message to the 105 shift supervisor

Preliminary & dialog get together

SM Graves
OC
Dummy

who was just entering the control room. The 105 shift supervisor called the Power supervisor via the sound-powered phone and was apprised that #3 boiler had been lost. The 105 shift supervisor ordered the reactor be shutdown at the normal rate. From the 105 console log the reactor was started down at 0844 and scrammed from 100 units at 0854.

Observations – There may be a loop-hole or trap in our present Process Standards if indeed we want to firmly require that a reactor be down within 10 minutes after a generator or boiler failure. The trap is that when a generator or boiler failure occurs, some amount of time will be expended to get the boiler and/or generator back in service. This is normal practice and I'm of the opinion we would not want to change this. In other words, when a fire goes out on a boiler, for example the personnel should first attempt to restart the fires and not run to a phone to report the problem. You can see then that the actual failure is not reported to the reactor operating personnel until this effort to regain normal operating status has been expended. As far as the reactor personnel have immediate knowledge of the problem is when it is reported to them and they can logically assume this as time zero and they have 10 minutes from that point in which to get the reactor down.

A possible solution to the above would be to assume that the amount of time you want to allow for ascertaining and/or correcting a problem is all used by the Power personnel and when they give notification to the 105 there should be a #1 S.C. scram. This would avoid compounding or adding to the length of time between equipment failure and action to attain a safer situation.

Another alternate ~~has~~ been suggested of relaxing the secondary system requirements when one K reactor is already shutdown. This is not new as the pre-844 Process Standards contained similar requirements. There are pros & cons to this one but overall I favor looking into this further since there is justification especially when you consider the secondary system to a single K reactor has a backup in the form of the steam driven pump.

Overall, I did not elaborate on Process Standard violations associated with this incident since the writeup I feel is self-explanatory and also this is all preliminary and not necessarily official-type information.

Richard D. Hickman

RW Process Engineer

DECLASSIFIED

[redacted]

(CL[redacted])

GENERAL ELECTRIC

HANFORD ATOMIC PRODUCTS OPERATION – RICHLAND, WASHINGTON

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TITLE

BPA POWER INTERRUPTION AT K PLANT

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AUTHOR

S. A. Wood

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(CLASSIFICATION)

54—5000—002

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IRRADIATION PROCESSING DEPARTMENT

GENERAL ELECTRIC

RICHLAND, WASHINGTON

99352

[redacted]

1. MA Clinton
2. RD Hickman
3. SA Wood-File

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This document classified by MA Clinton

July 1, 1965

M. A. Clinton, Supervisor
Process Engineering

BPA POWER INTERRUPTION AT K PLANT

Ref: Letter, G. Kestell to Distribution, "Power Interruption to Bus #2, 165-KE, June 25, 1965," dated June 30, 1965.

At 10:50 a.m., on June 25, BPA power was lost to #2 bus due to a switching error at 165-KE (see reference above), and was completely restored to normal by 11:25 a.m. KW reactor was operating at the time and was unaffected by the power loss. KE reactor had been down since 8:24 p.m., on June 23. The power loss caused #4 LL pump, which is fed from #2 bus, to transfer to emergency generator power. This occurred automatically and almost instantaneously, no changes being noted on any process water pressure or flow charts. No. 3 LL pump, which was also supplying KE, was on a different electrical bus and so was not affected.

The power loss also caused all three emergency backup diesel powered pumps to start. The TORP at KE prior to the incident was about 70 psi, and since the discharge pressure available from the diesels to the reactor, which was valved for charge-discharge operation, is about 110 TORP, this resulted in some diesel flow to be supplied to KE until 11:25, when the diesels were manually shut off. Part of the diesel flow was discharged into the pickup chutes through about 340 tubes uncapped on the rear for charge-discharge, which effectively stopped discharged fuel pickup due to the "murky" appearance of the water.

Eight KE far side crossheader screens were inspected, six at the bottom, one at the middle, and one at the top of the reactor. No. 2 crossheader screen contained "a tablespoon-ful of crud." The rest were clean. A survey of equilibrium operation temperature maps after startup from that outage indicate some scattered venturi screen plugging suspects which will be inspected the next outage.

[redacted]

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[redacted]

Backup adequacy was not reduced by the power loss since the secondary and last-ditch backup systems were not adversely affected by the incident. If BPA and steam power had been lost to KW at the same time as the KE incident, more last-ditch flow would have been supplied to them than under normally assumed emergency conditions since all three diesels were running and KE reactor was throttled at the time. If KE had not been throttled, then they would either have had four emergency backed up LL pumps on or V-72 closed, as required by Process Standards, which would have created enough back pressure at KE to provide adequate last-ditch flow to KW if needed.

SA Wood

Process Engineering

SA Wood:md

[redacted]

DECLASSIFIED

September 21, 1964

M. A. Clinton, Supervisor
Process Engineering Unit

190-H PROCESS PUMP COOLING COIL FAILURES

As per your verbal request on September 16, the following is a "paragraph" on the cooling coil failures experienced in 190-H.

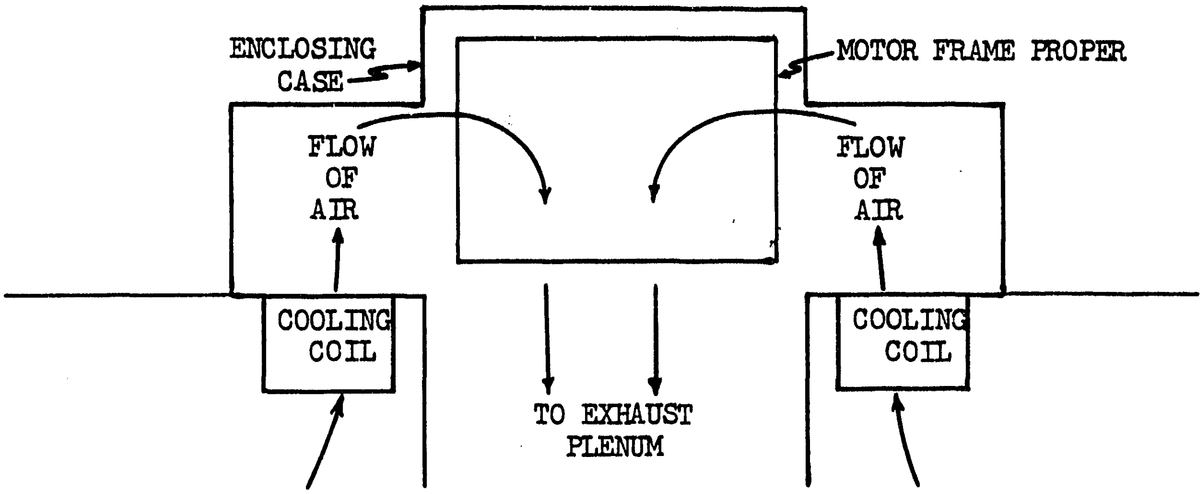
On September 4 of this year, during the 8-4 shift the 190 people informed us that No. 4 pump had a leak in its cooling coils. They indicated that they had shut the water off to the coil. In order to cool the motor they removed the cover plates from the motor and put a fan in the 190 building basement to force air up through the motor windings.

Dick and I went over to the 190 building to look at the situation and found that the outlet air temperature of this motor was only about 6°C. higher than the others, and 6° to 8° C below the indicated red line. We talked to Jim Frymier about the situation and learned that the only problem was that the back pressure from No. 3 pump's cooling coils was causing water to leak into No. 4 pump's coils. There was no means of preventing this. He was afraid that moisture might be picked up and possibly short the motor's winding out. For the next several days, we watched the situation closely and where no new complications developed we took no action.

Reading the supervisor's log book this morning, I noted that on the 4-12 shift September 15 of this year, the 190 people reported that No. 5 pump's cooling coils had a leak. I called Jim Frymier and learned that the same steps had been taken in this case as in the other one, and that once again there was no real problem.

Both Dick and I felt that having two coils developing leaks in such a short period of time may be indicative of a problem so we called upon Jim Frymier.

Jim told us that he was surprised that this had not occurred before because most of the other areas have expereienced this problem before. Past failures appear to be caused by stress corrosion failure. As background material, Jim told us that each pump motor combination has three cooling systems. First, a hydraulic system for cooling the bearings; secondly, a system for cooling the flywheel; and thirdly, the cooling coils used for cooling the air which is circulated through the motor windings. It is the latter systems we are concerned with. The system is shown in the following sketch.



The cooling coils are essentially "off the shelf" two pass, finned tube coils. The cooling water is drawn from the filtered water supply and exhausted back into the supply header of the pump. The motor is enclosed and provided with a cooling coil for two reasons:

1. To regulate inlet air temperature, and

2. To prevent the motor from becoming dirty, thus shortening its life, from building air.

These motors can operate, as they are now, being cooled by building air. The big disadvantage is that winding life will be shortened.

In summary then, the loss of these two cooling coils is not a serious problem., is not a new situation, and will be remedied during the next outage. They can not be repaired now because the vaults they are located in contain extremely high voltages.

Roger F. Greene
Process Engineering Unit
Process Technology Subsection
Research and Engineering

RF Greene:md

cc: JW Frymier
RW Reid
RE Spicka
RF Green-LB
Incident File-D
Extra (2)

54-3000-101 (9-59)

DON'T SAY IT --- *Write It!* VII

DATE 10-1-63

TO Mr Clinton FROM [illegible]

Goof File

F-Reactor Scram - 9-28-63

190 received a bearing temp annunciator on #5 pump. The operator mistakenly shut off the DC supply to the pump motor instead of resetting the annunciator. Loss of the DC supply caused the pump motor to drop out of synchronization which opened the undervoltage relay causing a 190 power failure relay to open in the 1 XX circuit. A full level scram resulted. A hot recovery was unsuccessful due to #10 VSR sticking.

"WATCH IT - ACCIDENTS DON'T ALWAYS HAPPEN TO SOMEONE ELSE"

54-3000-101 (6-58)

DON'T SAY IT --- *Write It!*

DATE 8-20-63

TO Menzo FROM Bill

On 7-10-62, During the BPA power failure, nos 1 & 3* high lift pumps failed to trip from the line. Since power was immediately restored, they continued to operate for a short time in cavitation until they were manually tripped. The general concensus here is that there is practically no connection between this incident and the burnup of #3 low lift on 4-16-63.

*These pump nos. are to the best of our knowledge

"BE SAFE - BE WISE - ENJOY ANOTHER SAFETY PRIZE" f

April 19, 1963

S. S. Jones, Engineer
Reactor Engineering

K REACTOR LOW-LIFT PUMP MOTOR FAILURE

A recent failure of a Westinghouse low-lift pump motor (#3) at KW has led to the request that R&E evaluate the safety aspects of operating with a substitute motor (1500 hp G-E river pump motor). Physical limitations will not permit a flywheel to be used with the substitute G-E river pump motor. I have been told that the river pump motor can be used and, in fact, one was used as a low-lift motor more than two years ago.

The recent failure is the third failure of this nature. One of the failures was on a prototype pump under Project 775. The other two failures have occurred since Project CGI-883. Although the cause of the problem has not been definitely determined, vibration or some unbalance allowing the rotor to contact the stator appears to contribute to the failure. Three motors have been modified in an effort to eliminate this problem and I understand that they are planning to have the remaining nine motors modified.

Utilization of the spare Westinghouse low-lift pump motor to replace the #3 unit puts us in the position of having no spares. Thus, another failure would require five-pump operation if an alternate motor cannot be made available. During bulk temperature limit operation this would require at least a 10 per cent reduction in level. Therefore, an incentive does exist for using a river pump motor as a substitute replacement.

When Bob Bell asked me for R&E evaluation of operation with a river pump motor used as a low-lift motor, he mentioned the following:

1. If another pump should fail, he would plan to install a river pump motor as a low-lift motor.

2. To provide spare motors so that the Westinghouse motors can be sent back for the modification, he may have a river pump motor installed as a low-lift motor.

In view of the above, I am asking that you evaluate the reactor safety aspects of operating a K reactor with a G-E 1500 hp river pump motor without a flywheel driving one of the low-lift pumps.

I would imagine that an evaluation of this motor usage would be desirable before the next motor fails. Even without another failure, an evaluation within a couple of weeks would be appropriate in order for Bell to continue his plans for reworking of the remaining motors.

L. C. Lessor

Engineer,
Process Engineering Unit

LC Lessor:md

cc: RS Bell
MA Clinton
WH Radtke
RW Reid
FW Van Wormer
LC Lessor-File

54—5000—002

IRRADIATION PROCESSING DEPARTMENT
GENERAL ELECTRIC
RICHLAND, WASHINGTON

ACCENT ON VALUE

April 11, 1963

M. A. Clinton, Supervisor
Process Engineering

165-KW INCIDENT

At about 11:42 p.m., April 7, the KW reactor was valved, ~~as~~ per procedure, to go onto the crossunder line. At this time, Nos. 3 and 4 low-lift pumps were supplying the reactor and the V-72 valve was open. The reactor valving status was such that all crossheader valves (four inch) were closed and the two-inch bypass valves on the A-B side fully open. According to procedure, the next step would be to remove the No 4 low-lift pump. A call was made to 165-KW control room at about the time previously indicated. In shutting off the No. 4 pump, it is customary to close first the discharge valve--which was done. With the No. 4 discharge valve closed, the chief operator, by error, then took the No. 3 low lift off the line. It is assumed that the No. 4 P.D. valve was fully or almost closed at this time. The riser pressure at KW reactor dropped to at least 38 psi (at mercoid location or 20 psi TORP) because the mercoid 3A on A riser (ELP) was set at 38 psi and did trip the steam turbine and the three diesels at 182. These four pieces of machinery, incidentally, performed as designed.

On the power side, as soon as the pressure in the line dropped, the Nos. 3 and 4 check valves banged shut. This was noted by the Power supervisor who immediately gave the order to reopen No. 4 P.D. valve and to restart No. 3 low lift. The diesels were kept running until it could be determined that no further trouble existed.

The entire matter was unknown to me until the end of the day on April 8, when you informed me. The supervisor's log at 105 KW, was scanned but not thoroughly read by me, it held very sketch information concerning the whole affair.

Only one standard violation is involved. According to PCA #3-20, the V-72 valve should, at the time the low lift was to have been removed from service, have been closed.

W H Radtke
Process Engineering
M.D.

WH Radtke:md

cc: WH Radtke (2)

APPENDIX

1. The procedure for the crossunder initiation was followed by 105 personnel.

2. PCA #3-20 was violated.

3. Corrective action was taken at 165-KW as soon as was humanly possible.

4. The flow to KW was reduced to less than 14,800 gpm (fact) and probably less than 7,000 gpm (estimate).

5. Temperatures showed that no significant trouble in flow reduction was experienced.

6. All backup components performed as designed.

April 24, 1963

R. S. Bell
Manager
KE-KW REACTOR OPERATION

INVESTIGATION OF UNUSUAL INCIDENT
TRIPPING NO. 3 LOW LIFT PUMP AT 190 KW

Attendance

RF Corlett	JC McLaughlin
OR Eastwood	G Fiorelli
WH Radtke	RG Clough
LC Lessor	KW McKay
WT Carpenter	

Description of Incident

J. C. McLaughlin, who chairmanned the investigation, opened at 11:00 a.m. by reading a prepared description of the incident (Letter, J. C. McLaughlin to R. S. Bell, April 8, 1963) which is here briefed:

> At approximately 11:42 p.m. on April 7, a Chief Control Operator at 165 KW, was in the process of setting up valving on the 165 KW control board for the 105 KW reactor to go on Crossunder. The final step in the procedure was to remove No. 4 low lift process pump from service. All preparatory steps in the procedure had been completed correctly. The procedure up to his point had isolated all flow from No. 4 low lift pump to the reactor via C and D risers. The only flow to the reactor at this point was provided by No. 3 low lift via A and B risers.
>
> The Chief Control Operator then committed the operating error of tripping off No. 3 low lift pump, cutting off the flow of process water to the reactor and this resulted in the starting of the 182 diesels and the 190 steam turbine as per design. These units performed perfectly as per design coming on the line and up to pressure almost immediately upon receipt of signal which must have originated KLP trip on "A" riser.
>
> According to the information available to me this a.m. the Supervisor who was present in the control room engaged in writing his log for the shift, heard the check valves slam. His visual examination of the board revealed what had happened and he instructed the Chief Control Operator to open the valves on the No. 4 low lift pump still operating and to restart No. 3 low lift pump, inasmuch as the 182 diesels and the 190 KW steam turbine were supplying the 105 KW reactor.
>
> Normal operating procedures were then conducted to remove these units from service and put No. 3 low lift on A and B risers as per the original intent.

Discussion by Investigation Group

The Reactor Operation Specialist related a discussion he had with the Chief Control Operator four hours previous to the incident regarding lack of promptness in carrying out requests from 105 for process water pressure drops. The

Chief Control Operator stated to the Specialist and also to his own Supervisor that he was "bugged" (his own words) because these requests for pressure drops came to him on the 182 telephone system instead of the direct 105 KW-165 KW voice power phone.

The ensuing discussion of this previous happening developed the following:

a. That the direct 105-165 phone should be used in requesting process changes.
b. That lack of communication or improper communication did not cause the incident being investigated.
c. That the occurrence of four hours before should be considered irrelevant to this investigation except insofar as it offers evidence regarding the emotional stability of the operator involved, especially since he asserts that this upset of four hours previous was the principal cause of his making the serious error.

The next phase of the discussion concerned a number of proposals for mechanical or electrical prevention of human error in operation of the water control board. Among the items mentioned were key-lock switches, rearrangement of switches on the control board, supervisory circuits to prevent tripping the "last pump", covers to be placed over essential switches before starting on any sequence of switching. One by one the proposals were disposed of, most being found impractical. Regarding those proposals that could be adopted, there was a lack of unanimity, in fact some strong arguments against adoption.

The employee's record as a Chief Control Operator was considered. He has made four observed errors on the control board, any one of which was potentially serious, within the past five months.

There followed a discussion of the need for capable operators regardless of the number and complexity of safety devices intended to prevent mistakes. The human factors involved in a supervisor's rating an employee he has to work with were also mentioned.

Recommendations

1. That the Chief Control Operator be reassigned to a position of less critical operational responsibility or in lieu of this action a more comprehensive supervisory coverage be maintained of his operational performance.

2. That investigation be continued on mechanical or electrical devices that could lessen the opportunity for operator mistakes.

Investigation adjourned at 12:55 p.m.

J. C. McLaughlin
J. C. McLaughlin
Manager, KE-KW POWER OPERATION

JCM:KWM:ap

cc: WJ Ferguson, RT Jessen, RW Reid
CH Greager, AR Maguire, OC Schroeder (4)
CN Gross, WW McIntosh, File (3)
LB

54-3000-101 (9-59)

DON'T SAY IT --- *Write It!*

DATE 5/6/63

FROM

TO

#3 Motor KW → Anything to do with April incident

54-3000-101 (9-59)

DON'T SAY IT --- *Write It!*

DATE 5/6/63

FROM Keith

TO Lott

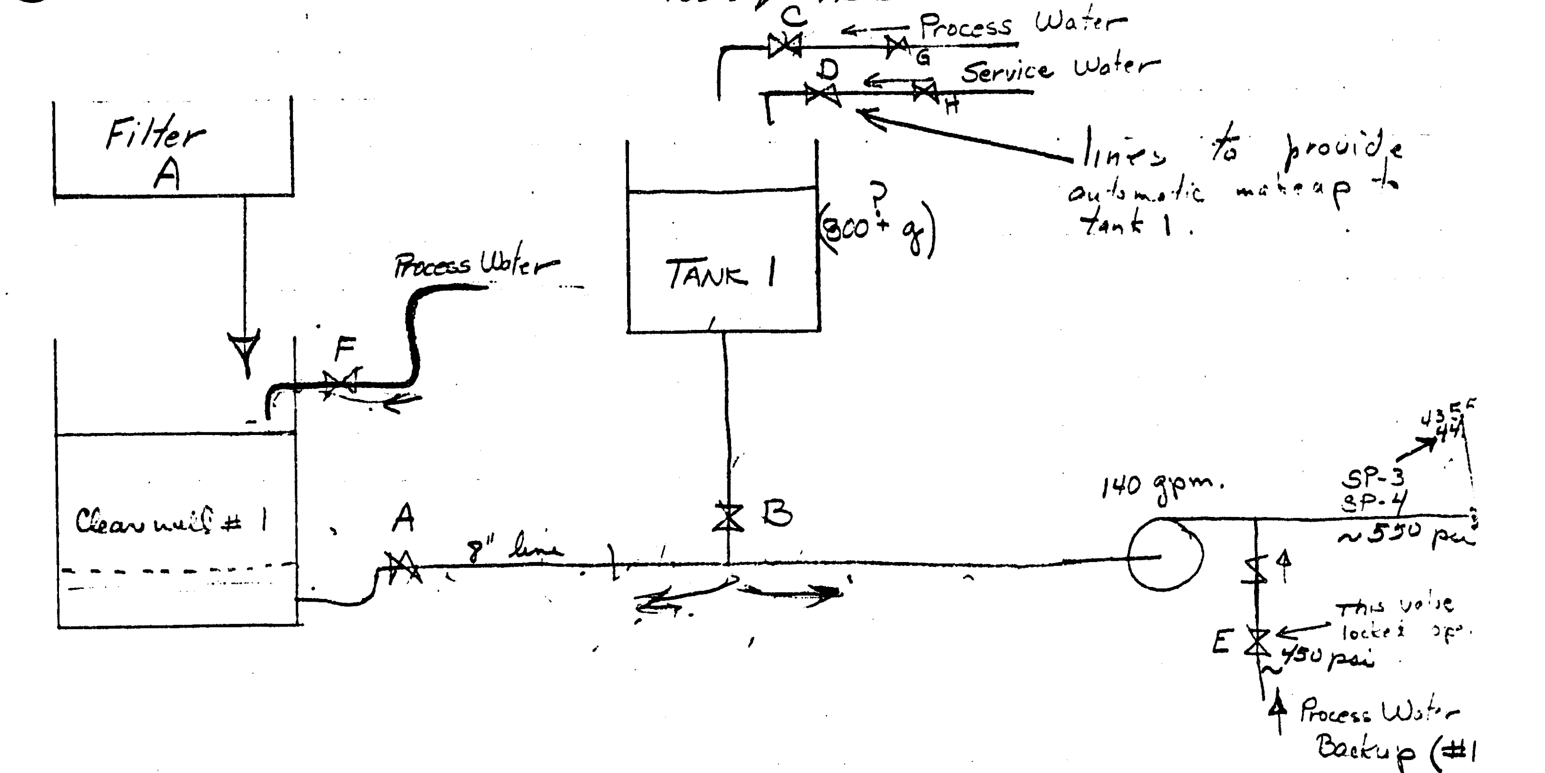
#3 Low KW → [illegible] with [illegible]

[illegible] → [illegible]

"WATCH IT - ACCIDENTS DON'T ALWAYS HAPPEN TO SOMEONE ELSE"

① RWR
② LC Lessor

Oct 30, 1962 Scram KE Reactor
4355 & 4456



1. Water level in Clearwell #1 dropped do to problems with Filter A system.

2. The normal procedure would be to open value B and close value A. This was done but Tank 1 emptied or nearly emptied and the reactor was scrammed due to low panellit.

3. The process water back-up (#1) automatically cut in and temperatures on SP-3 & SP-4 decreased rapidly on a 6 sec print out.

4. Various problems:
   a. Water from tank 1 would normally supply enough flow for several minutes. However, it appeared that the tank drained rapidly toward pump and also toward clearwell.

   b. Value C or G on process water makeup to tank 1 was closed.

54-3000-101 (9-59)

DON'T SAY IT --- *Write It!*

RECEIVED
JUL 16 1962
O. H. GREAGER

DATE July 16, 1962

TO O. H. Greager File 2-27 FROM R. W. Reid Reid

RE: ATTACHED ROUGH DRAFT REPORT, "POWER DISTURBANCE OF JULY 10, 1962"

The attached report may be of interest to you. Manufacturing is planning a formal report on this incident. FEO has extensive investigations underway and plan to issue reports and recommendations in about 30 days. I plan to send Windsheimer some questions which should be included in their review. Please return this draft after you are through with it.

RWR:mf

cc: File

"WATCH IT - ACCIDENTS DON'T ALWAYS HAPPEN TO SOMEONE ELSE"

[redacted] RD

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GENERAL ELECTRIC

HANFORD ATOMIC PRODUCTS OPERATION - RICHLAND, WASHINGTON

DOCUMENT NO.

SERIES AND COPY NO.

DATE

[redacted]RICTED DATA
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PE[redacted] IS PROHIBITED.

TITLE
Power Disturbance of July 10, 1962

OTHER OFFICIAL CLASSIFIED INFORMATION
THIS [redacted]TERIAL CONTAINS INFORMATION A[redacted]
THE NA[redacted] DEFENSE OF T[redacted]
WITHIN THE M[redacted]ONAGE LAWS,
TITLE 18, U.S.C[redacted] THE TRANS-
MIS[redacted]LATION OF WHICH [redacted]NNER
TO A[redacted] UNAUTHORIZED PERSON IS PROHIBI[redacted] BY
LAW.

AUTHOR
P E Baars

ISSUING FILE

T[redacted] LEFT UNATTENDED OR WHERE AN UNAUTHORIZED PERSON MAY HAVE ACCESS TO [redacted]CKED REPOSITORY WITHIN AN APPROVED GUARDED AREA. WHILE IT IS IN YOUR POSSESSION AND [redacted] A SIGNED [redacted] CLASSIFIED FILES, IT IS YOUR RESPONSIBILITY TO KEEP IT [redacted] THIS PROJECT AND FROM ANY UNAUTHO[redacted] PLACE OF RESIDEN[redacted]PLICATED. IF ADDITIONAL COPIES A[redacted]ED, OB[redacted] ISSUING FILE. ALL PERSONS READING THIS DOCUMENT ARE REQUESTED TO [redacted]GN IN THE SPACE PROVIDED BELOW.

ROUTE TO:	PAYROLL NO.	LOCATION	FILES ROUTE DATE	SIGNATURE AND DATE
J H Brown - ~~Hon Warren~~ -				

This is a very rough draft but thought it may be of interest.

Greg

SMG
Thanks, do you plan to issue?
Fred

54-3000-052 (7-59) A.E.C.-G.E.-RICHLAND, WASH.

DECLASSIFIED

(CLASSIFICATION)

[redacted]

DECLASSIFIED

July 12, 1962

INTRODUCTION

On July 10, 1962, at about 0016 hours, a fault occurred in a current transformer at Midway on a Priest Rapids Dam line. The fault caused a power disturbance in the HAPO distribution system which was sufficient to scram all operating reactors. B and C reactors were in shutdown status at the occurrence; all others, except KW, were at equilibrium power levels. This report provides a preliminary summary of the associated events at the various reactors.

SUBSEQUENT EVENTS

So far as can be determined, the disturbance was enough to trip out the 190 pumps at the old reactors (except C), all the high lift pumps at KE, and all but two of the high lifts at KW. Boiler and steam turbine response was fully adequate at all of the old areas, including DR, which had some difficulties, on the April 6 outage. Boiler response and reactor flow were likewise satisfactory at the K's.

The lack of trip-out of the C reactor 190 pumps is most likely due to less sensitive separation relay settings. There pumps are driven by induction motors and do not require as rapid separation from BPA as do the synchronous motors installed at the other old areas.

At D and DR reactors, the 181 and 183 electric pumps and the 105 building electric suppky and exhaust ventilation fans were not affected. At B and C reactors, the ventilation fans were not affected. Three of five 181 pumps tripped off. At B, three 183 pumps were operating; one of these, supplying fire and sanitary water, tripped off. At C, two 183 high lift pumps supplying the filtered water loop tripped off. Backup steam turbines came on the line automatically in replacement.

At F, the ventilation fans were unaffected, the 181 pumps tripped off, and two of 183 pumps tripped off. At H, where the front 151 bus was put out of service due to a failed circuit breaker, half the 181 and 183 pumps and the ventilation fans tripped out. One steam exhaust fan was on the line and continued, the other steam pump was down for maintenance. At KW and KE, all six low lift pumps continued to operate; six of eight river pumps tripped off at both reactors; and the exhaust fans stayed on while the supply fans tripped off.

There was no case noted of discontinuity in critical instrument and lighting power, except at H, where some lights were lost for five to eight minutes, and the exide lights did come on.

The export system was supplied entirely by three electric pumps at B. These pumps were not affected, but the surge suppressors did cycle once at all reactors. B noted approximately five minutes elapsed from start of export pressure drop to restabilization of the pressure. The D area pressure chart showed about three minutes for this transient. The normal suppressor cycle time is two minutes; considering the time scale on the recorder charts, the above times are consistent with this.

Events at H area were different from the other areas due to local circumstances.

On opening in response to the disturbance, circuit breaker C54 at 151-H shorted to ground causing main breaker on line CL-200 to open, thus de-energizing the front bus. Loss of the front bus, a momentary surge on the rear bus, tripped out 190 pumps and approximately 50 per cent of 181 and 183 pumping facilities. L2 feeder to 105 was connected to front bus and lost power, thus accounting for loss of normal lights and exhaust fans. L1 feeder was connected to rear bus and maintained service throughout the outage.

At 105 H, loss of L2 (buses 2 and 3) resulted in loss of normal lights, exhaust fans, etc. Upon loss of L2, the emergency line #1 (line 7 from 151 rear bus through 184 facility) supplied bus #3 in making the automatic switch to emergency A.C. Bus #3 was separated from #2 by electrical interlock which kept the normal lights off. (This is a planned interlock.)

At 0020 hours, the 151 operator, under instructions from 200 area dispatcher, switched line L2 from the dead front bus to rear bus thus restoring L2 to service in 105 resulting in the return of normal lights to service. (This accounts for the reported five to eight minutes that lights were out in 105 control room)

[redacted]

The 184 turbine alternator was not called upon for service during the outage since it responds only to de-energization of line 7 from 151 building. Line 7 is on the rear 151 bus. It was energized throughout the outage and actually supplied the emergency power for the outage to 105-H.

COMMENTS

The general picture seems to be that the disturbance was sufficient to trip off the high pressure pumps, but sufficiently short that trips of other electrical loads were mixed. It was apparent that the disturbance was too short to actuate the 184 emergency power turbine-alternators, except possibly at H where local occurrences played a role. The battery-powered D.C. motor-alternator systems at C and H were switched on the line.

In addition to the failed circuit breaker at H, the failure of two high lift pumps at KW to trip off appears also to have been a malfunction. There are two 13.8 kv buses supplying the high lift pumps at each reactor. One under-voltage relay at each bus should separate all three motors from the bus in such a disturbance. "This is being investigated further" SMC comments on RD copy #2

Further details are given in the tables which follows.

Reactor	Status at Disturbance	Change in Status as Result of Dist.	190 pumps or high lifts at K's	Duration of Disturbance	Steam boiler performance	Minimum TORP	Minimum Flow
B	Shutdown	None	2 on line, both tripped out.	Very short	Fully adequate	60	Shutdown
C	Shutdown	None	No change	Very short	Ditto	No change	Shutdown
D	Equilibrium	Scrammed, did not recover	Tripped out.	24 cycles, but very short.	Ditto	85	30,000
DR	Equilibrium	Ditto	Ditto	Estimated at 30 cycles.	Ditto	89	335,00
F	Equilibrium	Ditto	Ditto	24 cycles but very short.	Ditto	70	26,500
H	Equilibrium	Ditto	Ditto	#2 bus was tripped out due to circuit breaker failure. Brief dist. on #1.	Ditto	87	29,100
KE	Equilibrium	Ditto	Ditto	Originally stated	Ditto	See flow	65,000**
KW	Non-Equilibrium	Ditto	4 Tripped; 2 did not; 2 were manually removed*	Shorter	Ditto	See flow	48,500**

* The two high lifts which did not trip out went into severe cavitation almost instantly.

**Only three modified low lift pumps have been installed at KW, versus five at KE, in connection with the K flow increase project.

DECLASSIFIED

-4-

July 12, 1962

CONF

Reactor	# of Turbines on automatic	River Pumps	183 Pumps Low lifts at K's	Confinement Fans	Emergency Power to Critical Instru-mentation on Lighting
B	3 on manual (shutdown)	5 on, 3 tripped off	3 on, 1 tripped	Electric not affected.	No interruption noted; neither 184 turbine nor gasoline powered alternator came on.
C	--	~~off~~	2 high lifts on, these tripped, tur-bine automatically came on.	Same as B	Brief flicker noted; DC motor - alternator switched in; 184 diesel generator was not actuated.
D	7	Didn't trip off.	Did not trip	Same as B.	No loss noted; neither 184 turbine nor gas powered alternator was actuated.
DR	8	ditto	ditto	Same as B	Same as D
F	7	all tripped off	2 tripped	Same as B	Same as D
H	7	½ tripped	½ tripped	All electric tripped, 1 on steamer exhaust on, remained on, other steamer down for	Lighting serviced from failed bus out for 8 min.; DC motor-alternator set came on, exide lights were on. 184 turbine-alternator did not come on; not expected to.
KE	Not appl.	8 on, 6 tripped	All 6 remained; emergency bus separated, supplied from boilers.	Electric exhausts stayed on; supply fans tripped off.	Momentary flicker in lights noted.
KW	Not appl.	8 on, 6 tripped	Same as KE	Same as KE	No effect noted.

[redacted]

July 12, 1962

Reactor	Export System: Min. noted pressure	Export System: General	Equipment Malfunctions
B	50	B area was supplying export system with	None noted
C	50	3 electric pumps. None of these tripped	Same as B
D	30	out. All surge suppressors cycled.	S_me as B
DR	30	B area estimates approximately 5 min.	Same as B
F	0	time lapse from first drop in pressure to	Same as B
H	Near 0	restabilize. D area chart indicates the order of 3 min. Surge suppressors should cycle in about 2 minutes.	[illegible] A 151-H ~~transformer~~ supplying ~~#1-190 pump burnout~~ out. ~~This is felt to be the case of the 8 min. outage of #2 bus; this may have occurred before and been a partial~~ cause of the ~~general~~ disturbance.
KE	Not applicable.		None noted.
KW	Not applicable.		~~None noted.~~ [illegible]

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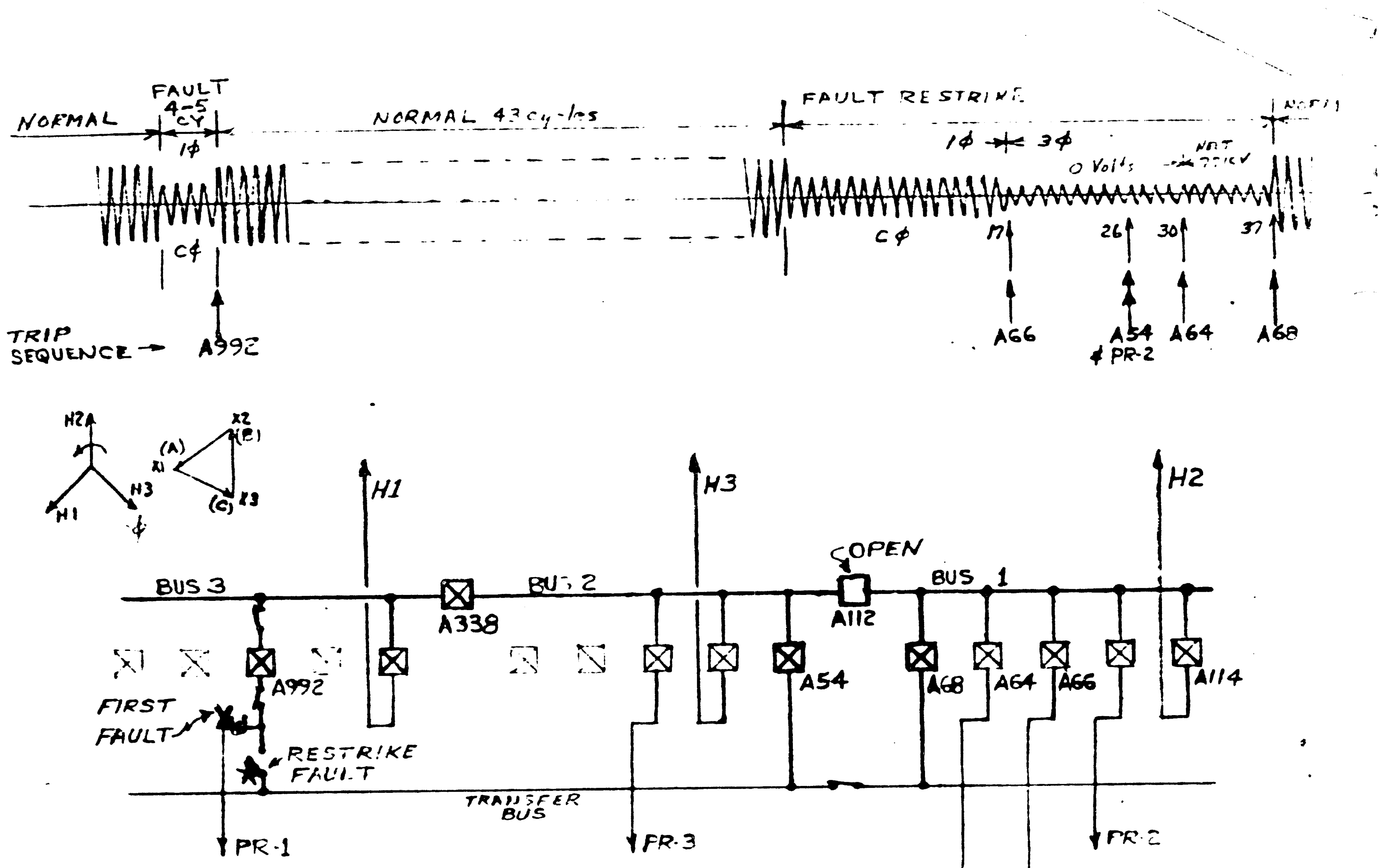

BPA FAULT
MIDWAY
1215AM - 7-10-62

REF DATA FROM HAYNES, CE&UO
7-11-62

Summary

The observed and recorded responses of H Area to the 7-10-62 electrical power outage can now be explained. The only equipment failure was C54 breaker - all other circuits operated <u>as planned.</u> The TA was not called upon or needed as emergency power was available from the rear bus at 151H

~~7-10-62 H AREA POWER~~ FAILURE

~~RESPONSE OF ELECTRICAL SYSTEM~~

~~00815 151-H~~ ar 151-H

On opening in response with the disturbance, Circuit breaker C54, shorted to ground causing main breaker on line CL200 to open, thus de energizing the front bus. Loss of front bus tripped out 190 pumps and ~50% of 181 and 183 pumping facilities. L2 feeder to 105 was connected to front bus and ~~that~~ lost power thus accounting for loss of normal lights and exhaust fans. L1 feeder was connected to rear bus and maintained service throughout the outage

~~00:15 105 H~~

Ar 105 H Loss of L2 (buses 2 & 3) resulted in loss of normal lights, exhaust fans etc. Upon loss of L2, the emergency line no. 1 (line 7 from 151 rear bus through 184 facility) supplied bus #3 in making the automatic switch to emergency A.C. ~~[illegible]~~ bus #3 was separated from #2 by electrical interlock which kept the norma lights off. (this is a planned interlock)

CLT 0020 hours ~~0030~~
~~151-H~~ The 151 operator, under instructions from 200 area dispatcher switched line L2 from the dead front bus to rear bus thus restoring L2 to service in 105 resulting in the return of normal lights to service. (This accounts for the reported 5-8 min that lights were out in 105 control room)

~~101-A~~ The 184 turbine alternator was not called upon for service during the outage since it responds only to deenergization of line 7 from 151 bldg. Line 7 is on the rear 151 bus, ~~and~~ it was energized throughout the outage and actually supplied the emergency power for the outage to 105H

1. Status of 181, 183 pumps. (C), (B), (F), +

2. Why power outage of 8 min at H

3. What caused scram at (ea) reactor

4. What was TORP. Flow, following Power Loss – especially at DR
No. of steam pumps 7? D, DR, 98?, X, H, (KE)

5. ~~[illegible]~~ Why did exhaust fans stay on while supply fans kick off. – Also status of supply fans at (ea) area (DR), C, X

6. Is there any info on length of surge suppression cycle & min pressure during cycle (C), B, D, DR, X

7. What about pumps supplying filtered water to shields HCRs etc 183.

8.

54—3000—101 AEC GE RICHLAND WASH

DON'T SAY IT --- *Write It!*

DATE July 10, 1962

TO S. M. Graves

FROM P. J. Zimmerman/phone

POWER FAILURE OF LAST NIGHT

Time of Outage: 12:16

Operating Status: B Reactor was down.

Steam turbine response TORP dropped to 60 psi and then came up to 130 maximum and then back to normal. Everything functioned all right.

Boiler Status: Since B and C were both down the steam pressure was very small and small increase required. Everything functioned all right. Current reactor status is down. Power loss was apparently so short backups did not come on. Still checking on it.

Confinement Status: Nothing unusual was logged. I am trying to contact supervisor.

Export Problems: Surge suppressors open. Pressure dropped to 50 psi. This was because of power loss not because of low pressure. We were on the crossunder line. No other problems reported up to now.

54-5000-002 [redacted]

IRRADIATION PROCESSING DEPARTMENT
GENERAL ELECTRIC
RICHLAND, WASHINGTON

May 29, 1962

R. W. Reid, Manager
Process Technology
Research and Engineering

BETTER RECORDS ON APRIL 6 ELECTRICAL POWER FAILURE

Ref: 1. Rogers, G. J., Preliminary Report on the Effects of the Electric Power Failure of April 6, 1962, on the Production Reactors, HW-73389, April 16, 1962.

2. Letter, Investigation of 230 KV Power Outage, L. L. German, May 4, 1962.

3. Rogers, G. J., Effects of the Electric Power Failure of April 6, 1962, on the Production Reactors, HW-73692, May 17, 1962, Unclassified.

Apparently the three referenced documents constitute the total documentation planned on the subject power outage. I have not yet seen reference 2, but conclude from references 1 and 3 that considerable additional data and observations should be recorded. We cannot necessarily foresee today all the uses to which these records may be put, and I will not take time to tell you in detail why considerable additional information should be recorded. Just consider for a moment the comparisons we would like to make were a similar incident to occur next week or next year. Such incidents have occurred infrequently and, for that reason, the details of any one incident may be quite significant to any future assessment of reactor safety, equipment reliability, etc.

To save time I will record a running commentary as I read reference 3. The commentary should indicate the types of information which bear recording. I have had no part in investigating the incident, so please do not make the mistake of thinking all points of interest are listed. Starting with the discussion on page 1, the commentary follows:

1. Actual power levels, bulk temperature, flow rates, pump configurations, valve configurations, etc., just before the incident should be recorded. How long had C and H been shut down and how many tubes were open?

2. Why were only four horizontal rods involved at 105-F and what really caused the malfunction caused by hydraulic control valves? Why was the hydraulic fluid cleaned and what were the observations, and are there any implications for other reactors?

B ✓
C Down
F ✓
H Down
K ?

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[redacted]

54-3000-002

[redacted]

IRRADIATION PROCESSING DEPARTMENT
GENERAL ELECTRIC
RICHLAND, WASHINGTON

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3. There should be a complete post-incident description as well as pre-incident description. Which low-lift pumps were the "selected" ones at K reactors (paragraph 4, page 2)? The number of turbine-driven pumps on automatic control should be recorded. This number, while covered by standards and well known today, is subject to change in the future, and any future re-examination of the incident would be hampered if the number were unavailable. Our records would not likely show how many were operating. This same reasoning can be applied to many of the items. Another example is the statement in the following paragraph that the export surge suppressors cycled normally upon the power failure. Normal today may not be normal a year from today and we may wish to know what normal was.

4. The export pumps were not started, the document says. What motions toward starting were made, if any? What orders were given? Was there confusion or absence of confusion? Was a man available to perform the start? Had the desirability of making a start occurred to pertinent supervision or managers?

5. Coolant flow was somewhat low at DR reactor. What is normal flow; what was the flow supplied? A primary cause for the reduced flow is given, implying other causes--unstated.

6. Considerable riser pressure fluctuations occurred during manual turbine control at H. The manual control is standard practice to prevent charge flushing. The minimum pressures during the fluctuations were close to the normal shutdown pressures; thus the maximums may have come close to flushing fuel, for all we know. Description and explanation of the fluctuation and its implications, if any, are needed.

7. What were the post-incident bulk temperatures, tube temperatures, flows, and valve configurations, etc? Some of these items are needed as a function of time.

8. I believe the steam pressure and flow charts from every boiler on the plant are worth recording. There was likely considerable variation. Boiler No. 2 in 184-D is, of course, of particular interest. Other charts are probably also desirable.

9. The paragraph on the forced draft fan is quite inadequate and would be so even were it understandable.

10. The paragraph on boiler controls (page 3, paragraph 3) espouses inconsistent views on control adequacy. I have a hunch the fuel-air ratios have been quite poorly controlled and that the word "adequate" is less descriptive than desirable.

[redacted]

IRRADIATION PROCESSING DEPARTMENT
GENERAL ELECTRIC
RICHLAND, WASHINGTON

[redacted]

11. Normal response of the 184 steam turbines needs to be described, in addition to the details provided on the various failures.

12. The design error in relaying under Project CGI-861 should be explained with a circuit diagram. If our engineers can make such an error, so can others, and the circumstances and details should be of interest to electric design people generally. The circuit breaker malfunction at 105-C (page 4, paragraph 1) might be of a great deal of interest, for similar reasons. Circuit breakers are vital safety gear; however, we should leave the significance and reporting to electrical experts.

13. Did the gasoline engine driven alternators come on and stay on with proper timing? Has the statement about the timing of C reactor restoration of normal BPA power some special significance (page 4, paragraph 2)? Were the battery-powered emergency lights useful--unusable?

14. Design personnel should have the name of the unsuitable valve available, and the vendor deserves a description of why his particular valve is not suitable in this application. The maintenance procedures for the confinement system were apparently inadequate and the details of this bear description. What was the normal testing frequency of the turbine exhaust fans? Details on the air switch may be desirable. Since the confinement ventilation system will likely be modified in the future, description of the design should be recorded at least by reference.

15. What plugged the needle valve on the dump-valve operator and why?

16. The brief laudatory paragraph on personnel performance and reaction is re-assuring, if true. I cannot quite believe everything went as well in this area as indicated, but realize the difficulty in obtaining reliable information.

We need not embarrass the Manufacturing people by issuing such records for general consumption; however, developing and maintaining one record file would be reasonable.

As I requested previously, would you please see if you can get reference 2. I have a hunch all is not well with utilities performance. Why was the power off for up to two minutes or, specifically, was or was not BPA reclosed in a few seconds by 151 operators at B and F? I think this is a very important question and can't understand why apparently no one in IPD has asked or answered it before. This matter may also have a bearing on the supervisory control question.

H. G. Spencer
Supervisor, Process Analysis Unit
Process Technology Sub-Section

HG Spencer:mf

DECLASSIFIED

cc: JH Brown
HGS-LB

[redacted]

[redacted]

(CLASSIFICATION)

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GENERAL ELECTRIC

HANFORD ATOMIC PRODUCTS OPERATION – RICHLAND, WASHINGTON

DOCUMENT NO. D Lab

SERIES AND COPY NO.

DATE 5-4-62

TITLE April 6 Power Failure

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AUTHOR

ISSUING FILE

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ROUTE TO:	PAYROLL NO.	LOCATION	FILES ROUTE DATE	SIGNATURE AND DATE

C-1616-DS (7 – 55) A.E.C.-G.E.-RICHLAND, WASH.

[redacted]

(CLASSIFICATION)

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IRRADIATION PROCESSING DEPARTMENT
GENERAL ELECTRIC
RICHLAND, WASHINGTON

May 4, 1962

S. M. Graves, Supervisor
Process Engineering
1704-D BUILDING, 100-D AREA

BPA LOSS

The following information has been obtained from operating instrumentation prior to and after the April 6, 1962 scram.

(1) Reactor flow - The Foxboro flow recorder at 105-F indicated that the reactor flow prior to the power outage was 88,500 gpm. The chart also indicates that the flow dropped to a minimum of 29,000 gpm and then increased to 32,000. The 29,000 gpm was that flow produced by the seven steam turbine pumps that were on automatic and the 32,000 gpm resulted from manual addition of two steam turbine pumps around three to five minutes after scram.

An actual flow decay rate from the recorder can not be obtained because of the small interval of time (less than two minutes).

(2) Power level - The Foxboro power level recorder indicated 1800 prior to scram. It dropped to a chart reading of around 25 immediately after scram. This recorder prints around 25 during shutdown. The power level recorder can not be accurate at low flows because the bulk outlet temperature of the reactor effluent can not be accurately measured at the reduced flow.

(3) Bulk outlet temperature - The Bristol bulk outlet temperature recorder showed an 87° C temperature prior to shutdown. It is an established fact that the outlet temperature at F Reactor can not be measured accurately while at shutdown flows. Therefore, chart readings after scram are not listed.

(4) Graphite central zone temperature:

"G" Stringer	Temperature
1073	640° C
1266	653° C
2662	657° C
3466	652° C
3484	632° C

IRRADIATION PROCESSING DEPARTMENT
GENERAL ELECTRIC
RICHLAND, WASHINGTON

(4) (Continued)

The temperature decay period was calculated to be 97 minutes following this scram.

(5) Percent Helium - The Bailey gas recorder indicated 96 percent helium at time of scram and 84 percent one hour after the scram.

(6) Boiler number and steam load - J. C. Baudendistel of Facilities Engineering, is plotting boiler load changes for all areas. He has contacted Jones and will submit the data to him when it is completed.

L. C. Lessor, Engineer
PROCESS ENGINEERING

LCL:cs

cc: File

5 8000-101 (9-59)

DON'T SAY IT --- *Write It!*

DATE ______

TO ______ FROM ______

J.C. Brudendistel 1704-F 5765 works for Bob [illegible] [illegible]

for # 6

He will supply Jones with the information in item # 6 (Boiler Data) for all reactors

"A GOOD DRIVER IS KNOWN BY THE FENDERS HE KEEPS"

3:05 PM

April 19, 1962

S. M. Graves, Supervisor
Process Engineering Unit
Process Technology Subsection

BPA LOSS - APRIL 6, 1962

The following information is requested from all reactors areas - except D and DR, which have been covered - for the power failure incident. This information is to be obtained from the conventional operating instrumentation by accurate reading of the charts (-5 minutes to + 1 hour following scram).

1. Reactor flow at and following scram.* ✓
2. Reactor power level at and following scram. ✓
3. Reactor bulk outlet temperature at and following scram. 92.3 -11.5
4. Graphite central zone temperatures. High 667 -661- 570 667- 650 - 600-570
5. Per cent Helium. 95%
6. From Power House: Boiler number and steam load with sufficient frequency to plot boiler load changes.

These data are requested for all reactors except D and DR.

S. S. Jones
S. S. Jones
Reactor Engineering Unit
Research and Engineering

SSJ:vw

cc: SM Graves (7)
FW Van Wormer
SSJ-File

* About 5-10 minute intervals.

April 19, 1962

BR Cremer
LC Lessor
DL Renberger

WR Smit
~~SA Wood~~
PJ Zimmerman

SM Graves

BPA LOSS

The attached letter from S. S. Jones requests collection of certain information just prior to and following the BPA outage on April 6. Would you please arrange to obtain this information within the next two weeks (particularly before available records may be lost or destroyed). I would suggest that this assignment might be appropriate to give to the engineering assistants. Please forward the completed data to me and I will arrange to give it to Jones.

cc: SM Graves-LB

Below is a list of information requested by S. S. Jones from B Reactor concerning BPA Loss - April 6, 1962

① Reactor flow @ and following scram

88,000 @ 3:09 PM	58,000 @ ~ 3:50 pm
32,000 @ ~ 3:12	58,000 @ ~ 4:00
38,000 @ ~ 3:20	60,000 @ ~ 4:05
54,000 @ ~ 3:25	63,000 @ ~ 4:10
41,500 @ ~ 3:28	70,000 @ ~ 4:15
49,500 @ ~ 3:40	32,000 @ ~ 4:20

② Reactor Power level @ and following scram
1930 @ time of scram
280 @ ~ 3:15 pm.

③ Reactor Bulk 92.8 @ time of scram
11.5 following scram

④ Central Graphite temps.
667 - 661 - 570 - 667 - 650 - 600 - 570

⑤ % He 95%

April 6, 1982 @ 3:09 pm.

Reactor Flow ⓔ and following scram - 5-10 min intervals (10 - 100)
Reactor Power ⓔ " " scram (25 - 250)

Power - 1950 @ time of scram
280 @ ~ 3:15
250 @ ~ 3:20
200 @ ~ 3:30
175 @ ~ 3:45
150 @ ~ 4:00

Flow - 88,000 @ time of scram
32,000 ~~@~~ @ 3:12
38,000 @ ~ 3:20 — started back up.
54,000 @ ~ 3:25 back down & —
41,500 @ ~ 3:28
49,500 @ ~ 3:40
58,000 @ ~ 3:50
58,000 @ ~ 4:00
60,000 @ ~ 4:05
63,000 @ ~ 4:10
70,000 @ ~ 4:15
82,000 ~ 4:20 remained @ 82000 until Flow was reduced.

April 20, 1962

S. M. Graves, Supervisor
Process Engineering

ELECTRICAL POWER FAILURE IN HAPO LOOP
ON APRIL 6, 1962

General

At 3:09 p.m., on April 6, 1962, a fault in the #3 leg of the HAPO loop is believed to have been sufficiently large to cause both the #1 and the #2 legs of the loop to relay open simultaneously. The exact cause and location of the fault in the #3 leg has not yet been determined. As a result of the total failure of the HAPO loop, all of the production reactors lost primary electrical power. The loop was re-energized at 3:11.5 p.m., and normal electrical power distribution was established by 3:17 p.m.

At the time of the malfunction, H reactor was in the midst of a large-scale retubing program, having been shut down six days before. As is normal for an extended outage, the reactor was valved down to very low flow, with the entire flow easily supplied by one electric process pump--in this instance #8 electric. Normal high tank filtered water and export line raw water facilities were available for automatic backup. Because of the low flow and top-of-riser pressure associated with shutdown conditions, the automatic pickup instrumentation on the 190 turbine backup pumps is unreliable. Essentially, while the turbine pumps are valved to the process system and are idling they are, for prátical purposes, under manual control during shutdown conditions. Again, consistant with normal practice, the filtered water supply to, among other things, the fog spray system was pumped by one electric and one steam pump simultaneously.

Emergency Electrical

When the primary power failure occurred, all electric pumping, of course, stopped. In addition, all building lights, electrical instruments (apparently), and building electric supply and exhaust fans failed. Before the auxiliary lighting came on, one portable standby Exide battery-light was manually turned on to provide some control room lighting. Subsequent chart examination shows the 184 steam powered generator functioned normally, coming up to speed within 15 seconds of the power failure. Following 184 generator operation, the auxiliary lighting in the control room and front and rear elevators became operational. Additionally, the electrical instrumentation, annunciator panel, etc. became operational again.

Secondary Water

Following the power failure, there was a period of about two to three minutes, during which time the TORP decayed to 50 psig (as read on the 105 gauges), before the 190 steam turbine pumps were manually brought up to speed. As the TORP decayed neither high tank check valve opened, as they theoretically should have based upon previous functional checks. Subsequent tests show, however, that when the reactor is throttled and supply header flow is thereby quite low, the high tanks check valves open about 5 psig lower than they do at normal unthrottled high flow. Therefore, it seems the high tank check valves were just at the incipient point of opening when the turbine pumps picked up the pumping load. As the turbine pumps picked up load, there was a brief period during which the TORP exceeded normal shutdown TORP by 65 psi, before settling back to normal.

Reactor Confinement

Upon power failure, all four motors driving the building supply and exhaust fans failed; however, the steam turbine driven exhaust fans did not pick up the load as they were designed to do. The turbine driven exhaust fans were manually started as quickly as possible, negating the immediate possibility of determining the cause of failure. Subsequent inquiry has revealed that the building intake dampers remained open, in contrast to their design. Additional checking by H Processing personnel and CG-791 project engineers show that sticking control valves apparently caused both the damper and the exhaust turbine malfunction. The presumption is the sticking is attributable to oil and varnish entrainments in the air supplied to the control valves from the badly overloaded 190 air compressor.

Raw and Filtered Water Pumps

The raw water export system functioned as designed when the surge suppressors opened at 182 upon power failure. As the suppressors were cycling, the indicated raw water pressure at 105 was only 30 psig. After the surge suppressors reset themselves the raw water system slowly stabilized back to normal pressure--it is estimated that this took about 10 minutes.

Upon power loss the filtered water system pressure fell from 105 to 60 psig, being sustained at this pressure by the steam pump which was simultaneously pumping with the electric pump. Later, as the electfic pump was restored to service there was some pressure fluctuation in the filter system, however, nothing sufficient to cause safety concern.

Conclusions

The power failure showed the adequacy of the present backup system, at least during shutdown conditions. At least one engineering item and one procedural item require correction to ensure a high level of reliability and personnel safety, however. Engineering-wise, an improved source of oil free instrument air should be promoted as soon as possible. To enhance personnel safety during electrical power failure, the portable Exide battery lights should have their switches checked routinely so the lamps automatically turn on during power failure.

Byron Cremer

Process Engineering

BR Cremer:md

cc: JW Frymier
AK Hardin
RW Reid
AP Vinther
BR Cremer-File

April 19, 1962

S. M. Graves, Supervisor
Process Engineering Unit
Process Technology Subsection

BPA LOSS - APRIL 6, 1962

The following information is requested from all reactors areas - except D and DR, which have been covered - for the power failure incident. This information is to be obtained from the conventional operating instrumentation by accurate reading of the charts (-5 minutes to + 1 hour following scram).

1. Reactor flow at and following scram.* ✓
2. Reactor power level at and following scram.✓
3. Reactor bulk outlet temperature at and following scram.
4. Graphite central zone temperatures.✓
5. Per cent Helium. ✓
6. From Power House: Boiler number and steam load with sufficient frequency to plot boiler load changes.

These data are requested for all reactors except D and DR.

S. S. Jones

S. S. Jones
Reactor Engineering Unit
Research and Engineering

SSJ:vw

cc: SM Graves (7)
FW Van Wormer
SSJ-File

---

* About 5-10 minute intervals.

April 19, 1962

BR Cremer
LC Lessor
DL Renberger

WR Smit
SA Wood
PJ Zimmerman

SM Graves

BPA LOSS

The attached letter from S. S. Jones requests collection of certain information just prior to and following the BPA outage on April 6. Would you please arrange to obtain this information within the next two weeks (particularly before available records may be lost or destroyed). I would suggest that this assignment might be appropriate to give to the engineering assistants. Please forward the completed data to me and I will arrange to give it to Jones.

cc: SM Graves-LB

R.W.R.

DLN

April 13, 1962

E. J. Filip
Manager
H Reactor Operation

POWER FAILURE REPORT - H REACTOR
Ref: Your reports, same subject, dated 4/10/62

Discussion of the power failure of April 6, 1962, with FEO and R&M representatives has resulted in the following agreements concerning problems encountered by H Reactor during the outage:

1. Exhaust Fan Turbines
   I am assuming that you will start work immediately to relieve the entrained oil problem in the compressed air to the exhaust fan controller. You may also wish to look at the frequency of operation of this equipment to assure that problems such as the oil entrainment are uncovered as they occur.

   Bob Reid will shortly be issuing a letter outlining the conditions to be met in operating the confinement exhaust system until such time as the troublesome steam valve and alignment problems can be resolved by FEO.

   Beyond the steam valve and alignment problems, there is some indication that we have not been as careful as we should be in the maintenance of the exhaust fan equipment and controls associated with the confinement system. The maintenance of an operable confinement system represents a serious commitment in the area of reactor safety and should be accorded appropriate attention.

2. Control Room Lighting
   Even though your emergency generator responded properly, I gathered from your report that there was no light in the control room for a short period of time. If you do not already have Exide-type emergency lights available, I would suggest that they be put in the control room as soon as possible. This should be done even though you expect no problems with your emergency lighting system.

It was gratifying to note that there were no boiler load pickup problems in H Area. This performance should not, however, delay the installation of the improved boiler control instrumentation arising out of the F Area tests.

Will you please confirm that action has or will be taken on the above items.

Manager - Manufacturing

GC Schroeder:rf

cc: JH Brown
KT Jensen
FF Vlacil
GC Schroeder - LB
File

RWR

April 12, 1962

C. N. Gross
Manager
F Reactor Operation

POWER FAILURE REPORT - F AREA
Ref: Your report, "BPA Electrical Failure - April 6, 1962,"
dated April 9, 1962

Discussion of the power failure of April 6, 1962, with FEO and R&E representatives has resulted in the following agreements concerning problems encountered by F Reactor during the outage:

1. F Reactor Emergency Power Supply
It is my understanding that Maintenance Engineering is already working with Project Engineering to provide a temporary change in the emergency power circuit which will handle this problem until such time as FEO can contact the vendor for a permanent solution. This temporary change will be the subject of a Design Change which I understand is also in preparation. Meanwhile, you should provide F Reactor with interim procedures designed to make sure that emergency power in 105-F is available in the least possible time should another power failure be experienced. Although your report was not specific on this point, you should provide, if they are not already available, battery-operated emergency lights for the control room so that a totally dark control room is avoided.

2. 184-Emergency Generator
The problem here appears to be primarily one of maintenance. I am assuming that the instructions issued for interim operation are adequate to assure safe operation until the next outage and that the problem will be cleared at that time.

3. Horizontal Control Rods

The problem here appears to be one of maintenance and I assume that you will be expediting the repairs to the rod controls.

4. Building 181 Pump Motors
The automatic restarting of these motors is not of concern from a reactor safety standpoint; however, as you stated in your report, the problem should be investigated during the next outage.

5. <u>Steam Turbines</u>

Although the F report mentioned no difficulties with the steam turbines driving the confinement exhaust fans, this was a problem in some other areas. Bob Reid will shortly be issuing a letter outlining the conditions to be met in operating this equipment until steam valve and alignment problems can be resolved by PEO.

Beyond the steam valve and alignment problems, there is some indication that we have not been as careful as we should be in the maintenance of the exhaust fan equipment and controls associated with the confinement system. The maintenance of an operable confinement system represents a serious commitment in the area of reactor safety and should be accorded appropriate attention.

Will you please confirm that action has or will be taken on the above items.

Manager - Manufacturing

OC Schroeder:rf

cc: JH Brown
EF Jasper
FF Vlasil
OC Schroeder - LB
File

April 12, 1962

W. J. Ferguson
Manager
B-C Reactor Operation

POWER FAILURE REPORT - B AND C REACTORS
Ref: Your report, same subject, dated 4/10/62

Discussion of the power failure of April 6, 1962, with FEO and R&E representatives has resulted in the following agreements concerning problems encountered by B and C Reactors during the outage:

1. B Reactor Emergency Power Supply
   It is my understanding that Maintenance Engineering is already working with Project Engineering to provide a temporary change in the emergency power circuit which will handle this problem until such time as FEO can contact the vendor for a permanent solution. This temporary change will be the subject of a Design Change which I understand is also in preparation. Meanwhile, you should provide B Reactor with interim procedures designed to make sure that emergency power in 105-B is available in the least possible time should another power failure be experienced. Although the B Area report was not specific on this point, you should provide, if they are not already available, battery-operated emergency lights for the control room so that a totally dark control room is avoided.

2. Solenoid Failure
   The solenoid failure on the C Reactor emergency generator at 184-B is a maintenance problem and I assume that it is already taken care of.

3. Incoming Emergency Power - 105-C
   As in the case of B Reactor, an interim procedure should be supplied to 105-C for providing the incoming emergency power until such time as the problem resulting in failure of the circuit to close can be identified and corrected.

4. DC Emergency Lighting Circuit
   I assume that you will continue to look for the cause of the malfunction in the DC emergency lighting circuit at 184-B. Battery-operated emergency lighting may be desirable here also if it is not supplied.

5. Steam Turbines

Although the D-C report mentioned no difficulties with the steam turbines driving the confinement exhaust fans, this was a problem in some other areas. Bob Reid will shortly be issuing a letter outlining the conditions to be met in operating this equipment until steam valve and alignment problems can be resolved by ETS.

Beyond the steam valve and alignment problems, there is some indication that we have not been as careful as we should be in the maintenance of the exhaust fan equipment and controls associated with the confinement system. The maintenance of an operable confinement system represents a serious commitment in the area of reactor safety and should be accorded appropriate attention.

It was gratifying to note that there were no boiler load pickup problems in D-C Area. This performance should not, however, delay the installation of the improved boiler control instrumentation arising out of the F Area tests.

Will you please confirm that action has or will be taken on the above items.

Manager - Manufacturing

CC Schroeder:rf

cc: JK Brown
RT Jessen
FW Vlacil
CC Schroeder - LB
File

F-Plant Incident

[redacted]

DECLASSIFIED

GENERAL ELECTRIC

HANFORD ATOMIC PRODUCTS OPERATION - RICHLAND, WASHINGTON

DOCUMENT NO. 816-17

SERIES AND COPY NO.

DATE April 10, 1962

[redacted]

TITLE

ELECTRIC POWER OUTAGE
D AREA, APRIL 6, 1962

OTHER OFFICIAL CLASSIFIED INFORMATION

[redacted] SECS. 793 AND 794. THE TRANS- [redacted] TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.

AUTHOR

JT BAKER

ISSUING FILE

THIS DOCUMENT MUST NOT BE LEFT UNATTENDED OR WHERE AN UNAUTHORIZED PERSON MAY HAVE ACCESS TO IT. [redacted] PROVIDED BELOW.

ROUTE TO:	PAYROLL NO.	LOCATION	FILES ROUTE DATE	SIGNATURE AND DATE
~~[illegible]~~				
FW VanWarner				
~~JT Baker (Ret. [illegible])~~				

DECLASSIFIED

54-3000-052 (7-59) A.E.C.-G.E.-RICHLAND, WASH.

[redacted]

[redacted]

Distribution: 1. OC Schroeder
2. AR Maguire

IRRADIATION PROCESSING DEPARTMENT
GENERAL ELECTRIC
RICHLAND, WASHINGTON

DECLASSIFIED

April 10, 1962

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O. C. Schroeder
Manager - Manufacturing
Irradiation Processing Department

ELECTRIC POWER OUTAGE - D AREA, APRIL 6, 1962

On April 6, 1962 at 3:11 p.m. a complete loss of electric power occurred at D Area scramming both D and DR Reactors. Although electric power was restored at 3:15 p.m., an all clear was not received to restart the 190 electric pumps in time to make a scram recovery. D Reactor was started up following a minimum outage of 34.3 hours and DR Reactor after an outage of 36.5 hours. The following summarizes the experience at both Reactors and in Power during this period.

D REACTOR

D Reactor had been in operation for 29 hours since the last outage. At the time of the power failure the reactor was at nonequilibrium operating condition. All turnaround poison had been removed except for three splines and the calculated scram recovering time was 19 minutes. The operating power level was 1730 MW with a bulk outlet temperature 84.5° C. There were no unusual operating problems at the time the scram occurred. All safety circuit systems worked according to design except for the 105 emergency electric power supply and the exhaust fan turbines. Process water flow dropped from 87,000 gpm to 35,500 gpm, and there was no detectable increase in bulk outlet temperature due to the flow loss. Following restoration of instrument power, approximately 45 seconds after the scram, the "corn-popper" temperature monitor indicated individual exit tube temperatures of 50° C on the hotest tubes. The temperature gradually decreased to less than 32° C within 15 minutes. The thermal shield flow dropped from 1200 gpm to 660 gpm due to transfer of supply from normal process water to filter water back-up.

The 105-D electric supply did not transfer to the emergency power supply although the 184-D emergency alternator came on the line. Further investigation revealed a design shortcoming in the newly installed 105 distribution system (Project CGI-861) which prevented the emergency power supply to transfer. Project Engineering has been alerted of this fault and is redesigning the system to eliminate this problem. When the emergency supply power failed to transfer, the emergency gasoline generator came on the line in about 45 seconds and supplied instrument power to the control room.

All supply and exhaust fans dropped off the line, and the steam driven exhaust fans failed to come on as designed. No. 9 exhaust fan turbine had been previously isolated from the system for repairs. No. 10 exhaust fan should have come on the line, but it did not. Failure of this fan to operate was found to be due to the fact that the Ruggles-Klingman air operated valve in the turbine steam supply line failed to open. These valves were known to be unreliable and Project Design has been working on this problem since they were installed during Project CGI-791.

[redacted]

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IRRADIATION PROCESSING DEPARTMENT

GENERAL ELECTRIC

RICHLAND, WASHINGTON

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O. C. Schroeder April 10, 1962

Major work accomplished during the outage included rear face gas leak repairs, rear pigtail replacement and front nozzle lug ring replacement.

DR REACTOR

Prior to the scram the reactor was operating near-equilibrium power levels of 1800 MW. The reactor had been in operation 78.8 hours since the last outage. All safety circuit systems and emergency electrical power supply worked according to design. The process water flow dropped below the normal value expected after the complete loss of power due to failure of No. 5 boiler to pick up the steam load as rapidly as needed. Process water dropped immediately to approximately 22,500 gpm, and within six minutes following the scram, two additional steam pumps were placed on the line at 190-DR bringing the flow back up to 31,000 gpm. The far top of riser pressure dropped to a minimum of 50 psi and the top of near riser to 60 psi following the scram. When additional steam pumps were added, the pressure increased to approximately 80 psi. There was no indication that high tanks cut in during this period. Monitoring of individual exit tube temperatures with the "corn popper" indicated a maximum tube temperature of 50° C shortly after the scram. As the process water flow was increased the tube temperature decreased to 35° C. Bulk outlet temperature decreased to 32.5° C about one minute after the scram and over the next 20 minutes gradually decreased to 25° C.

The thermal shield pressure dropped to 6 psi and recovered almost immediately to near normal pressure of 45 psi. The thermal shield cooling flow was being supplied with filtered water.

The reactor was down for a total of 36.5 hours which was 1.5 hours beyond the minimum due to difficulties encountered during the helium leak check.

Major work accomplished during the outage included thermocouple and RTD repairs, helium leak check for processing tube leaks and gas leak repairs.

POWER BUILDINGS

181-D Building - all pumps dropped off, all switches were cleared and pumps were made available when power was restored.

182-D Building - No. 4 electric condenser pump dropped off and No. 2 steam condenser pump was put in service. All surge suppressors operated satisfactory. The steam driven export pump was made ready for service.

183-D/DR buildings - All equipment operated satisfactory except the 183-D electric driven hi-lift pump. The copper oxide rectifier burned out when attempting to start this pump, and it was necessary to use a fire extinguisher to extinguish the flames in the rectifier. The damaged rectifier was replaced during the outage.

[redacted]

[redacted]

IRRADIATION PROCESSING DEPARTMENT
GENERAL ELECTRIC
RICHLAND, WASHINGTON

O. C. Schroeder April 10, 1962

184-D Building - The emergency generator came on the line automatically and functioned satisfactory during the entire period. The deareator feedwater heater controls worked satisfactory. The boiler control worked satisfactory, but the steam pressure dropped 40 psi below the normal pressure of 230 psi on the system due to malfunction of No. 5 boiler force draft fan. Additional tests will be required to determine cause of this failure. The normal steam load before the outage was 89,000 lbs per hour with these boilers. The steam load during the power failure was 351,000 lbs per hour, an increase in load of 262,000 lbs per hour.

190-D/DR Buildings - A two to three minute delay was experienced in closing the 190-D and DR cone valves due to failure to immediately restart the control valve motors after normal power had been restored.

The process water pressure at 190-DR dropped to 65 psi with seven steam driven pumps on automatic. Two additional idling pumps were immediately placed on the line to raise the pressure to 90 psi. Failure of the seven steam driven pumps to deliver adequate pressure was due to the lower steam pressure caused by failure of No. 5 boiler to pick up the load as rapidly as needed.

The 190-D annex No. 2 pump motor would not restart due to dirty relay contact points. Cleaning of these points corrected the problem.

OVERTIME HOURS REQUIRED FOR D-DR OUTAGES

	Exempt	NonExempt
D Processing	0	72
DR Processing	0	0
Maintenance	24	149
Total	24	221

J T Baker
for Manager
D-DR Reactor Operation

JT Baker:met

DECLASSIFIED

[redacted]

ROUGH DRAFT

April 10, 1962

To: File

From: J. W. Frymier

ELECTRICAL POWER FAILURE
H POWER OPERATION

A power failure (Critical Z) occurred on the HAPO loop of the 230 KV electrical system at 3:09 PM, April 6, 1962. The system was re-energized at 3:11.5 PM and returned to normal at 3:17 PM.

A planned extended tube replacement outage was in progress at 100-H Area, consequently only minimum power equipment was in service to support shutdown flows. All emergency equipment functioned as designed.

190-H Building

Conditions Prior to the Outage

No. 8 Annex pump was supplying process water flow with the by-pass valve. No. 2 and No. 13 turbine driven pumps were idling at no load. No. 2 turbine controls were set on automatic *(means really remote control at the 190 Control Panel.)* at the sub-panel. The turbine acceleration controls in the 190 control room were set on manual.

Conditions following electrical failure

Immediately after failure, the 190-H Chief Power Operator accelerated the No. 2 turbine pump manually with the master pneumatic control. Process header pressure fluctuated between 40 and 120 psi TORP. No. 8 Annex pump was restarted and resumed normal pumping at 3:13 PM. No. 2 turbine was returned to normal emergency service at this time.

Building 184

Conditions prior to outage

No. 2 and 3 boilers were in service, generating 25,000 and 24,000 pounds steam per hour, respectively. All emergency equipment was set for automatic operation.

Conditions following electrical failure

The emergency generator accelerated immediately and the generator breaker closed in approximately 14 seconds.

No. 2 and 3 boiler steam generating rates increased to 52,000 and 47,000 pounds steam per hour, respectively, with a total load pick-up of 50,000 pounds steam per hour. Steam pressure reduced from 228 to 225 psi momentarily.

The 1700 area breaker opened on power loss and was not reset until normal power was restored at 3:17 P.M.

Building 183

Conditions prior to outage

The head house and filter bay were shut down. The high tank pump and No. 2 steam driven emergency pump (idling--no load, automatic control) were in service.

Conditions following electrical failure

The filter floor operator received a low pressure annunciator signal on the emergency water system. He immediately surveyed the pump room and observed that No. 2 emergency steam pump had accelerated and was maintaining system pressure with some flucuation (60-100 psi). The high tank pump was returned to normal service when electrical power was restored.

Building 182

Conditions prior to outage

No. 4 electric condenser water pump, No. 1 steam (governor control) and No. 2 electric export water pumps were in service. The two export water pumps were in service to support 100-D Area operations through import utilization.

Conditions following electrical failure

Annunciation was received in 183 Building head house of difficulties within 182 Building, and an operator was dispatched to investigate. No. 4 electric condenser water pump had stopped, but no attempt was made to start a steam driven condenser water pump since this is not essential to shutdown operation.

No. 2 electric export water pump was stopped, but the steam driven export water pump was operating under full governor control (no condensing).

The operator could not determine if the surge suppressors had cycled on power failure, but it is assumed they did. System pressure reduced immediately from 245 to 10 psi, increased to 172, reduced to 155 for approximately three minutes, then increased to the normal 250 psi. Total elapsed time in cycling was approximately 12-15 minutes.

No. 2 export and No. 4 condenser water pumps were returned to normal when electrical power was restored.

Building 181

Conditions prior to outage

Two electric river water pumps were in service to maintain 182 reservoir level.

Building 181 (cont.)

Conditions following electrical failure

Both pumps stopped, but no attempt was made to start steam driven pumps since adequate reserve was maintained in 182 reservoir.

/do

cc: EJ Filip
GW Wells
LB - JWF

IRRADIATION PROCESSING DEPARTMENT
GENERAL ELECTRIC
RICHLAND, WASHINGTON

April 10, 1962.

E. J. Filip
Manager
H Reactor

Total Power Failure at H Reactor.

On Friday, April 6, 1962, at 3:09 PM, there was an electric power failure in the HAPO power distribution network. All electric power to H Area was lost. No incident occurred which had serious potential. An informal investigation was held after the incident to obtain a better understanding of what had happened. Following is a listing of statements pertinent to the power outage as it affected the reactor.

1. H Reactor had been shut down for six days. The reactor coolant flow was at shutdown pressure, with all headers valved down such that the flow through the reactor was minimal within Process Standards. Tube replacement operations were in progress.

2. The electric power failed at 3:09 PM. The system was re-energized at 3:11.5 PM and was normal at 3:17 PM.

3. Lighting in the 105 building was lost for a short period of time until the area emergency alternator picked up the load as designed.

4. Since the control room was dark, it could not be determined with certainty that the instrumentation was functioning on emergency 105 power as designed. However, when lights were restored (estimated at one minute or less), it was quickly determined that coolant pressure had not dropped low enough to require high-tank coolant.

5. There were surges on the import coolant pressure, but an immediate inspection revealed that the import system had functioned as designed; it had not tripped and supplied coolant to the reactor.

6. Upon failure of the electric power, the emergency ventilation system did not function as designed.

   a. The dampers in the supply air ducts did not close, apparently due to sticking.

   b. The master controller for the steam exhaust fans and dampers did not function. Thus, there was no exhaust fan in service until it was manually started. A later investigation revealed that the probable cause of the failure could be the result of entrained oil in the compressed air to the controller.

Planned corrective measures to insure functioning of the ventilation system in the future include daily tests and exercises of the system during outages as well as during operation. The probability of failure should be reduced considerably by the installation of a new air compressor in the near future.

Project Engineers for CG-791 have rechecked the system faults and will make additional recommendations as their inspection determines.

A. P. Vinther
Manager
H Processing

AP Vinther:ecj

cc: BR Cremer
File
LB

54-3000-215 (11-60)

KE-...

HANFORD ATOMIC PRODUCTS OPERATION

GENERAL ELECTRIC

RICHLAND, WASHINGTON

April 10, 1962

O. C. Schroeder
Manager
MANUFACTURING OPERATION

ELECTRICAL POWER OUTAGE

On Friday, April 6, 1962, at 3:09 p.m. an interruption of BPA electrical power to the 100 Areas shut down all operating reactors including 100 KE and KW. At KW normal conditions (shutdown status) were restored at 3:20 p.m. At KE normal conditions (operating including high lift pumps) were restored at 3:22 p.m.

The loss of all BPA electrical service extended for approximately 2½ minutes. The interruption was reported as caused from a fault on the No. 3 230 KV line. A planned Critical "W" existed at the time of the fault with No. 3 line open at 100 K and the 230 loop open between 100 KE & KW for line maintenance on this section of the line. The fault caused breakers at 100 F on No. 2 line and at 100 B on No. 1 line to open, interrupting all electrical service to the 100 Areas.

At 100 K Areas all emergency power equipment responded as per design taking over all emergency electrical loads without any incidents. All low lift pumps remained in service except No. 5 Low Lift which has been moved from B-E emergency bus to Bus A as part of the CGI 833 Project, which when completed will also move No. 2 low lift from C-F busses to D bus, and will be normal design criteria for these pumps to drop out of service on a BPA separation. Only No. 5 pump has been changed to date in both KE & KW and their dropping out of service was as per design.

All service water pumps (3) at KW and (3) at KE remained in service. All river pumps at the 181 Bldgs. dropped out of service as per design. All other predetermined as per design services supplied from the B-E-C-F busses supplied by the emergency generators remained in service.

This action at both 100 K Areas was initiated by the tripping of the 47 relays in cubicles 17 A and 26 A. These are phase sequence and under voltage relays designed to protect the local emergency generators in case of line under voltage. These 47 relays tripped the 86 K1 and 86 K2 relays, which in turn trip all circuit breakers required to separate the emergency busses B-E-C-F from the BPA system and drop all predesigned nonrequired equipment from the above busses.

All high lift pumps dropped off the line as all electrical power was lost on the 13.8 V bus bars. The 27 relays (under voltage) tripped the 105 Safety circuit and all equipment on the 4160 V busses A-D-L-M as per design.

KE-KW

54-2000-215 (11-60)

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Boiler performance was entirely satisfactory and steam loads are shown in the following tabulation:

Boiler No.	Before Outage	During Outage
No. 1 KE	16,500# per HR.	41,500
No. 3 KE	16,000 " "	40,500
No. 1 KW	12,500 " "	40,800
No. 2 KW	15,000 " "	38,000

As shown they are well below the 58,000# per HR. ratings of the boilers. There is no recording of generator loads so the loads on the generators and their performance were noted by visual observation by the Supervisors and operators during the short period the emergency existed. According to their observations in both areas the generators picked up the load instantly with a normal voltage and frequency drop of approximately 200 volts and 2.5 cycle drop in frequency with a recovery to near normal in less than two minutes, which is normal recovery as observed in our regular scheduled acceleration tests of the generators.

Load on the generators under the emergency condition averaged about 3,000 KW per unit.

As all emergency equipment functioned as per design and operating conditions stabilized under the emergency conditions (loss of BPA Power) no immediate action was initiated to return to normal via BPA until advised the system was stable. Upon receipt of this advice the necessary procedures were initiated to restore normal operating conditions.

J. C. McLaughlin
J. C. McLaughlin
Manager
KE-KW POWER OPERATIONS

Approved: [signature]
R. S. Bell
Manager
KE-KW REACTOR OPERATION

JCM:ap

cc: File
LB

54—5000—002

IRRADIATION PROCESSING DEPARTMENT
GENERAL ELECTRIC
RICHLAND, WASHINGTON

[redacted]

April 9, 1962

O. C. Schroeder
Manager
Manufacturing Section

BPA ELECTRICAL FAILURE - APRIL 6, 1962

This is a preliminary report of observations made at F Area during the above mentioned electrical outage.

SUMMARY

1. Electrical Outage at 105-F - The 105-F reactor was tripped out at 3:09 p.m. on April 6, 1962, and for various reasons did not have normal electrical back-up for approximately six minutes. Some or all of the reasons are listed below.

2. 105 Emergency Alternator - This piece of equipment apparently worked satisfactorily but readings on certain instruments were erratic.

3. 184 Emergency Generator - Normal operation was obtained in about 15 seconds but then tripped out after 11 minutes due presumably to vibration and a worn latch.

4. Electrical Equipment Room in 105-F - Considerable difficulties were experienced in switching the electrical loads in this room during the first five minutes or so of the outage. It may be that a design change will be required to automatically transfer the electrical power from the 184 emergency generator to the reactor buildings.

5. Top of Riser Pressure - Contrary to previous reports, no major difficulties were experienced with this phase of the outage.

6. Horizontal Control Rods - Only one of four HCR's that should have scrammed into the reactor operated satisfactory.

7. Building 181 Pump Motors - When electrical power was restored, two motors at the river pump house started automatically, which is contrary to present design.

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GENERAL ELECTRIC
RICHLAND, WASHINGTON

[redacted]

PRELIMINARY RESULTS OF OUR INVESTIGATION (Numbers used - same as Summary)

1. Electrical Outage at 105-F - The reactor was without normal or emergency power for approximately six minutes due to an apparent inability of the new electrical equipment recently installed under Project CGI-861 to automatically transfer the emergency electrical power from the 184 generator without a manual re-set. We understand that this same difficulty was experienced by both the B and D reactors. This apparent design inadequacy is being investigated at the B reactor today, and since the reactor is down, an actual test can be made. In the meantime, we will proceed to instruct both Processing and Electrical people as to what additional procedures must be put into effect in case of another electrical failure in the near future.

2. 105 Emergency Alternator - No additional comments regarding this equipment at this time, -- see Summary.

3. 184 Emergency Generator - As stated in the Summary, this equipment started and operated satisfactorily for 11 minutes but then because of vibration and a worn latch, the turbine tripped out. An operating delay was experienced in reclosing the generator braker, but the problem was not critical since normal power had been restored to 105 and 190 buildings. As an additional test, the generator was put into operation on the 4-12 shift of the same day, and after an hour of operation, tripped out again. In case of an electrical outage, the power operators have been instructed to watch this particular trip point to prevent the generator from dropping the emergency power. Repairs to the latch will be made during the next outage or other modifications may be made sooner.

4. 105 Electrical Equipment Room - Preliminary known details regarding this equipment are covered under Item 1 above.

5. Top of Riser Pressure - No additional comments at this time,-- see Summary.

6. Horizontal Control Rods - Only four of the present seven rods (three being half rods) are fixed to scram in case of an electrical power failure. The fact that only one of these four rods entered the unit is probably due to the two-way - four-way valves that have not been functioning properly. As a matter of record, replacements have been ordered. A second rod actually entered the unit when electrical power was again interrupted during switching in the equipment control room. The remaining two rods entered the unit without difficulty when normal oil pump pressure was applied ---this is, under non-emergency conditions.

[redacted]

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[redacted]

7. Building 181 Pump Motors - The reason why two motors at the river pump house started automatically is unknown. However, certain electrical changes were supposed to have been made sometime ago to prevent the motors from starting automatically and perhaps these two motors did not have this particular design change completed. This, too, will be investigated during the next outage.

CN Gross

MANAGER
F REACTOR OPERATION

CN Gross:cs

cc: RG Clough, Jr.
MP Johnson
EJ O'Black
RM Scott
File
LB

[redacted]

54—30

IRRADIATION PROCESSING DEPARTMENT
GENERAL ELECTRIC
RICHLAND, WASHINGTON

April 10, 1962

C. C. Schroeder, Manager
Manufacturing Section
1704-H Bldg., 100-H Area

<u>POWER FAILURE REPORT - B AND C REACTORS</u>

On April 6, 1962, at approximately 3:08 p.m., B-C Reactor Operation experienced a total power failure. All power to the 151-B substation was lost for approximately two minutes. As a result, the entire area should have been without power until such time as the 184-B emergency generators and the 105-B gasoline generators functioned. The time without power was extended beyond this time due to equipment difficulties. At the time of the failure, C Reactor was shut down and B Reactor was operating.

Most equipment functioned as designed. The emergency steam turbines accelerated in a few seconds and supplied ample cooling water to the reactors. Some of the difficulties experienced with the emergency equipment are:

1. At B Reactor, power was off approximately eight minutes. Emergency power should have been supplied within 25 seconds. The long delay was caused by the tripping of the incoming line circuit breakers preventing closure of the emergency power circuit. The power was off until such time as necessary circuit breakers were manually closed. The fault in the operation of the system was a design error. This problem is being resolved and a design change is being prepared to correct the situation. In addition to correction of this design inadequacy, it is felt that at least one power level indicator should be battery operated to determine the condition of the reactor during abnormal situations such as existed during this power interruption. Action on this item will be initiated through ~~through~~ ARE.

   Water pressure increases were obtained twenty minutes after shutdown, but full pressure was not realized until 50 minutes after shutdown. This time delay, along with resetting of the HCR position indicators precluded a hot startup recovery.

2. The C Reactor emergency generator at 184-B was on automatic position, but failed to automatically supply emergency power. The steam supply solenoid valve required manual operation. Emergency

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power was supplied in approximately 25 seconds. The solenoid is being repaired. The emergency incoming circuit at 105-C did not close as required. Tests will be conducted during the next reactor outage to determine the difficulties. As at B Reactor, all indicators of reactor power were inoperative.

has been replaced.

3. The DC emergency lighting circuit at 184-B failed to function. Four subsequent tests disclosed no malfunction.

4. At 183-C, the emergency light and power circuits did not operate due to incorrect switch settings. The weekly check list will be revised to prevent a reoccurrence.

In summary, most of the emergency equipment, particularly the critical equipment, operated satisfactorily. We are not satisfied with certain of our PM check frequencies and results and will take action to revise as necessary. A follow-up report will be issued to cover the recommended changes.

WJ Ferguson

Manager
B-C Reactor Operation

WJ Ferguson:WDH:fc

cc: JW Baker
RE Dunn
WD Hamilton
CE Harkins
RM Smithers
File
LB

cc:

July 24, 1962

Dr. R. E. Trumble, Supervisor
N Reactor Process Development
Research and Engineering

ANALYSIS OF APRIL 6 POWER FAILURE

Attached is a review report of the BPA-HAPO electrical power incident of April 6, 1962, based partly on data and evidence available and partly on engineering logic. Insufficient data and facts were available to permit an engineering analysis as such. The case was characterized by (1) lack of data, (2) denial of access to vital information, (3) delay in supplying data requested, and (4) poor quality of basic information supplied. Under item (4) the copy of the oscillograph records requested is unreadable and could not be enlarged for detailed study as planned.

It was somewhat disconcerting to find that no minutes were available of the official investigation, although a great deal of emphasis was placed on the comments of expert witnesses.

Relay demonstrations were made, but have little more weight than performances by skilled technicians. In general it seems logical to say that the performance from a safety standpoint was according to plan, with minor malfunctioning which has been quickly recognized and corrected. On the other hand the performance of the high voltage distribution system was erratic, inconsistent and demonstrated a lack of integrated system planning, involving coordination of the BPA network and the HAPO loops. Continuity of full scale operation is dependent upon provision of a second and independent source of electrical power other than Midway.

Floyd D. Robbins
N Reactor Process Development

FDR:dc

ENGINEERING ANALYSIS

of

THE BPA-HAPO ELECTRICAL POWER INCIDENT

April 6, 1962

by

F. D. Robbins

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INTRODUCTION

The Hanford electrical power distribution system was separated from the Bonneville Power Administration network on Friday, April 6, 1962. All reactors operating at the time scrammed and all except one stayed down after power was restored resulting in appreciable down time. Any incident vitally affecting the operation of the reactors should be examined in the light of nuclear reactor safety with particular reference to such things as safety controls, electrical switching and the performance of the backup electrical power supply.

The incident in question was serious enough in that it put in simultaneous jeopardy all operating reactors but still more grave in that it brings into focus the question as to whether the HAPO electrical network meets the rigorous performance criteria of modern power systems. These requirements, however stringent they may seem, become even more exacting when examined from the uncompromising viewpoint of nuclear reactor safety. The objective of this report is ~~not punitive or~~ rigorously analytical, but rather is intended as a commentary of ideas on the major factors involved in the incident based on a review on all data, reports and information available, and upon some exploratory field work.

SUMMARY

The total loss of outside electrical power to all Hanford reactors on April 6, 1962 was brought about by a heavy fault on No. 3 230-KV transmission line ~~number three~~ near its terminus at Midway switching station, folowed by improper operation of the relays on transmission lines numbers one and two. There is no evidence to show that the fault was caused by erroneous manipulation of switches at K Reactor following repair on a line section there. There is considerable evidence ~~and it is logical~~ that the fault occurred near Midway and was possibly initiated by severe wind and sand storm conditions. Sufficient data and evidence was not available to make an engineering analysis supported by proper documentation. A subsequent fault at Midway on July 10, 1962 is discussed in the report because it supports the credibility of some of the observations made.

The following ideas are presented as considered opinions regarding the incident in question:

1. Reactor electrical systems performed as planned except for minor malfunctions which have been corrected.
2. The high voltage electrical system performed in an erratic and unpredictable manner.
3. The high voltage system should be considered from an integrated system standpoint for planning so that any fault anywhere is cleared precisely and quickly.
4. A second connection to the BPA network independent of Midway (such as Franklin switching station) could ensure continuity of full scale operation of large enough capacity and properly relayed.
5. The second outage demonstrated that Midway is vulnerable.
6. The second outage demonstrated that failure of one piece of equipment (the Midway current transformer) can cause failure of the system.
7. Failure of one type of equipment in various strategic locations (such as the GCX-15 relays) can cause failure of the system.
8. Performance of the GCX 17 relays at Midway on transmission line No. 3 indicates that replacement of the present GCX 15 relays at Midway on Line No. 1 and 2 is advisable as recommended.

CHRONOLOGY OF THE INCIDENT (Fig 2)

Prior to the incident 230 KV transmission Line No. 3 was opened at station A-21 by opening oil circuit breaker No. A-379 and its associated disconnects to permit work on line section A7-9.[1] OCB No. A-376 at KW Reactor, OCB No. A-396 at KE Reactor, and associated disconnects were open, isolating line section A7-9 from transmission line

No. 1 from the west and line No. 2 from the east. Two figures adapted from HW-70670 are shown in Appendix B for convenience. Figure 1 shows a simplified geographic one line of the HAPO network and Figure II is a simplified one line diagram of the HAPO network showing circuit breaker numbering, rating and location. A complete and detailed description of the HAPO high voltage complex can be found in previous documents.(2)(3)(4) The essential details of the Midway switching station are shown on a simplified one line diagram as Figure III, Appendix B.

All reactors were provided with 230 KV power by the loop formed by transmission lines No. 1 and No. 2. Line No. 1 was protected by OCB No. A-336 at Midway, and Line No. 2 was protected by OCB No. A-114 at Midway. Transmission Line No. 3 was energized and protected by OCB No. A-56 at Midway but was "dead-ended" at K Area switchyard A-21 and at line switchyard A-22, 4 miles south of F Reactor. Disconnect switch A-369, normaly open, located at switchyard A-22 was also open on the day of the incident.

Transmission Line No. 3, a 795 MCM-ACSR steel tower line without overhead ground wire, except on the fisst seven towers from Midway and the first six towers out from K reactor switchyard, was thus energized but idle for its entire length. The line is about 16.5 miles long from Midway to point P with a lateral to K Reactor, switchyard A-21, about 3.1 miles long. Ground switches A-7376, A-7379 and A-7396, all on the line section under repair, would normally all be closed.

Predicted weather conditions were favorable for the scheduled maintenance. Examination of photographs of the line section under maintenance revealed that the cables comprising the line were in bad condition and certainly needed replacement. Apparently normal safety precautians were taken and the repair was completed without delay or mishpa in spite of the fact that the weather conditions changed radically. The change in weather was recognized as hazardous but the repair work had proceeded to such a point that it could not be abandoned and normal service restored, so was completed in spite of high winds with heavy dust and debris conditions. Some tumbleweeds were being blown about and could have piled upon the transmission line at some of the towers.

Records seem to indicate that the repair had been finished, all ground switches opened and that the disconects associated with OCB ~~No.~~ A-379 were closed. The position of OCB No. A-376 and A-396 and their associated disconnects was not covered in any reports but investigation shows that they were open during the repair procedure and were still open when the incident occurred.

DISCUSSION

The conditions indicated above prevailed on April 6, 1962 at 3:09 P. M. (1509 hours) at which time a purported double line to ground fault occurred on Line No. 3. There was no positive sequence load on this line at the time so the fault would therefore be composed of negative and zero sequence components only. Such a fault could be caused by lightning, massing of weeds on the line, dust, or by causes unknown. It is not likely that such a fault could have been caused by closing a circuit breaker in on a grounded line. No tangible evidence is available as to the exact cause of the fault. Line No. 3 is protected by a 15,000 MVA oil circuit breaker bank with a 3 cycle opening time capability. The breakers are controlled by GCX-17 Reactance Distance Relays, Type IBCG ~~IR-30~~ ground relays, Type CFZ Phase Comparison Relays, Type CV-1 undervoltage relays, Type IJS synchonism check relays and type VAR-11-D40A, Federal Pacific recloser relays. (5)(6)(7) Circuit breaker bank A-56 was opened at 3:09 PM by its GCX-17X relays, clearing the fault in 3-3/4 cycles as indicated by oscillograph films. Breakers were reclosed by the recloser relays, and held, in approximately 4-1/2 seconds. A question arises as to why reclosure has to be delayed for 4-1/2 seconds because an arc fault is usually extinguished (cleared) within about 17 cycles from the time of breaker opening. (All timing is based on fault time as time zero.)

Transmission line No. 1 is protected at its Midway terminus by a 15,000 MVA oil circuit breaker bank (A-336), fault current interruption controlled by GCX-15 directional distance relays.(8) Reclosing relays havebeen installed recently and are Federal Pacific Type VAR-11-D40A set for 4-1/2 seconds as on Line No. 3. This breaker did ~~had~~ not operate during the incident. The GCX type is designed to see, and operate on, faults on the transmission side of the bus. The line section between Midway substation and the B-C Reactor substation (A-2) is protected by oil circuit breakers banks A-322 and A-323 each rated at 10,000 MVA interrupting capacity and 3 cyle opening speed. The breakers are controlled by differential relays and GCX 15 directional distance relays.[8] The A-322 and A-323 breakers were opened by the GCX-15 relays approximately 1-3/4 cycles after breakers A-56 had opened line No. 3 or in 5-1/2 cycles from fault time (time zero). The operation of these relays during the incident represents malfunctioning because:

1. The relays operated after the fault had been cleared.
2. The relays should not have opened on a fault beyond the Midway bus.

Subsequent field tests of the GCX-15 by others under simulated faults seem to indicate that an inherent weakness exists in this type of relay in that the improper coordination of the contacts allows the ~~GM~~ ohm unit contacts to close before the directional and overcurrent contacts can open following a fault, (Figure IV).

Reports of conferences with Outside Public Utilities made by others indicate that this conclusion is justified and that the unreliable characteristics of the GCX-15 have been known and recognized for an appreciable period of time and that the deficiency can be corrected by rebuilding the GCX-15 or replacing it by the GCX-17.[7]

Transmission Line No. 2 is protected at the Midway substation by OCB bank A-114 rated at 15,000 MVA with an opening time of 3 cycles. The breakers are controlled by suitable relays including GCX-15 directional distance relays, VAR-11-D40A Federal Pacific reclosers, and type IBCG ground relays.[10] This breaker did not operate during the incident. The next protective breakers on No. 2 line are located at the 251 substation (A-8) (Figure V). The breaker banks proceeding from Midway substation are A-386, A-384 and A-382. None of these breakers opened although they are interposed between the breakers which did open, at 100 F, and the fault. The next breakers in the line are those at substation A-6 at F Reactor area. These breakers are equipped with the

GCX-15 relays but no reclosers. The breakers at A-6 substation in order of their position in the line proceeding from Midway are A-366, A-364, and A-362. Breaker bank A-366 was tripped by its GCX-15 relay and opened at 6-3/4 cycles from time zero, or 3 cycles afer fault clearance. Operation here was improper in that the tripping occurred after the fault had been properly cleared by No. 3 transmission line breaker A-56 at Midway and also because the A-366 relays over reached the three breakers at substation A-8 (A-386, A-384, and A-382) and the line breakers at Midway (A-114). Moreover the relays seem to have tripped on first zone which is bounded by (or should be) 85 per cent of the distance to the next breaker bank, in this case, A-382 at Substation A-8.

RESTORATION OF THE HIGH VOLTAGE NETWORK

Breaker bank A-56 was properly reclosed by its VAR-11-D40A relay after an elapsed time (from fault time zero) of 4-1/2 seconds. Breaker bank A-366 was closed manually by the A-6 substation operator 2.5 minutes (9000 cycles) after the fault. Closure of these breakers energized the 230 KV switchyard at all reactors. Breakers A-322 and A-323 were closed manually by the substation operator at A-2 substation (151-B) approximately ten seconds later, reconnecting transmission line No. 1 into the loop. Since the breakers at Midway, A-336 on Line No. 1, A-114 on Line No. 2 and A-56 on Line No. 3, are all set to reclose after 4-1/2 seconds (270 cycles) there exists no reason for delaying reclosure of any or all breakers in the loop. (Figure V). Ideally any line section under fault should be cleared by the two nearest breakers, in each direction from the fault, in 3 cycles and restored again in the shortest possible time. The limitation on reclosure in the shortest possible time is the danger of arc restrike, if less than 17 cycles is chosen as a minimum. Further limitations extending this minimum time might be the speed closing capability of the breakers and time of clearance from the bus of loads which cannot tolerate high speed reclosure.

REACTOR RESPONSE

The status of the production reactors at 3:09 (3:10) PM on April 6, 1962 was as follows:

B Reactor - operating at equilibrium power level

C Reactor - down

D Reactor - operating at equilibrium power level

DR Reactor - operating at equilibrium power level

F Reactor - operating at equilibrium power level

H Reactor - down

KE Reactor - operating at 3/4 equilibrium power level

KW Reactor - operating at equilibrium power level

The operating reactors, B, D, DR, F, KE and KW were scrammed by the power loss relays in about 17 cycles from the time of opening of OCB bank A-56 at Midway or 20-3/4 cycles from time zero. The operating reactors transferred in each case to their respective secondary systems. None resorted to the tertiary (last ditch) systems. The operating reactors attempted to recover following the restoration of power 2.5 minutes after the fault. KE Reactor only succeeded. This reactor recovered at 3:42 which was an elapsed time down, from time zero, of 33 minutes. The performances of the reactors were as follows:

B Reactor recovered on April 7, 1962, 6:55 PM (1855), downtime was 27 hours 46 minutes.

C Reactor scheduled down was brought up at 3:45 PM (1545) on April 7,1962. No delay was attributable to the power outage.

D Reactor recovered on April 8, 1962 at 1:30 AM (0130). Downtime was 34 hours and 21 minutes.

DR Reactor recovered on April 8, 1962, at 4:22 AM (0422). Downtime was 37 hours 13 minutes.

F Reactor recovered on April 8, 1962 at 9:54 AM (0954). Downtime was 42 hours and 45 minutes.

H Reactor was on extended scheduled shutdown until April 14, 1962 at 3:59 PM (1559) at which time it was up in normal manner. Power loss incident did not interfere with the scheduled procedure.

KE Reactor recovered by a hot startup on April 6, 1962 at 3:42 PM (1542). Downtime 33 minutes.

KW Reactor did not attempt to recover but stayed down because of scheduled shutdown. The reactor was up again on April 10, 1962 at 11:48 AM (1148) in normal manner.

In the discussion above the time cited for the reactor to recover is defined as the elapsed time from the time of the fault until criticality was achieved.

ANALYSIS

Available data and reports do not offer enough information on which to base a sound engineering analysis of all the event s which took place in this incident. That a double line to ground fault did occur is reasonably certain based on the fact that reports from the A-2 substation (151 B) and the A-6 substation (151 F) agree with each other ~~and~~ but both ~~agree~~ disagree with the log at Midway switching station. Oscillograph records taken at Midway, ~~also~~ however, confirm this conclusion. All evidence fixes the place of the fault near Midway. The chief operator at Midway was on duty at the time of the incident and saw the reflection of the flash. His impression was that (1) it was within the first three tower spans from Midway, (2) was not lightning.

No evidence of lightning faults appears in the Midway log on thisdate nor was any lightning observed in the vicinity. In addition to this, the towers near Midway are equipped with overhead ground lines (static wires). None of this, however, precludes the possibility of lightning striking the No. 3 line within Zone 1 from Midway, passing along the line and going to ground near Midway. Field observation with 7power glasses revealed no evidence of a heavy flash-over line to line to ground. Meteorologica reports from Stampede Pass, Pendleton, Yakima and Walla Walla indicate no lightning on the day in question. Spokane reported some evidence of lightning in the distance. The possibility of a lightning stroke being the primary cause of the fault on No. 3

transmission line seems to be remote based on existing evidence.

Maintenance records and the investigating committee report indicate that No. 3 transmission line was carefully inspected from Midway to the K Reactor substation by the Construction Engineering and Utilities Operation group.(9) Each tower was climbed and inspected as closely as possible including string insulators and the jumpers at the dead end towers at Midway. No evidence of arcing was found except on suspension insulators. The B phase string on tower No. 30 was replaced and tested. Some evidence of burning was observed but was judged to be the result of lightning flashovers antedating the present incident. Similar strings found on towers No. 38 and 39 were removed and inspected with the same results as above. All insulators were approved for service as a result of the tests.

Subsequent field inspection by the author of the first five towers at Midway revealed no evidence of flashover as mentioned previously. The arrangement of towers on No. 3 transmission line near Midway is shown on the field sketch, Figure VI. Static or overhead ground lines extend from Midway to and including No.7 tower. The No. 1 tower is a tall dead end tower in line with a row of similar towers all facing north. This tower is well protected on the windward side by other towers and lines. Tower No. 2 is a turning tower facing northeast and not protected from the prevailing wind side by other towers. Both towers are clearly shown in Figure VII (Appendix B), a photograph taken on July 10, 1962, looking north from Midway substation roof. Tower No. 1 is in the foreground, center, and No. 2 to the reader's left in the near background.

Clearances on tower No. 2 appear to be critical, even under quiescent conditions. Two of the jumpers have insulator strings, the third one does not. The result of this unsymmetrical arrangement is unequal movement under strong wind conditions especially if the wind is gusty. The position of the tower is such that the angle between the incoming and outgoing conductors is less than 90 degrees thus making the clearance on the two westerly conductors (B & C phases) impaired and unequal and causing unpredictable movements under strong gusty wind conditions. Tumble weeds and other debris could easily pile up in the corners, especially on C and B phase wires.

Tower No. 3 is shown in a similar photograph (Figure VIII), and is identified as the low tower to the readers right of center in the near background. Similar conditions prevail on this tower except that the angle is not so acute and the tower is so placed that the prevailing wind direction is nearly parallel to the conductors. There is a strong possibility that under the conditions prevailing at the time of the fault, strong gusty winds, thick dust conditions and with a great deal of flying debris, that the resistance to ground and between lines dropped to such a point that an arc was formed. Flashover tests at the University of Washington indicate that even a small discharge will initiate a heavy arc which has low resistance and no reactance. These things, plus the fact that at least two experienced operators at Midway heard a loud noise and one saw a flash makes it probable that one of these towers is the locale of the fault with No. 2 tower as the most likely suspect. More specifically with violent galloping of the conductors and jumpers due to gusty wind conditions coupled with thick dust debris conditions phase wire C would be most likely to go to ground involving phase wire B on the next voltage peak. The physical conditions are clearly shown in Figures IX and X, closeup photographs also taken on July 10, 1962 from the foot of each tower. Some evidence of this arc should be visible, most probably on C phase jumper on No. 2 tower. The arc could also have started in tower No. 3 or tower No. 1. It was also observed that the grounding of these towers was not particularly good and that the grounding of the station is in our opinion inadequate for the present size of the facility. High resistance grounds increase the possibility of "arcing grounds" with resultant high frequency transients and the possibility of a voltage peak of three times the nominal line to neutral crest.(12)(13)(14) The violent results of such an arc are shown on Figures XI and XII, photographs taken recently of a current transformer failure in a Priest Rapids transmission line terminus at Midway Switching Station of BPA.

In this incident the arc caused by the failure of the current transformer was properly cleared but an oil fire ensued. The smoke from the oil fire cause an arc between adjacent disconnect switches going to the 230 KV auxiliary bus (which was energized). Figure XIII (Appendix B) clearly shows that an arc did indeed form between the disconnects which were in the position shown. The spacing between the disconnects is approximately 12 feet. The second arc was at first a single line to ground (12 cycles), then for a time was line-to-line to ground (1 cycle), then was a line to line to line to ground (15 cycles) fault. Relaying failed to clear the fault properly, normally 3 cycles, allowing the fault to remain for 20 cycles and causing the voltage on the Midway busses to drop below 50 KV (nominal 230 KV). All Hanford reactors scrammed.

The second incident was in no way connected with the April 6 trouble but the impact of the later occurrence on the analysis of the first case cannot be ignored. It certainly illustrates the Trumble axiom that in dealing with nuclear reactor safety any system implicated must be judged on the basis that an incredible sequence of incredible events can occur at anytime.

EFFECT ON HANFORD SYSTEM

The oscillograms of the fault of April 6 was obtained and enlarged to study the transient portion. Figure XIV shows the actual oscillogram trace and Figure XV the blown up portion. It is apparent that the fault was on No. 3 line with a current crest of approximately 6000 amperes. The official report of the incident describes the fault as follows: "By examination of the oscillograph charts from Midway, it was determined that the fault on the No. 3 line was a double (B and C) phase to ground fault. This is the first double phase to ground fault in the history of the Hanford system operations"(9)

The Midway log is not in agreement with the statement above. A transcript of the April 6, 1962 entry from the Midway substation log reads as follows:

"3 10 P. A 56, Hanford No. 3 line relayed and reclosed.

Targets: GCX B phase Z-1, Carrier,

Carrier Gnd., Inst. Gnd. Overcurrent,

JM Annunciator 3,000 amps or over.

JM on A 336 - 7.5 x 160 (1200 amps)

JM on A 114 - 5 x 120 (600 amps)"

The emphasis on the significance of the double phase to ground fault, supported by tenuous evidence, is not understandable here. Any transmission line protective relay system must guard against single line to ground (zero sequence), line to line (negative sequence), line to line to line (positive sequence), and various combinations of these types of faults. It is true that approximately 70 per cent of all power system faults are line to grouand (zero sequence), ten per cent are double line to ground (negative and zero sequence) and only five per cent are 3 phase (positive sequence),(15) with the remaining fifteen per cent of varying combinations of these.

The capabilities of the GCX-15 relays which protect transmission lines No. 1 and 2 are as follows:(6)

"These directional distance relays meet the present-day demands for high speed protection of transmission lines. They operate on reactance and, therefore, are universally applicable to all lines, even very short lines where arc resistance can appreciably affect distance measrement. They are normally used to protect either single or parallel transmission lines against phase to phase, three phase, and double phase to ground faults. When so used, line-to-line potentials are employed on the relay units. By using GCX relays energized from line-to-neutral potentials, protection can be provided against single-phase-to-ground faults" (Emphasis supplied)

The capabilities of the type GCX 17 relays which protect transmission line No. 3 are as follows:(7)

"Type GCX relays instantly isolate faults occurring within the protected zone, operate in a short (intermediate) time on faults on the next section, and in a longer (back-up) time on faults in other sections to which it is desired to give back-up protection. The types GCX17A and GCX 17B relays provide this characteristic 3-step, time distance protection against three-phase faults, phase-to-phase faults, and double phase-to-ground faults."

The records show that during the fault line No. 1 was feeding 1200 amperes, and No. 2 line 600 amperes, into the fault. Breaker bank No. A-386 was also carrying 600 amperes and was nearer to the fault than A-366 but did not open.

In the second case on July 10 the current on the three transmission lines seems to have been No. 1 line, 1600 amperes; No. 2 line, 1200 amperes; No. 3 line, 1200 amperes. None of the breakers protecting these lines operated even though the second phase of the fault was sustained for about 20 cycles. The GCX relays concerned in this second and similar case did not malfunction as postulated in the April 5 case. The inevitable conclusion seems to be that the relaying system cannot be depended upon to clear the HAPO system precisely in a planned and timely manner by reason of either maladjustment or inconsistent malfunctioning.

It is also to be observed that the failure of one component can and did cause a failure of the whole system. If a second supply source independent of Midway (such as Franklin) had been available on April 5, 1962, then such a performance would have nullified the advantage.

It was mentioned earlier that all reactors scrammed properly and none had to go to the tertiary (last distch) system. Some electrical malfunctions occurred at some of the reactors nicely summarized by Rogers:(16)

"The most significant equipment malfunctions were: (1) slow load pickup by one boiler in 184-D, (2) failure of automatic transfer to emergency electric power at 105-B, D and F, (3) failure of turbine driven exhaust fans to start automatically at 105-D and H and failure of suply air ventilating damper automatic closure at 105-H; and (4) failure of loop KER-3 to dump automatically."

In addition to the above emergency power from the 184 C building was not automatically transferred because of a circuit breaker malfunction. The B, D and F failures were caused by a design error in the relaying provided by Project CGI-861. Prompt and aggressive action seems to have been taken to correct these malfunctions.

APPENDIX A

References

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2. HW-61887 Robbins, F. D., "Reliability and Safety of the K Reactor Cooling System, Part I, Engineering Analysis of the Electrical Power and Control System", 4 April 1960 (Secret)

3. HW-66363 , "Reliability and Safety of the Electrical Power Supply Complex of the Hanford Production Reactors", Figure 6, Page 65 and Figure 7, Page 66.

4. HW-70670 , "Engineering Analysis of the High Voltage Power System of the Hanford New Production Reactor", Figures X, XI, and XII.

5. ASA 32.2 (AIEE) Automatic Station Control, Supervisory and Associated Telemetering Equipment. October, 1956 (In Electrical Engineering, May, 1959)

6. GET-1768B "The Art of Protective Relaying", 1957. The General Electric Company.

7. GEA-2170G "Type GCX Reactance Distance Relaying Equipment" (GCX 17) The General Electric Company

8. GEA-2170D "Directional Distance Relays" (GCX 15) The General Electric Company

9. Report "Investigation of the 230 Kv Power Outage", 3 May 1962 L.L. German

10. GEA-3206C "Directional Overcurrent Relays", The G E Company

11. HW-73389 Rogers, G. J., "Preliminary Report on the Effects of the Electric Power Failure of April 6, 1962, on the Production Reactors", 16 April 1962 (Unclassified)

12. BOOK "Electrical Transmission and Distribution Reference Book", Chptr 19, "Grounding of Power System Neutrals", S. B. Griscom

13. IBID., Chptr 14, "Power System Voltages and Currents During Abnormal Conditions", R. L. Witzke

14. BOOK "Fundamentals of Circuit Interruption", Erwin Salzer (1950)

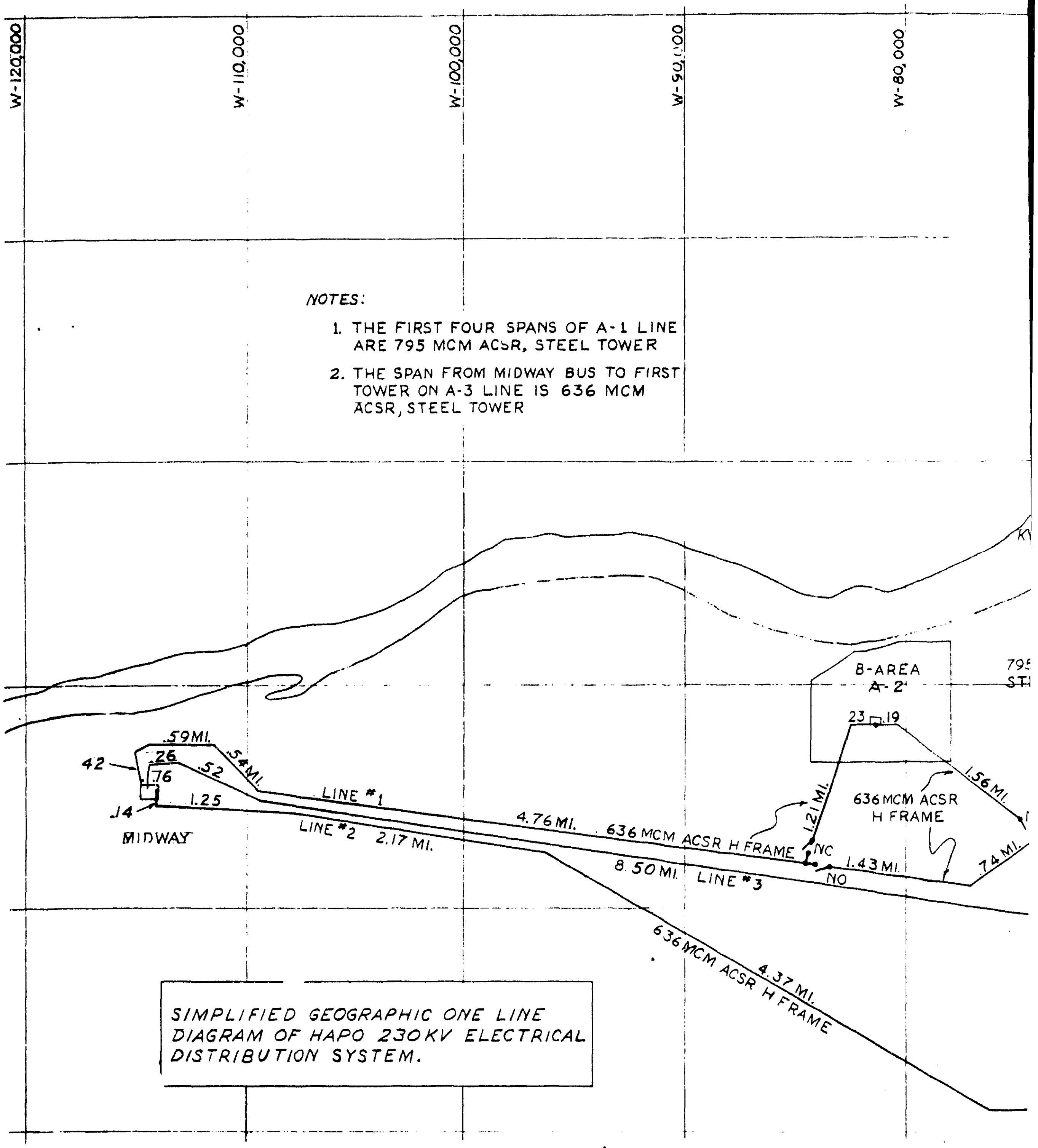
15. BOOK "Electrical Transmission and Distribution Reference Book" Chptr 11, "Relay and Circuit Breaker Applications", E. L. Harder, J. C. Cunningham

16. HW-73692 Rogers, G. J., "Effects of the Electrical Power Failure of April 6, 1962 on the Production Reactors", Rogers, G. J. 17 May 1962 (Unclassified)

APPENDIX B

ILLUSTRATIONS

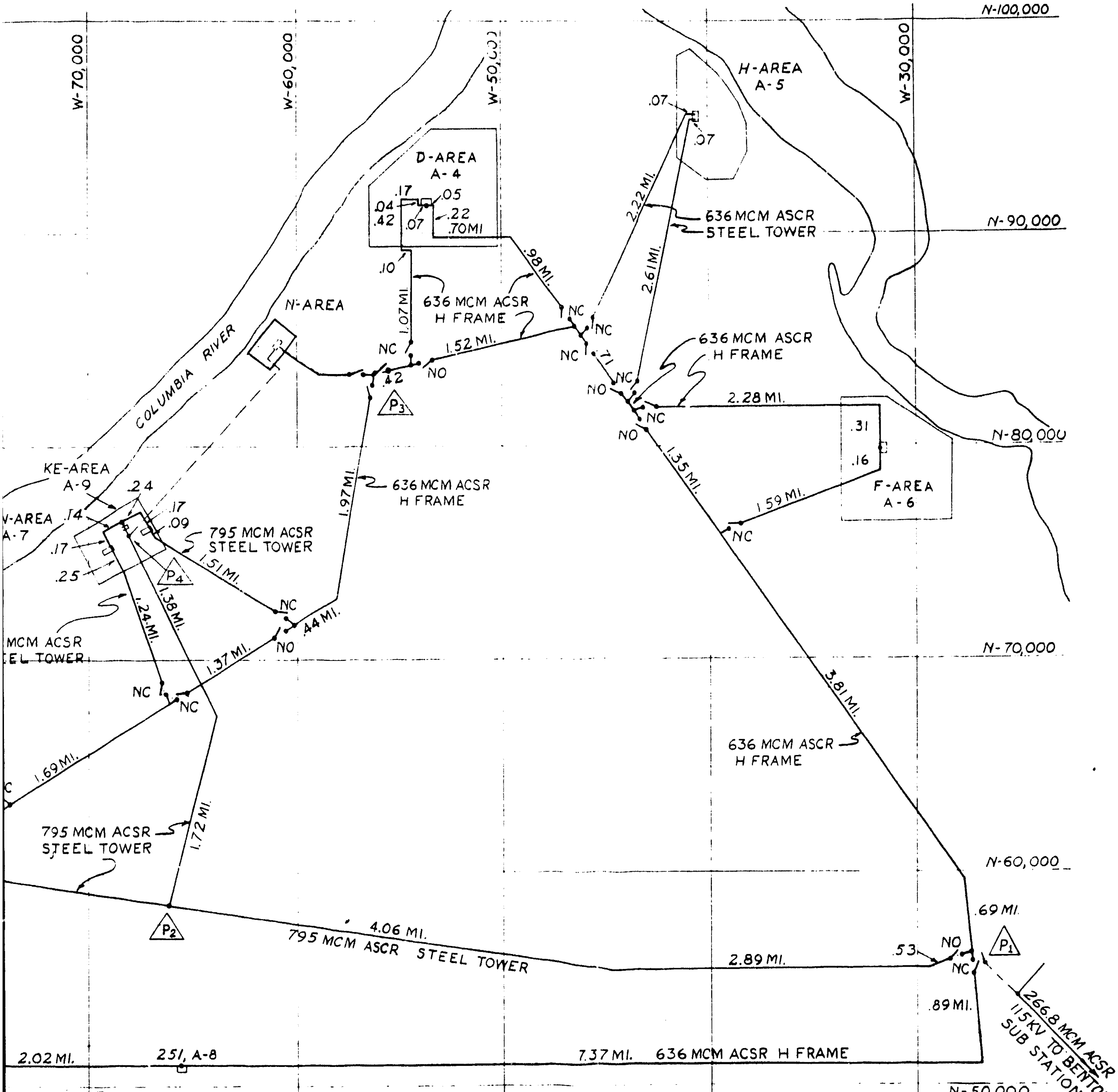
UNCLASSIFIED



F

SIMPLIFIED ELECTRI
230 KV TRANSMISSIO

[redacted]



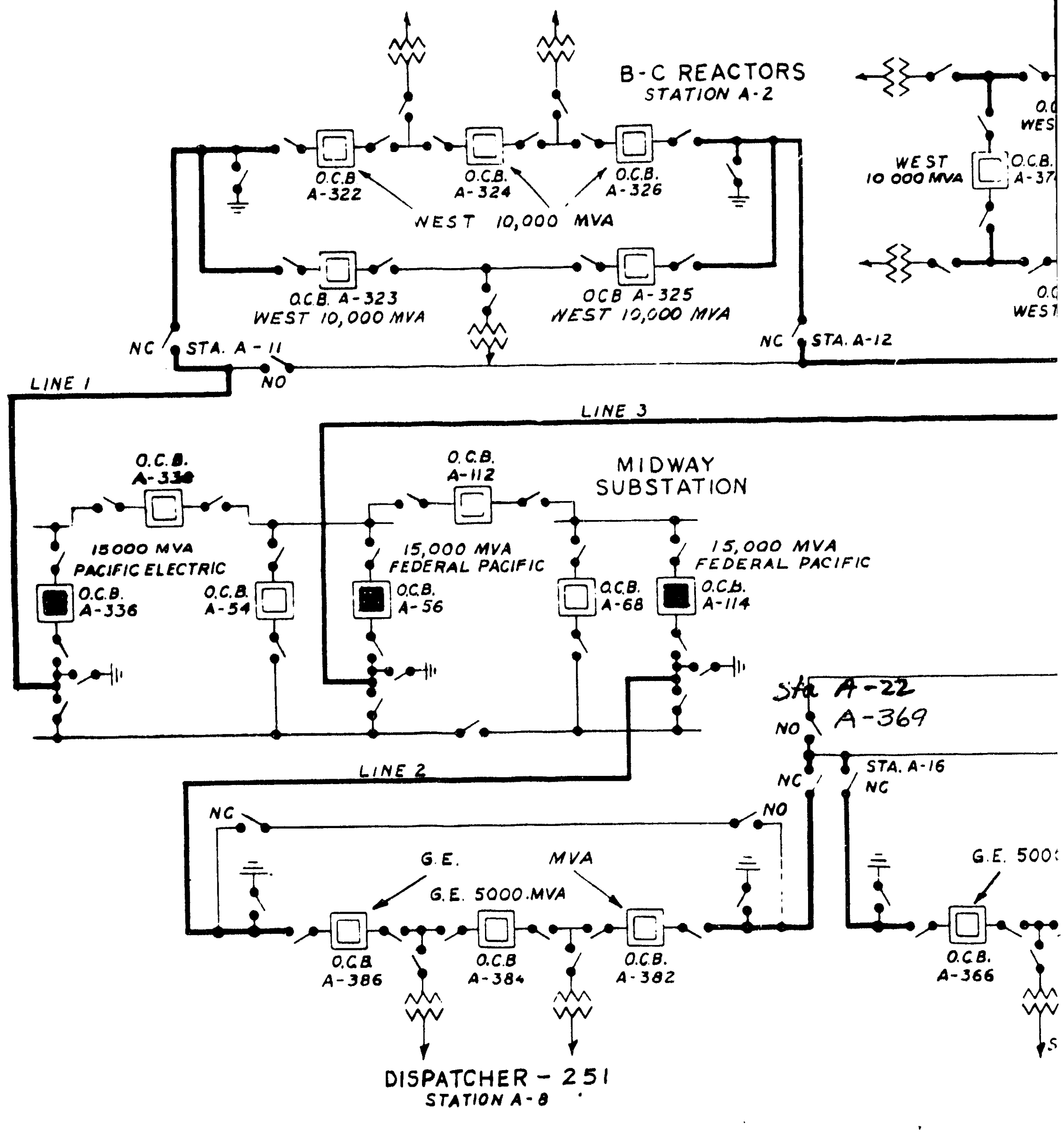
I

AL ONE LINE DIAGRAM OF HAPO
N SYSTEM -- GEOGRAPHIC

UNCLASSIFIED

Fig I

UNCLASSIFIED



SIMPLIFIED ELECTRICAL ONE I

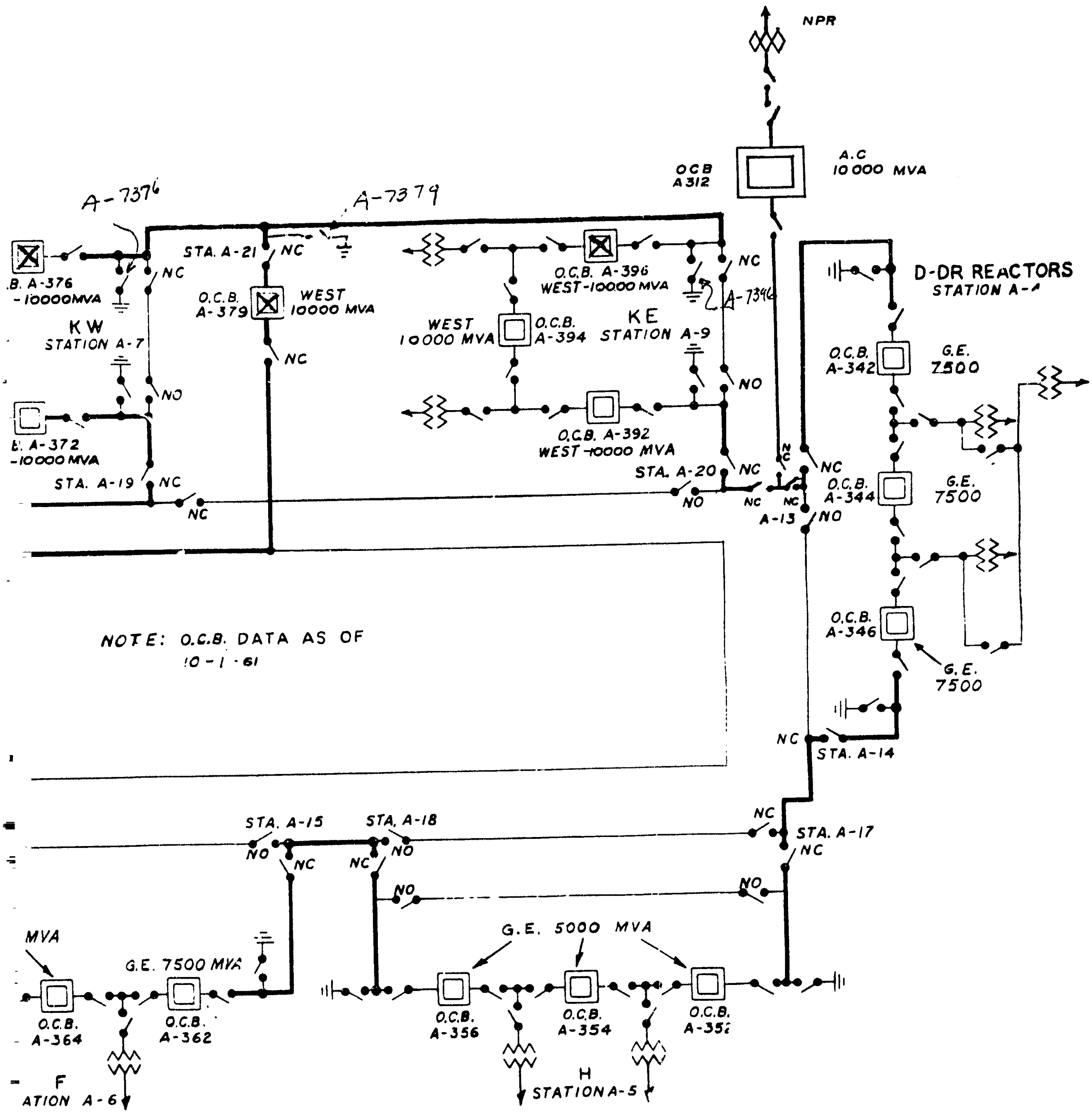


FIGURE XII

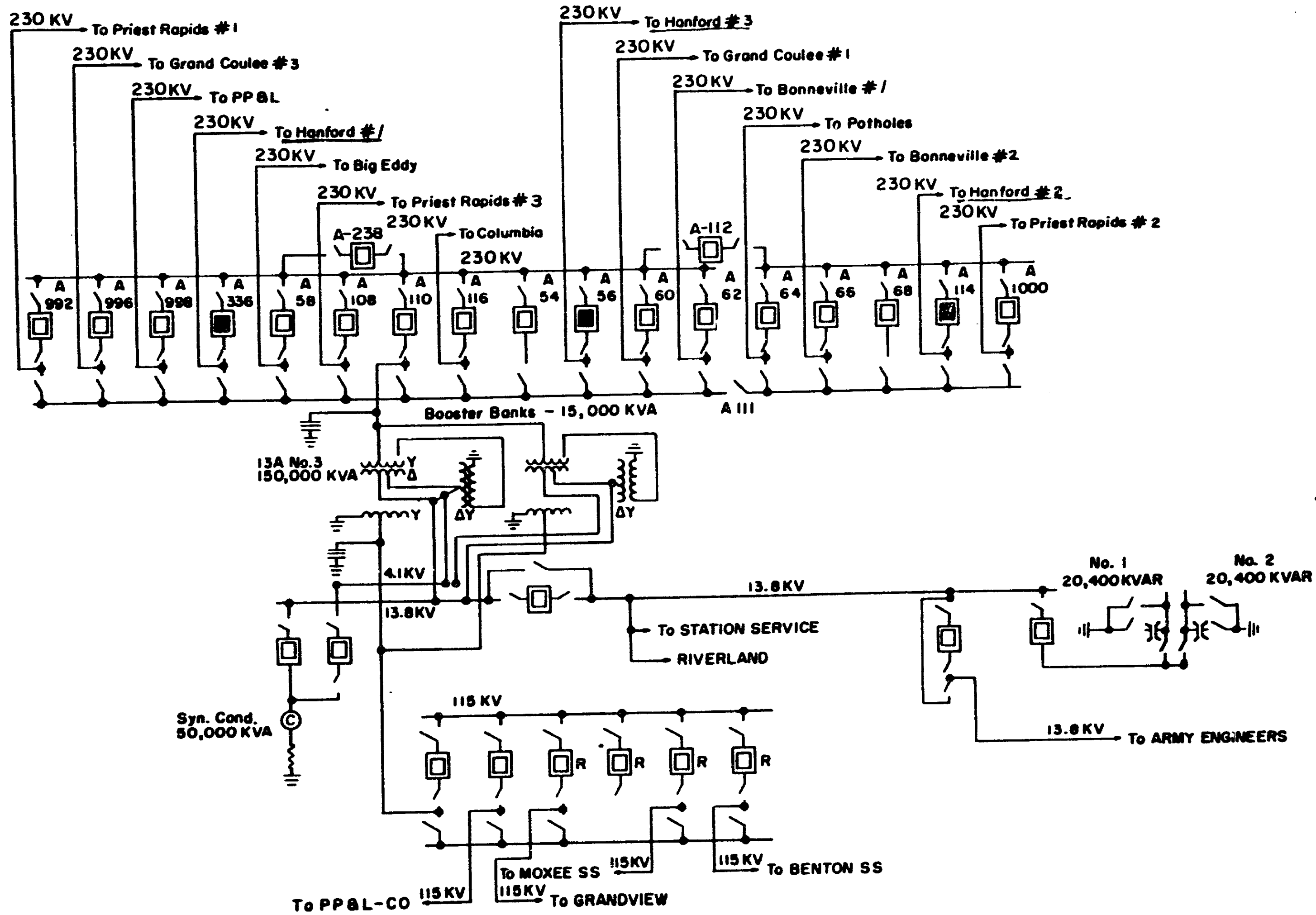
INE DIAGRAM OF HAPO 230KV TRANSMISSION SYSTEM

UNCLASSIFIED

[redacted]

FIGURE III

SIMPLIFIED ELECTRICAL ONE LINE DIAGRAM OF MIDWAY SWITCHING STATION



The figures with red indicators are associated with HAPO directly.

[redacted]

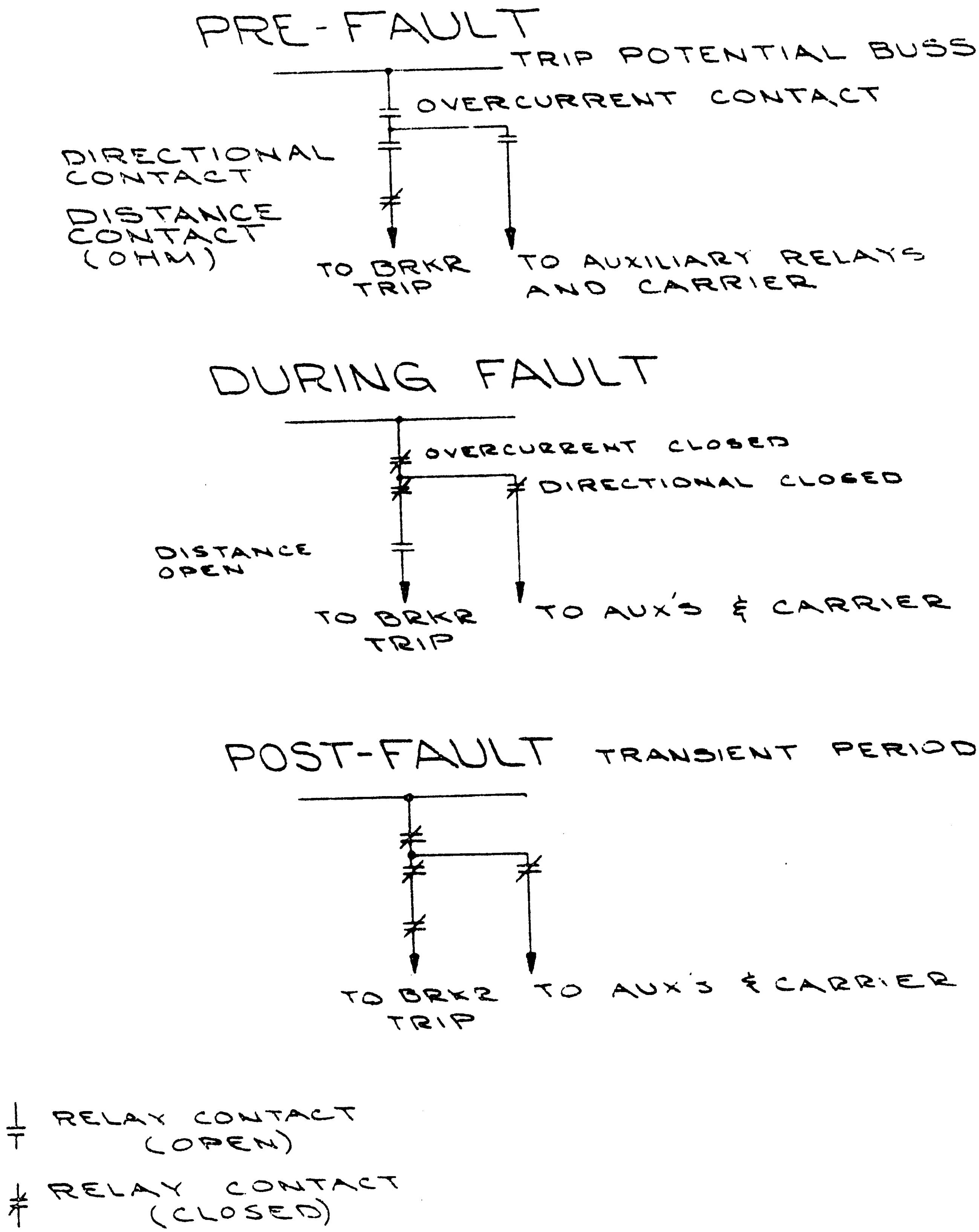

PRE-FAULT
TRIP POTENTIAL BUSS
OVERCURRENT CONTACT
DIRECTIONAL CONTACT
DISTANCE CONTACT (OHM)
TO BRKR TRIP
TO AUXILIARY RELAYS AND CARRIER
DURING FAULT
OVERCURRENT CLOSED
DIRECTIONAL CLOSED
DISTANCE OPEN
TO BRKR TRIP
TO AUX'S & CARRIER
POST-FAULT TRANSIENT PERIOD
TO BRKR TRIP
TO AUX'S & CARRIER
RELAY CONTACT (OPEN)
RELAY CONTACT (CLOSED)

FIGURE IV

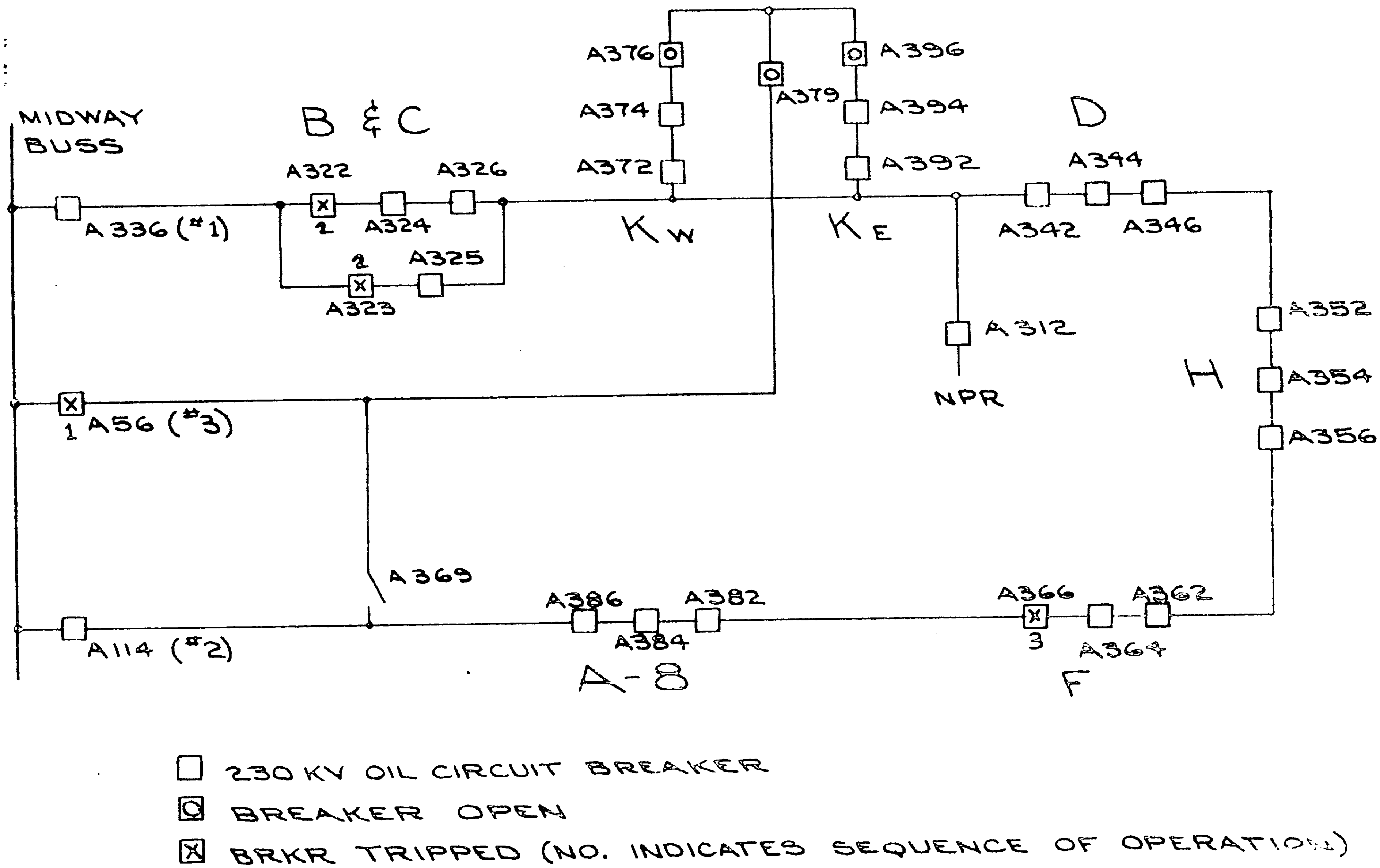


FIGURE V

SIMPLIFIED ONE LINE DIAGRAM OF HAPO 230 KV LOOP

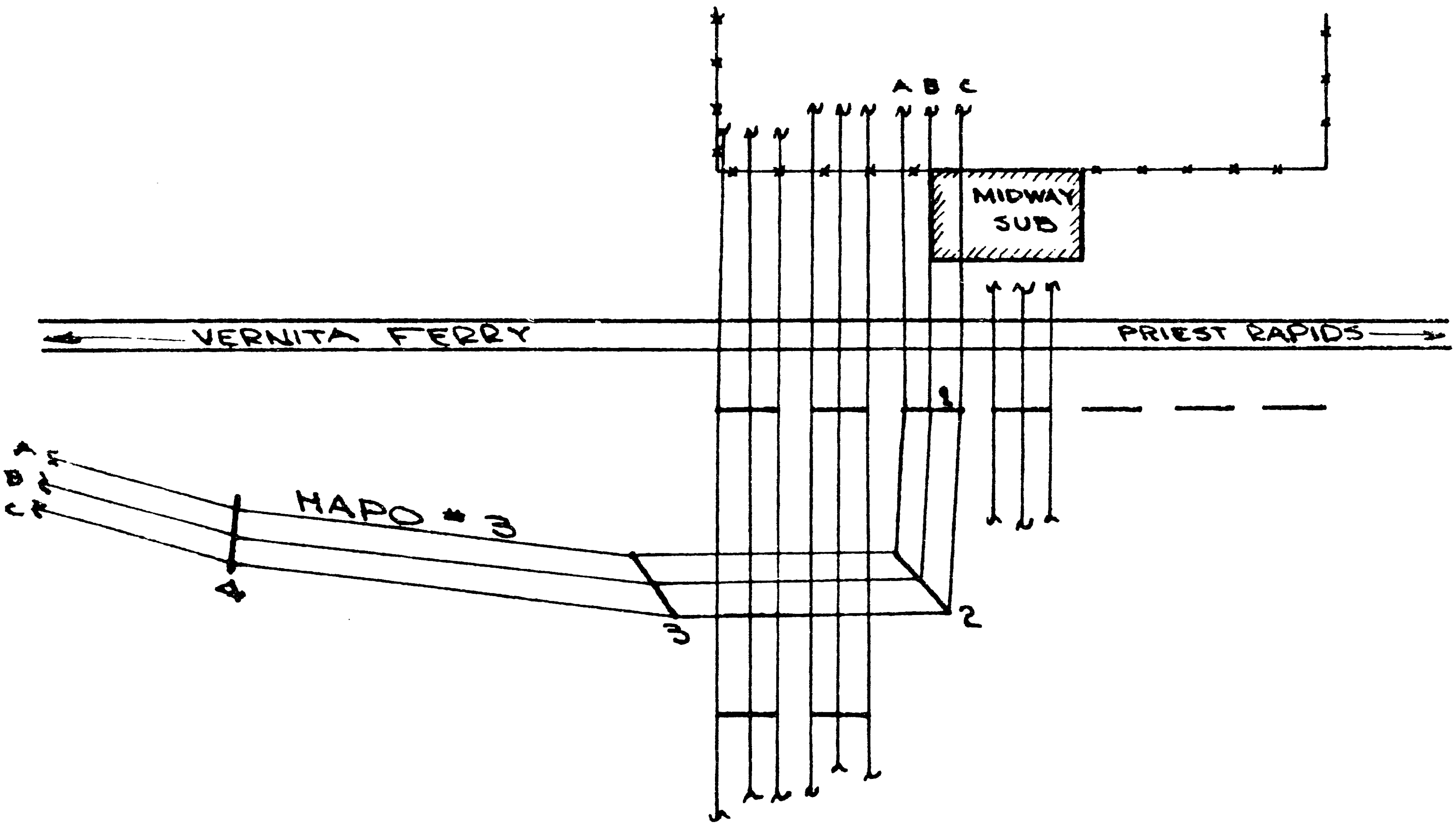


FIGURE VI

FIELD SKETCH OF HAPO #3 TRANSMISSION LINE
NEAR MIDWAY SUBSTATION

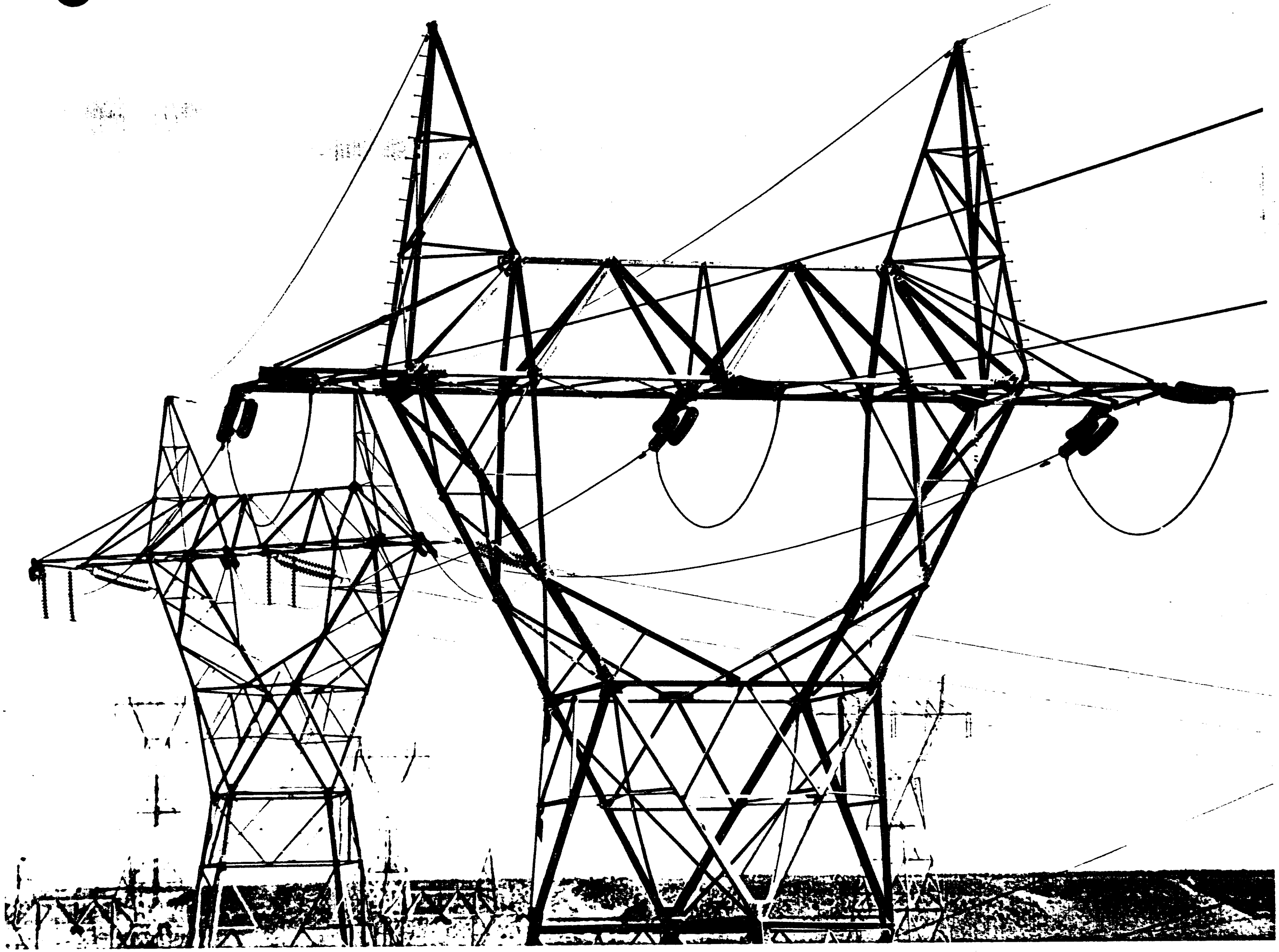


FIGURE VII

TOWERS NO. 1 AND 2, LOOKING NORTH AND SLIGHTLY EAST FROM MIDWAY SS ROOF

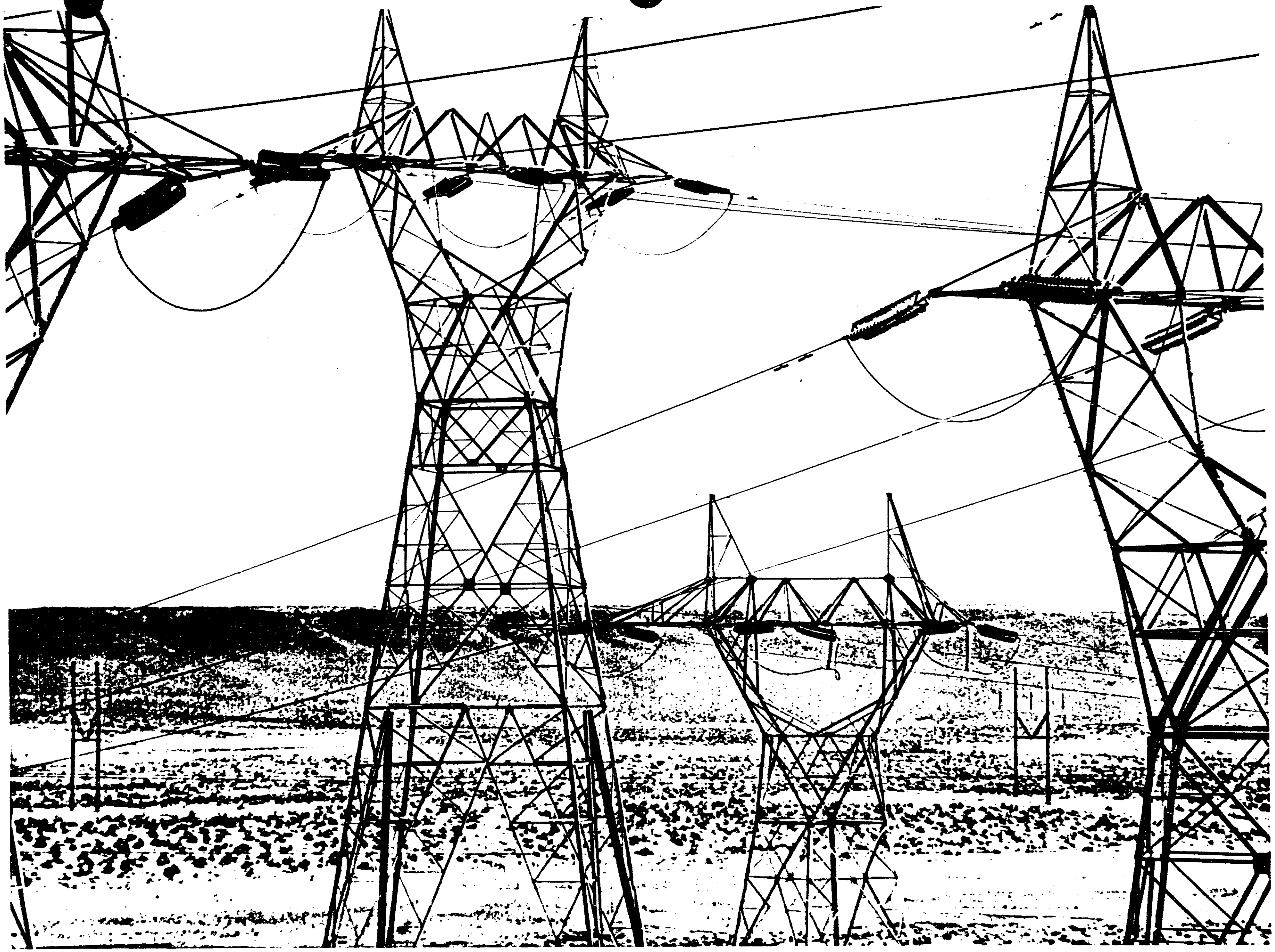


FIGURE VIII

TOWER NO. 3, FROM ROOF OF MIDWAY SUBSTATION, VIEW NORTHEAST

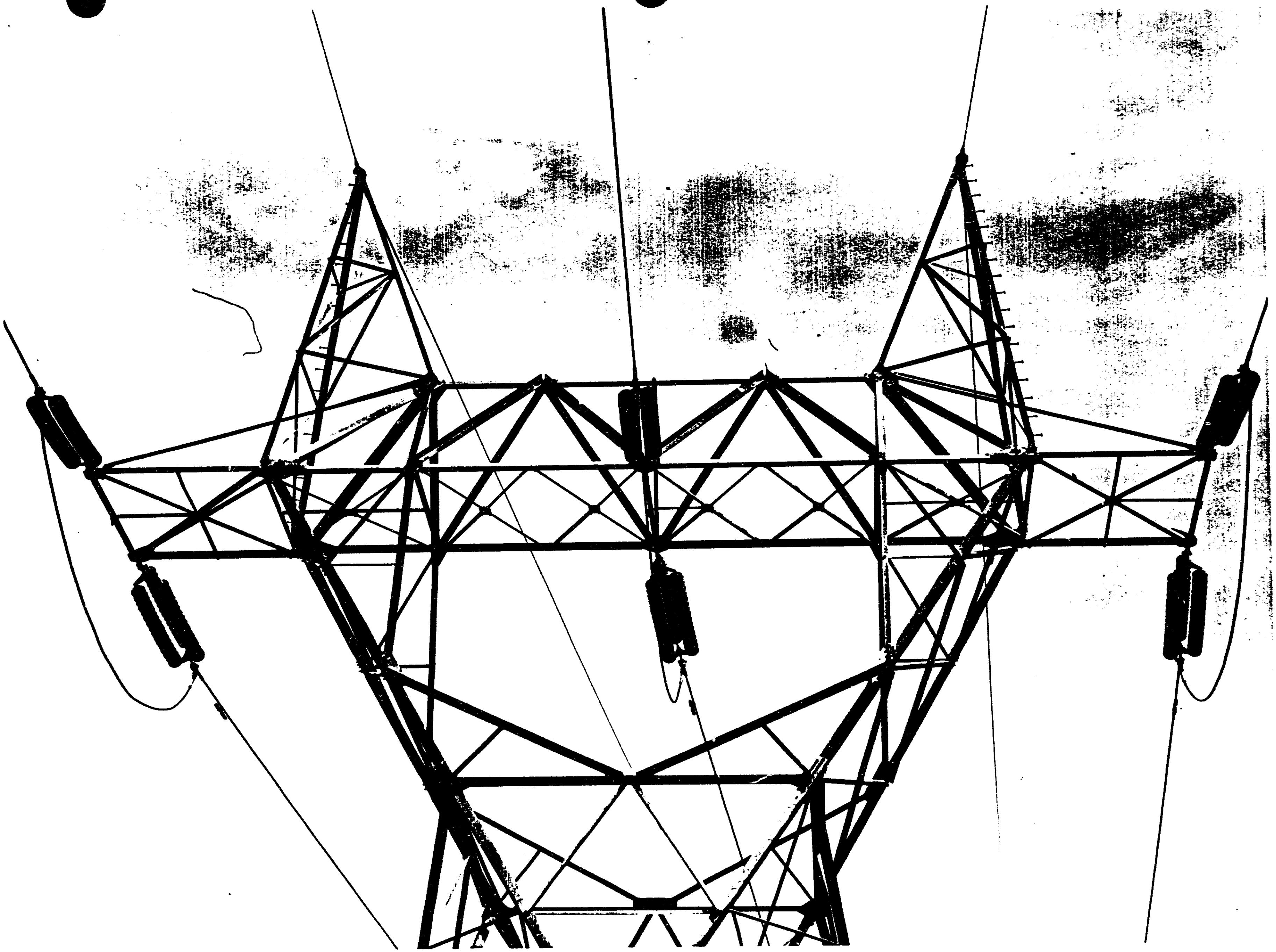


FIGURE IX

TOWER NO. 1, LOOKING UP AND NORTH FROM TOWER BASE

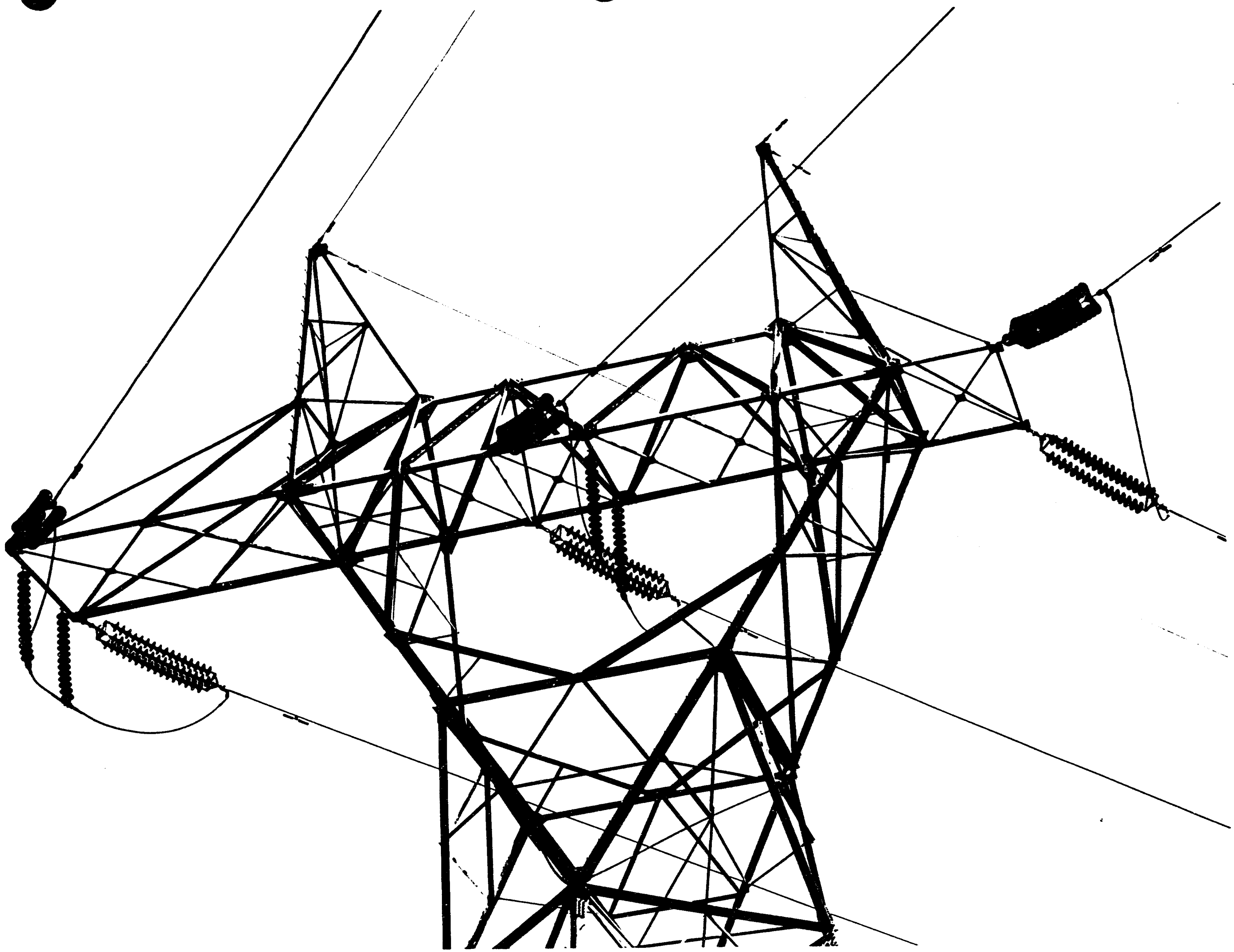


FIGURE X

TOWER NO.2, LOOKING UP AND NORTHEAST FROM TOWER BASE

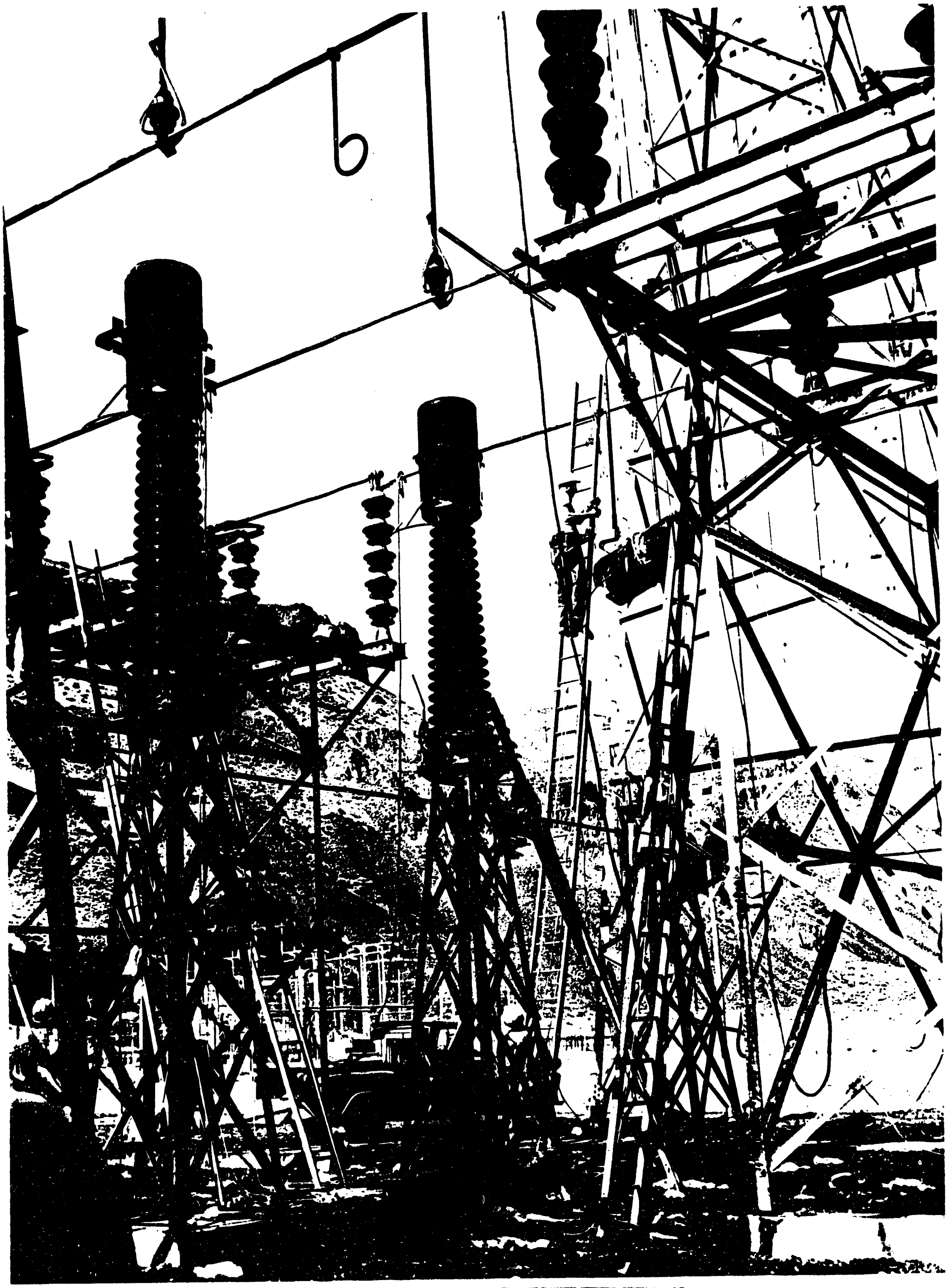


FIGURE XI

VIEW OF CT'S ON AFFECTED LINE

FIGURE XII

CORE OF FAULTED HAEFELY CURRENT TRANSFORMER

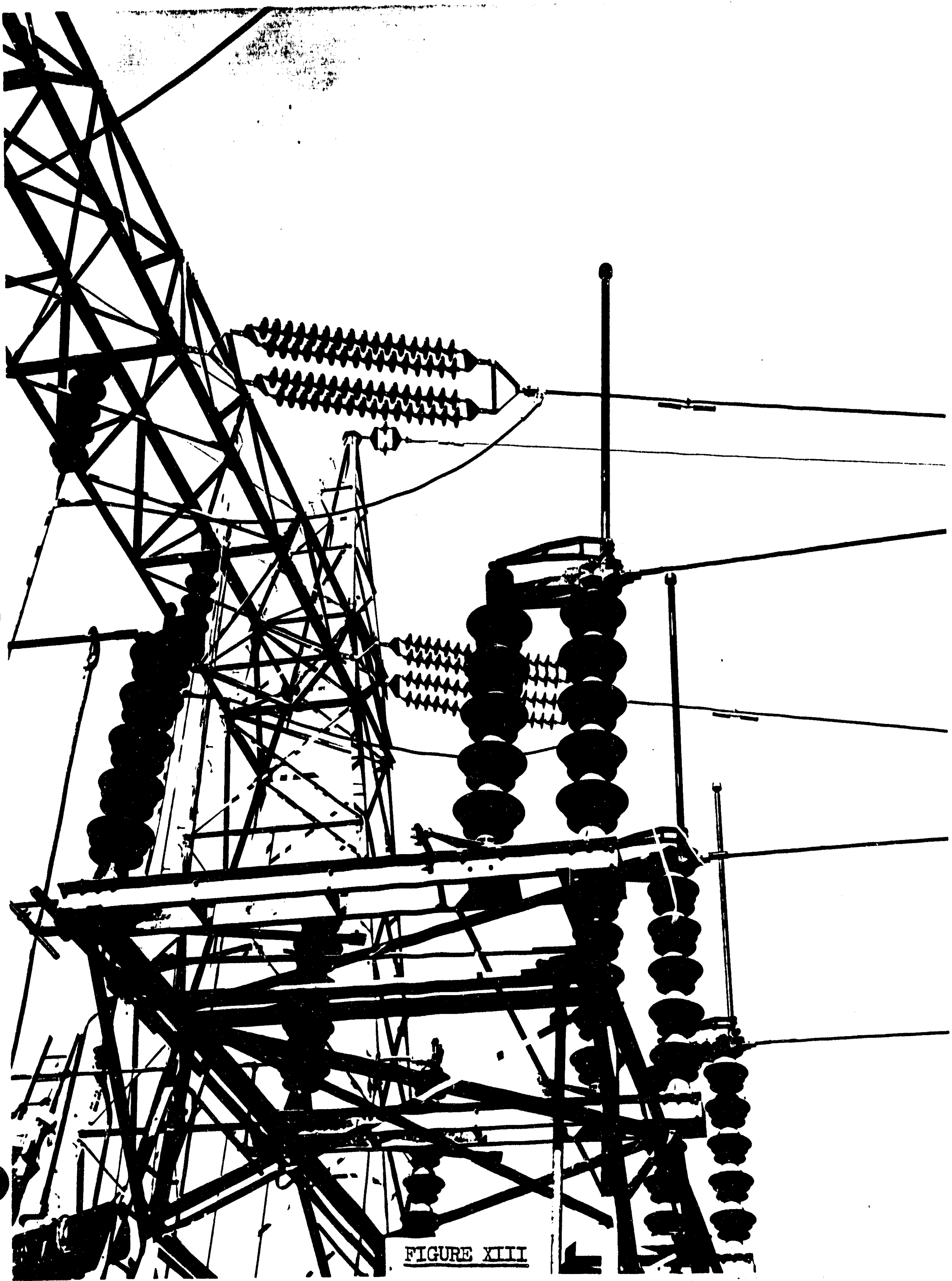
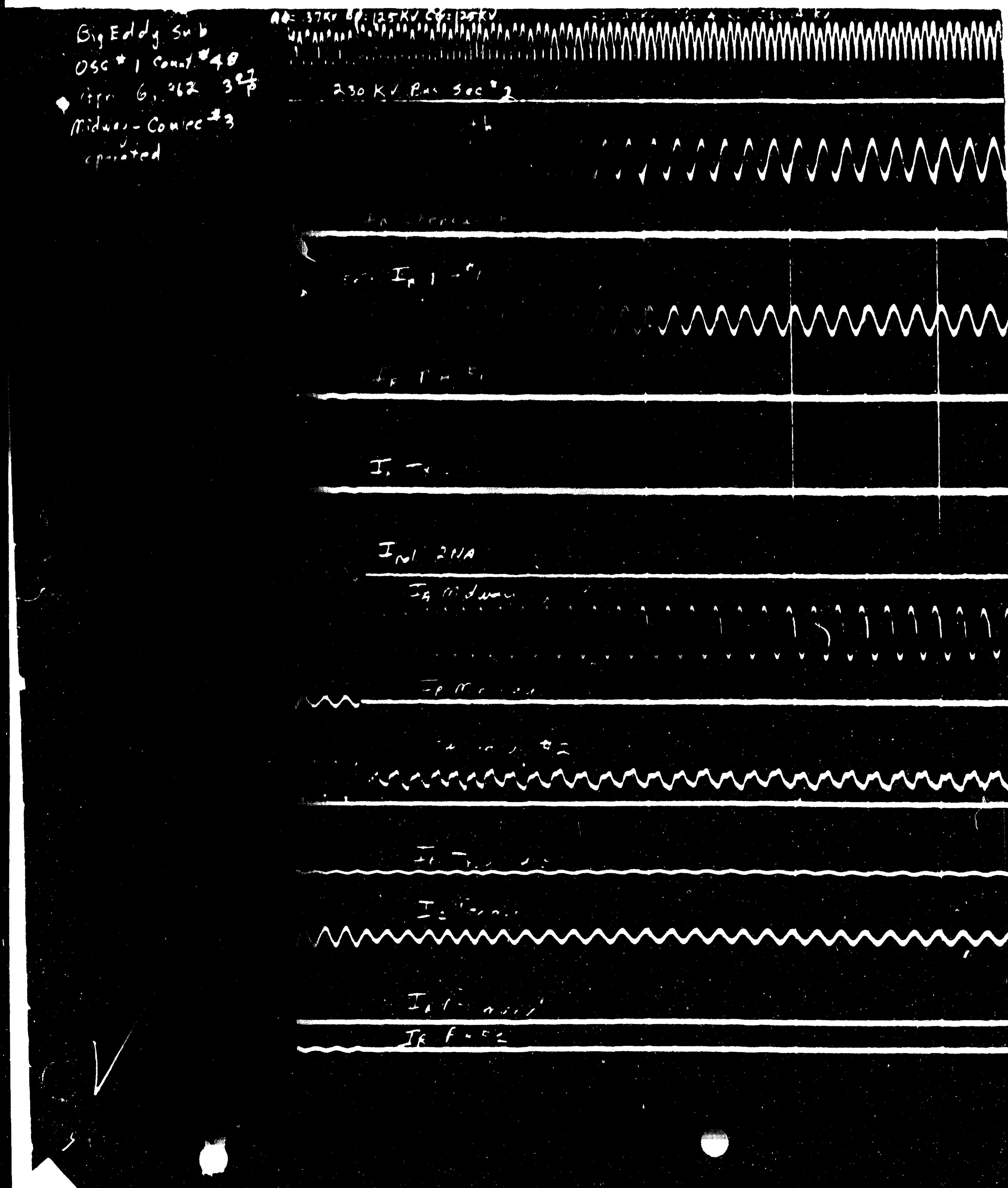
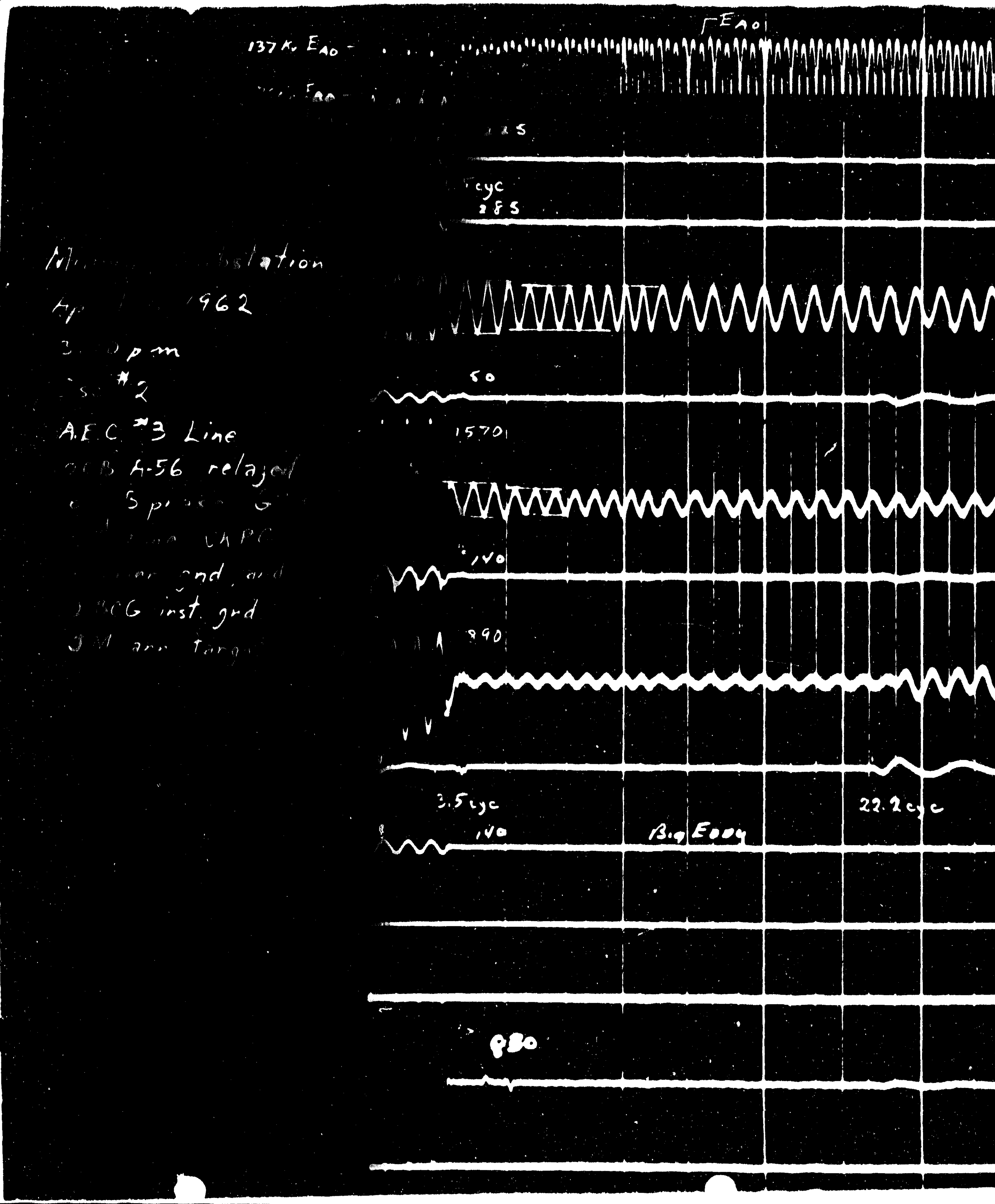


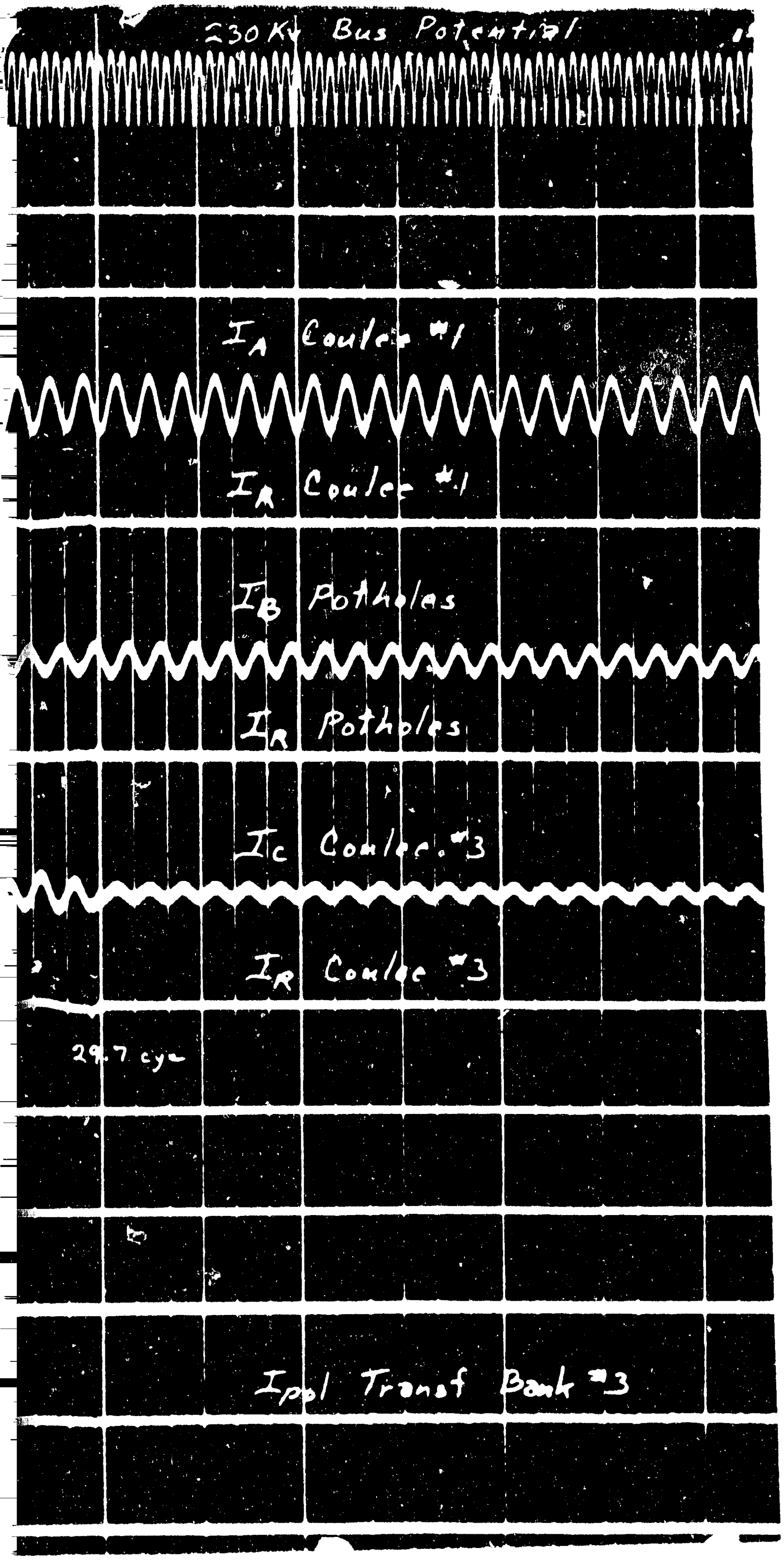
FIGURE XIII

DISCONNECT BETWEEN 230 KV LINE (PRIEST RAPIDS #1) AND 230 KV BRKR SHOWING SMOKE BLACKENING OF INSULATORS, TOP OF FAULTED CT(4/9/62)


Big Eddy Sub
OSC #1 Count #48
Midway - Coulee #3
operated
230 KV Bus Sec #2

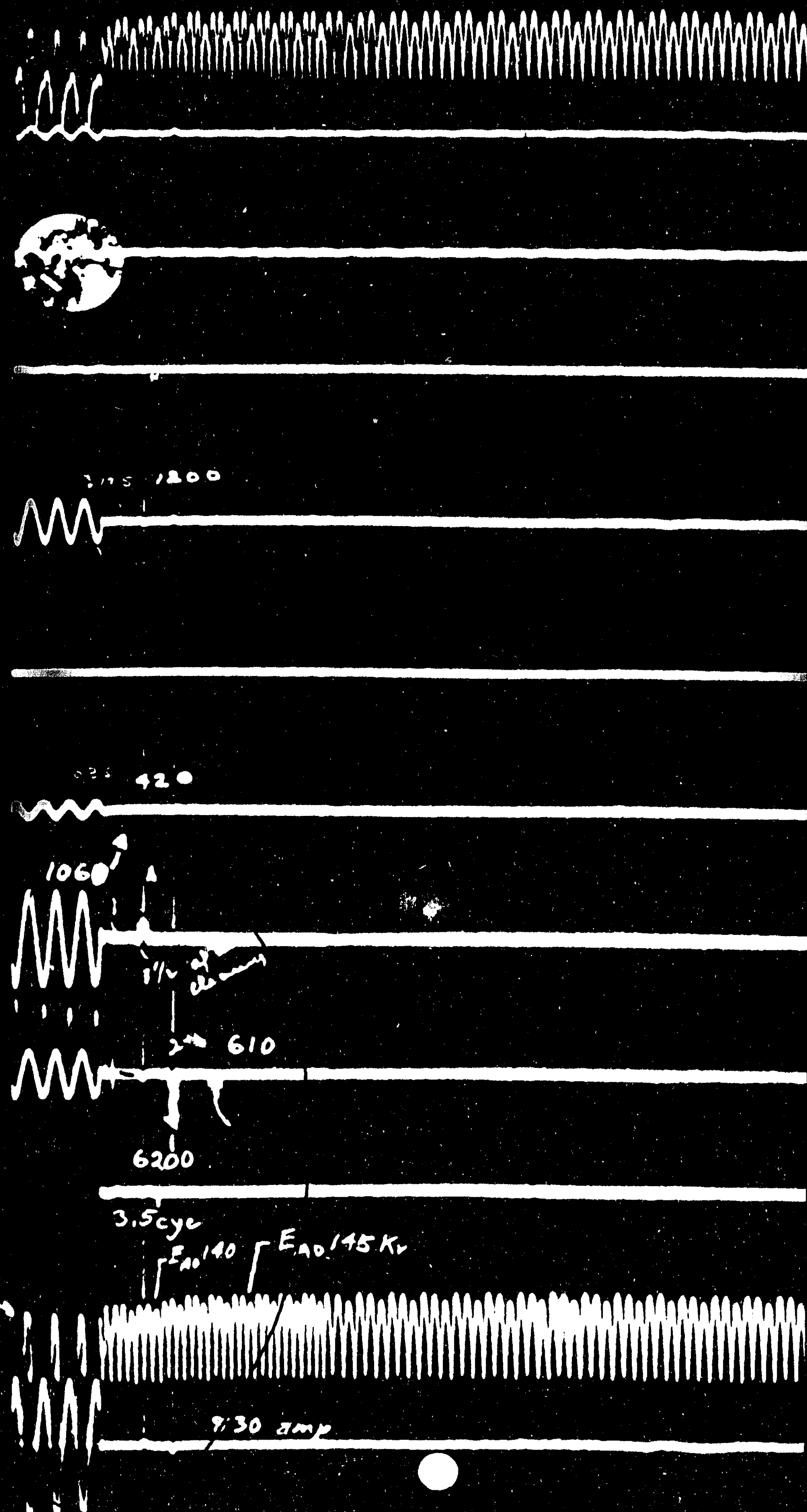


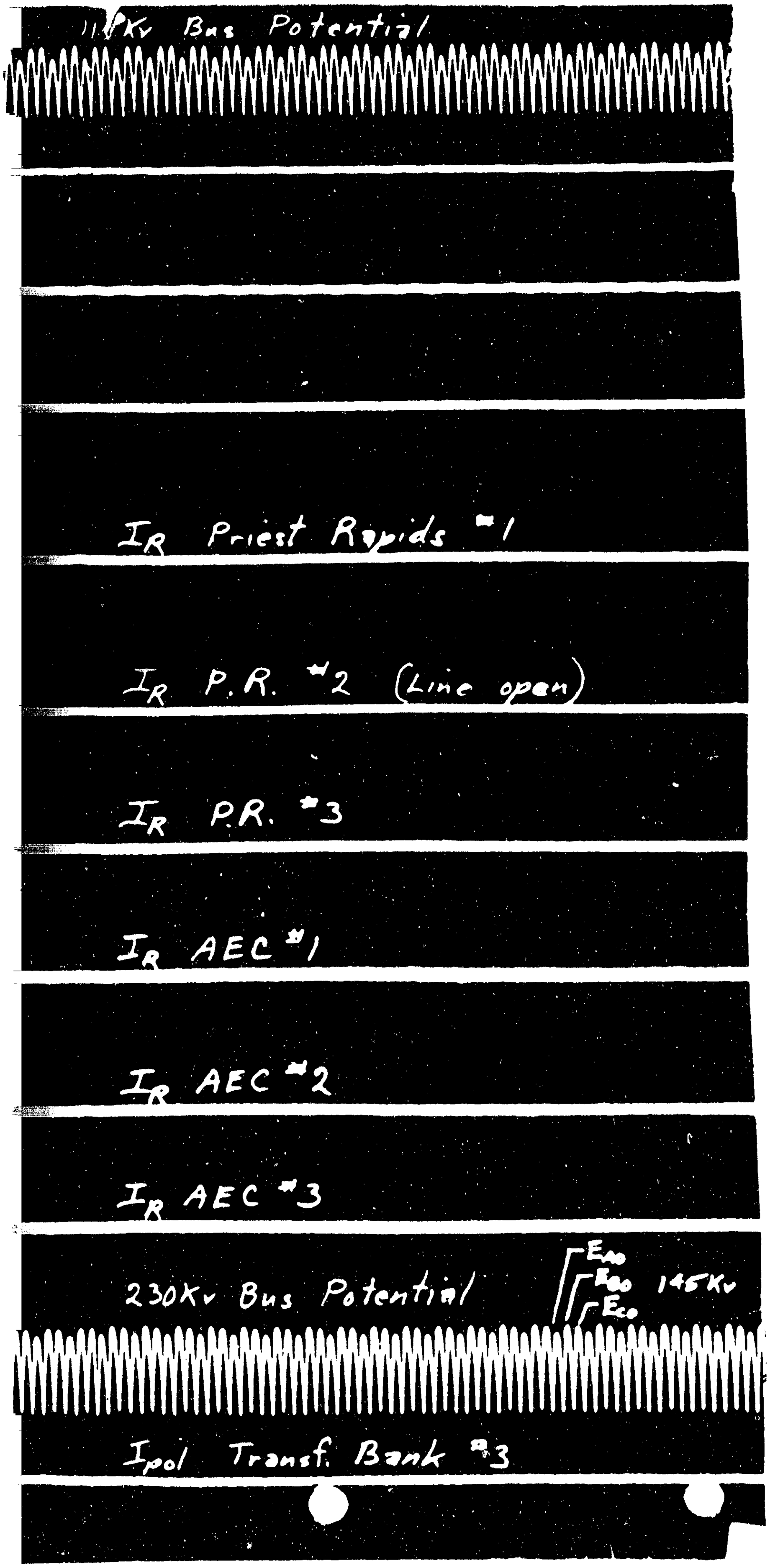
137 Kv EAO
EAO
285
1962
A.E.C. #3 Line
A-56 relayed
inst. grd
50
1570
140
890
3.5 cyc
22.2 cyc
140
980



230 Kv Bus Potential
I_A Coulee #1
I_R Coulee #1
I_B Potholes
I_R Potholes
I_C Coulee #3
I_R Coulee #3
29.7 cyc
Ipol Transf Bank #3

Midway Substation
April 6, 1962
3:10 p.m.
Osc #1
AEC #3 Line OCB
A-56 relayed by
GCX BØ 1st Zone,
Carrier Ground CKPG,
and IBCG inst. gnd.
JM ann target 25 amp.




Kv Bus Potential
I_R Priest Rapids #1
I_R P.R. #2 (Line open)
I_R P.R. #3
I_R AEC #1
I_R AEC #2
I_R AEC #3
230Kv Bus Potential
E_{AO}
E_{BO} 145Kv
E_{CO}
I_{pol} Transf. Bank #3

DECLASSIFIED

[redacted]
(CLASSIFICATION)

DOCUMENT NO. 1.10

SERIES AND COPY NO. 6

DATE 4-9-62

GENERAL ELECTRIC

HANFORD ATOMIC PRODUCTS OPERATION - RICHLAND, WASHINGTON

[redacted]

TITLE

COMPLETE BPA POWER LOSS

[redacted]THER OFFICIAL CLASS[redacted]FORMATION

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AUTHOR

CC Schroeder

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~~H. F. Spencer~~				JD
~~A K Harden~~				AK Harden 5-2-62
~~S M Jones~~				
R. W. Reid				

4-3000-052 (7-59) A.E.C.-G.E.-RICHLAND, WASH.

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Distribution

1. WE Johnson
2. JH Brown
3. OC Schroeder
4. CH Greager
5. RT Jessen
6. RW Reid
7-8. AB Greninger

[redacted]

April 9, 1962

W. E. Johnson
GENERAL MANAGER

COMPLETE BPA POWER LOSS

Below is a short account of the recent complete separation of the 100 Areas from the BPA power source. We understand that CEAU personnel are investigating the cause and our comments are confined to events in the 100 Areas.

SUMMARY

Complete loss of BPA power occurred at approximately 3:10 p.m. on 4-6-62. The power loss affected all 100 Areas and lasted approximately 2 1/2 minutes. Transfer to backup cooling supplies was successfully accomplished at all areas and no damage was sustained by reactor facilities. Reactor recovery was attempted in some cases but was successful only at KE Reactor. The incident revealed a number of items which merit further investigation either because the data are so far incomplete or performance was abnormal in some respect.

DISCUSSION

Reactor status prior to the outage was as follows:

- B Reactor - equilibrium operation
- C Reactor - shutdown
- D Reactor - equilibrium operation
- DR Reactor - equilibrium operation
- F Reactor - equilibrium operation
- H Reactor - shutdown
- KE Reactor - approximately 3/4 equilibrium power level
- KW Reactor - equilibrium operation

All operating reactors scrammed following the power outage with no abnormalities noted in safety circuit or safety control system operation. Bulk outlet

[redacted]

[redacted]

temperatures at all reactors declined normally with no significant surges in temperature observed. The operating reactors transferred to secondary cooling systems (steam pumps at the old reactors, local emergency generation at the K's) in the expected fashion, with the exception of DR where the top-of-riser-pressure apparently dropped somewhat lower than would be expected.

At C Reactor the transition to steam backup was automatic with no significant variation in shutdown flow observed. At H Reactor secondary flow was manually valved in. Top-of-riser-pressure at H dropped to approximately 45 psi. This pressure would have been expected to trip the high-tanks but did not. Further investigation is planned.

Last ditch coolant flow was not required in any area. High-tank flow was not initiated; no cross-tie lines opened in the K Areas. B Area was providing flow to the export system from electric pumps and power loss properly caused a cycle of surge suppressors at various 100 Areas. The system apparently suffered no damage.

Performance of auxiliary equipment of various kinds has not yet been completely determined. Backup electric power from the power house generator was satisfactory in some cases but apparently did not operate properly in others. Determination of the performance of the battery supplied backup electric power also remains to be clarified.

Building ventilation and air flow control is now a part of the confinement system and the electric fan drives are backed up with steam in the old areas and with first emergency electric and then diesel drives in the K Areas. At K, the diesel drives were not required since the emergency electric power functioned properly. At the old reactor areas the performance of the backup drives was varied with proper response obtained in some cases and failure to operate in others. Details of this performance remain to be examined.

Special experimental facilities performed satisfactorily with some exceptions. The H-1 loop recirculating pumps transferred to battery backup properly with no special problems encountered. The DR-1 gas loop was transferred to the 184 electrical bus and functioned properly. Temperatures of the samples returned to normal in five minutes. In the KER loops there was a normal transfer of primary pumps to emergency power. The pressurizer heaters and makeup pumps were without power and loops 3 and 4 depressurized. Loop 4 was dumped normally to backup cooling. Loop 3 did not dump through the normal dump valve either automatically or manually and finally was dumped through an emergency operating valve. Behavior of the KER facilities will be further investigated. — Not so!

Following clearance from the electrical distribution system (BPA was back to normal at the end of approximately 2 1/2 minutes) varying attempts at recovery were made. Only KE Reactor, operating at 3/4 power prior to shutdown, was successful.

[redacted]

DECLASSIFIED [redacted]

CONCLUSIONS

This very severe test of the production reactor equipment has so far revealed that the following items should be further investigated:

1. The only dual area operating two reactors at equilibrium was 100-D. Boiler performance and the reasons for the larger than expected decrease in top-of-riser-pressure at DR require further study.

2. The discrepancy between the apparent top-of-riser-pressure reached at H Area and the high-tank trip point.

3. Performance of the emergency power generating equipment (184 generators).

4. Performance of KER equipment.

5. Performance of the backup drives for ventilation fans.

6. Finally it appears in order to review once more the communications and bases for clearance to attempt recovery following a power outage of this magnitude (nothing specific occurred to stimulate this conclusion).

A report on the incident for transmittal to the AEC-HOO is being prepared. The information outlined above was hurriedly gathered and will be amplified and amended as the complete story is assembled.

OC Schroeder
Acting General Manager
for

OC Schroeder/JHB/bc

[redacted]

[redacted]
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GENERAL ELECTRIC

HANFORD ATOMIC PRODUCTS OPERATION – RICHLAND, WASHINGTON

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	AUTHOR	ISSUING FILE
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R. W. Reid				[signature] 6/27/62
~~H. G. Spencer~~				[signature] 6/28/62
~~S. M. Graves~~				
~~McClintock~~				

C-1616-DS (7 – 55) A.E.C.-G.E.-RICHLAND, WASH.

[redacted]
(CLASSIFICATION) DECLASSIFIED

54—5000—002

IRRADIATION PROCESSING DEPARTMENT
GENERAL ELECTRIC
RICHLAND, WASHINGTON

[redacted]

May 12, 1961

S. M. Graves, Supervisor
Process Engineering
PROCESS TECHNOLOGY OPERATION

BPA VOLTAGE FLUCTUATION

The electrical cross tie across the Cascade Mountains, connecting eastern and western Washington in the BPA power grid, was out of service for maintenance on Wednesday, May 3. Because an overload condition developed in the Seattle-Puget Sound area, electrical circuit breakers began parting on the Portland-Seattle part of the grid at 0906. As this transient condition progressed, the portion of the total load carried by Priest Rapids and Coulee Dam shifted.

While the electrical grid in eastern Washington remained integral, the load shift between Priest Rapids and Coulee Dam caused a voltage fluctuation and a very slight frequency dip. As recorded at Midway, the frequency dipped momentarily from 60 cycles per second to 59.5 and then back to 60 cycles per second. The root mean squared voltage in the HAPO loop dropped from 230 KV to 216 KV and then overshot to 240 KV before stabilizing back to 230 KV.

In spite of no critical power situations existing in the HAPO 230 KV loop, all of the reactors had indications of the voltage fluctuation. Of the seven operating reactors at the time, only H Reactor was immediately scrammed. Investigation disclosed the following conditions were observed at the reactors at the time of the voltage fluctuation:

105-H - The control room lights dimmed momentarily, and numerous annunciator panel lights lighted, including the "normal drive HCR" annunciator, the "3X phanocharger" annunciator and the "instrument supply" annunciator. While the preceding annunciator lights were specifically observed, there is a definite possiblity that others may have been on as well.

The reactor operator noted that the HCR's had not moved, so he immediately started to reset the annunciator panel. Simultaneously, the control room lights, which had dimmed momentarily, brightened greater than normal and each of the four "Beckman trip" annunciator lights came on. Coincident with the "Beckman trip" annunciator, the "Panellit water LP" annunciator was tripped by the row relay on 37 row. Simultaneously, the reactor was automatically scrammed.

Very shortly after the trip on 37 row, numerous other row relay lights lighted on 28 row and above. A rapid survey of the Panellit board

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revealed no gauges resting on a trip point. Preparatory to making the hot recovery, two successive 10 psi TORP reductions were ordered and the Panellit board was reset.

Examination of the flow recorder chart, after recovery, showed that the flow abruptly dropped about 1000 gpm at 0907, and slowly lost an additional 100 to 200 gpm over the next minute. At 0910 the chart shows that the flow was starting to increase again as the two successive 10 psi TORP reductions reduced flow another 2000 gpm. As the reactor went critical at 0917, the TORP was progressively increased until the flow was back to the pre-scram level.

105-F - The reactor was operating when the power-supply incident occurred. Annunciator lights indicated a 190-F Power failure; though other than a momentary slight loss in flow, there were no other indications of failure. The reactor continued operating without incident.

105-D - The reactor was operating when the power-supply incident occurred. Several annunciator trips were received, but all were reset immediately. A momentary loss of 35 psi TORP was noted.

105-DR - The reactor was operating when the power-supply incident occurred. Several annunciator trips were received, but all were reset immediately. A momentary loss of about 1000 gpm was recorded.

105-KE, KW - Both reactors were operating when the power-supply incident occurred. Various annunciator trips were received at both reactors, but all were immediately reset. A loss of about 3000 gpm of flow was recorded at each reactor. An automatic power transfer was affected at KW Area, transferring power from one bus to another.

105-C - The reactor was operating when power-supply incident occurred. Several annunciator trips were received; however, all were immediately reset. Approximately 24 hours after the incident, the reactor was scrammed when a VSR dropped into the reactor, tripping the SNM relay, giving a number 2 SC scram. Recovery from the scram was successful.

Apparently the VSR dropped when the batteries, supplying DC current to energize the VSR broke, began to fail. A check of the cause of battery failure showed that the motor-generator charging set was inoperative, presumably having failed at the time of the BPA power incident.

105-B - The reactor was down at the time of the power-supply incident. Process water was being supplied by steam turbine pumps, with the electric pumps set on recirculation. Power was lost to five of the electric process pumps.

Assimilating the observations at all of the reactors, the following conclusions can be reached.

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1. Probably all of the reactors received "Beckman trip" annunciators because of the 0.5 cycle per second frequency dip.

2. In all probability, H Reactor was <u>not</u> scrammed by a Beckman trip in spite of what the annunciator panel showed. The reason for this is that all of the Beckmans are designed to allow as much as a 20 cycle (1/3 second) frequency dip. In contrast, the relays in the annunciator circuit allow no such delay.

3. In all probability all reactors, as well as F, probably received a "Power failure" annunciator light. However, as in the case of the Beckmans, there is built into the power failure relays a provision for up to a 20 cycle frequency dip. Again, however, there is no such frequency dip provision in the relays in the annunciator circuit.

4. Practically as a matter of certainty, H Reactor was scrammed by a low trip on one of the 25-75 Panellit gauges on 37 row. The following analysis will show this reasoning:

Total instantaneous flow reduction = 1[illegible]00 gpm

Individual tube flow reduction = $\frac{1[illegible]00 \text{ gpm}}{1[illegible]00 \text{ tubes}}$ = 1 gpm/tube

The equation governing flow through the venturis is:

$$F = 2.76 \sqrt{P_{FH} - P_p}$$

Rearranging, $$F^2 = (2.76)^2 (P_{FH}) - (2.76)^2 (P_p)$$

Then, the total Panellit pressure deviation is given as follows:

$$dP_p = \left(\frac{\partial P_p}{\partial F}\right)_{P_{FH}} dF + \left(\frac{\partial P_p}{\partial P_{FH}}\right)_F dP_{FH}$$

Performing the indicated differentiation yields:

$$dP_p = -\left[\frac{2F}{(2.76)^2}\right] dF + \left[1\right] dP_{FH}$$

Assuming a typical tube flow of 45 gpm, and a P_{FH} reduction of 35 psig due to the 35 psig TORP reduction:

$$dP_p = -\left[\frac{(2)(45)}{(2.76)^2}\right]\left(-1 \frac{\text{gpm}}{\text{tube}}\right) + \left[1\right](-35 \text{ psig})$$

$$dP_p = \frac{90}{7.6} - 35 = -23 \text{psig}$$

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> Thus, if any 10-90 Panellit gauge was initially operating at less than 33, or any 25-75 Panellit gauge was initially at less than 46, the reactor would have been scrammed by a Panellit trip. On 37 row, as well as several other rows, there are numerous 25-75 Panellit gauges which regularly operate at between 40 to 50.

In conclusion, the scramming of H Reactor can doubtless be attributed to a low trip on one of the 25-75 gauges on 37 row. Such tripping of the 25-75 gauges will remain unavoidable any time a sudden TORP or flow reduction occurs. The solution to this situation is either to replace the 25-75 gauges with 10-90 gauges or to pre-set the 25-75 gauges to read higher. Unfortunately, neither solution is wholly without compromising drawbacks.

B. R. Cremer
Process Engineer

BRC:rb

cc: AP Vinther
File

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IRRADIATION PROCESSING DEPARTMENT
GENERAL ELECTRIC
RICHLAND, WASHINGTON

May 5, 1961

JT Baker
RF Corlett

PRELIMINARY OBSERVATIONS OF REACTOR TRANSIENTS
DURING ELECTRICAL POWER REDUCTION OF MAY 3, 1961

A number of observations were made during the power reduction of May 3, 1961. They include:

1. Riser pressure reduction of approximately 35 psi.
2. Flow recorder reduction of approximately 1000 gpm.
3. 16 point recorder temperature increase of .5 degrees (very questionable).
4. Apparent power level reductions shown by deviation recorder and Beckmans.

Probably the best measure of what really happened is the riser pressure recorder since,

1. The riser pressure is not subject to changes in instrument voltage.

2. The flow recorder is phase sensitive and cannot be relied upon to give a true measure of flow with abnormally low instrument voltage.

3. The 16 point recorder cannot be relied upon to give a true measure of rapid outlet temperature changes because of the slow response time of the thermocouples. The present couples tied into the 16 point recorder may take from two to five seconds to respond. In addition, the .5 degrees is very questionable because no indication was noted on the recorder strip chart at the time of the power reduction. Changes in chart speed made since the power reduction make an "after the fact" examination of the charts practically a guess.

4. A slight flow reduction will not cause any appreciable change in reactor power level. Indications of level reduction by the deviation recorder and Beckmans result from reduction in instrument voltage rather than actual power level changes.

Even the riser pressure reduction may not be completely accurate since there may be a certain amount of overswing by the recording needle. In addition, a momentary pressure reduction may not result in a significant flow reduction because of the inertia of the water in the piping system. The indicated pressure reduction was about 35 psi which would correspond to a total flow reduction of about 2500 gpm. The resulting increase in bulk outlet temperature would be about

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2.5 degrees, however, because of the possible riser pressure recorder overswing and fluid inertia, the actual bulk temperature increase was probably less than 2.5. In any event, the water temperature in the downcomer was still below saturation temperature.

Gene Blanchette is examining the 190-pump transients more closely and expects to have a more detailed picture in the near future.

A. Russell
Process Engineering
RESEARCH & ENGINEERING SECTION

AR:mf

cc: SM Graves
A Russell-File

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HANFORD ATOMIC PRODUCTS OPERATION – RICHLAND, WASHINGTON

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SERIES AND COPY NO.
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DATE
September 27, 1960

TITLE
TRANSFORMER BURNUP INCIDENT AT DR

AUTHOR
H. G. Spencer

ISSUING FILE

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TH[redacted]RIAL CONTAINS IN[redacted]AFFECTING THE NA[redacted] UNITED STATES WITHIN THE [redacted] THE ESPIONAGE LAWS, TITLE [redacted] 794, THE TRANS- [redacted] REVELATION OF [redacted] MANNER [redacted] UNAUTHORIZED PERSON IS PR[redacted] LAW.

[redacted] NOT BE LEFT UNATTENDED OR WHERE AN UNAU[redacted] ACCESS TO IT. WHEN [redacted] ORY WITHIN AN APPROVED GUARDED AREA. WHILE IT [redacted] HAVE OBTAINED A SIGNED RECEIPT FROM CLASSIFIED FIL[redacted] YOUR RESPONSIBILITY [redacted] NTS WITHIN THE LIMITS OF THIS [redacted] FROM ANY UNAUTHORIZED PERSON. ITS TRANSMITTA[redacted] AT YOUR PLACE [redacted] ENCE IS PROHIBITED. IT IS NOT TO BE DUPLICATED. IF ADDITIONAL [redacted] ED, [redacted] THEM FROM THE RELATED ISSUING FILE. ALL PERSONS READING THIS DOCUMENT ARE [redacted] D [redacted] O SIGN IN THE SPACE PROVIDED BELOW.

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54-3000-052 (7-59) A.E.C.-G.E.-RICHLAND, WASH.

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DISTRIBUTION

1. DS Lewis
2. JL Benson
3. SM Graves
4. AK Hardin
5. RW Reid
6. HG Spencer

September 27, 1960

D. S. Lewis, Acting Manager
D & DR Reactors Operation
IRRADIATION PROCESSING DEPARTMENT

TRANSFORMER BURNUP INCIDENT AT DR

Ref: (1) Letter from JL Benson to SM Graves, "Transformer Burnup Incident at DR," 4/25/60.

(2) Letter from DS Lewis to SM Graves, "Transformer Burnup Incident at DR," 6/10/60.

(3) Personal notes of SS Jones.

We have looked into the nuclear safety implications of the subject and similar possible incidents and have reached the conclusions that there are no nuclear safety implications in any credible incident or action that causes trip-off or shut-off of primary pumps. In this context, "nuclear safety" excludes the effect of a bulk temperature surge. The problem of temperature surges from this cause will be discussed later.

Our main concern as regards nuclear safety in this type of incident was whether or not the few main pumps left running would cavitate and vibrate so badly as to endanger the water piping. We find that tests which simulated conditions of interest in 558 pumps were run several years ago. The conclusion from the test observations[3] is that the water piping is not endangered.

As regards the damage of pumps from cavitation during such incidents, we believe that manual action of the operators can be relied on to limit the duration to an acceptable period. After all, such incidents will be quite infrequent. It may be that some operator education is called for in this area, both from the standpoint of what to do after something happens, as well as on not initiating such cavitation inadvertently. We have not tried to determine whether or not such education is now adequate, considering this to be the responsibility of Power Management. In any event, we believe that such education, if needed, would be adequate and likely preferable to installation of automatic devices.

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D. S. Lewis — September 27, 1960

As regards the bulk temperature surges resulting from this kind of incident, a division into two types of causes may be made:

1. Incidents in which the power loss relays initiate scram.

2. Incidents which power loss relays did not initate scram and scram is initiated by the Panellit system.

The first type can never be more severe than a BPA power failure, and it is properly allowed-for by present bulk outlet temperature restrictions.

The second type may or may not be a little more severe than a BPA-caused surge, depending on Panellit trip settings. Included with this second type should be operator error in handling the discharge cone valves, as well as inadvertent cut-off of pumps. We believe that the presently assumed surge magnitudes and frequencies, in bulk limit calculations, properly allow for these possibilities. Reactor Engineering concurs in this view. We think the frequency of this type of incident is extremely low. This does not mean that every reasonable effort should not be made to prevent these incidents. Again, as suggested above, we believe the main preventive measure should be operator education, if this is not now adequate.

We have done some thinking about automatic equipment to keep the operator from turning off pumps or closing discharge valves, when they should not be turned off or cloased. We have not come up with any workable ideas, but there may be some. We do not think there is much justification for such equipment, and do not plan any further action, but you may wish to ask one of the engineering groups to try to come up with a relatively inexpensive solution. We hope this answers your questions on this matter. If it does not, please contact me at your convenience.

ORIGINAL SIGNED BY
H. G. SPENCER

Supervisor, Process Analysis
Research and Engineering Section
IRRADIATION PROCESSING DEPARTMENT

HG Spencer:mf

[redacted]

VII

54-3000-101 (9-59)

DON'T SAY IT --- *Write It!*

DATE

TO ________ FROM ________

April 1960 - Bus relay trip KE - Loss of electrical power to three high lift pumps. Remaining high lift operated for short time in severe cavitation

April 1960 - Power loss at DR to two pumps

" 1960 - Loss of power at H because of ground at F

May 1960 - Discovered TAC limits wrong. At least one reactor operated over revised limits

Aug 1960 - Bolt lodged in header screen. Made dime sized pieces from screen wire. These pieces could have caused severe reduction in tube flow.

Jan 1961 - Correction of leaking pigtail by disconnect very soon after shutdown

"SOME LEARN FROM EXPERIENCE, SOME NEVER RECOVER FROM IT"

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Section IV

See HW-64140 Secret Documented Incident Folder

Follow up w/ Pump samples.

February 26, 1960

S. M. Graves, Supervisor
Process Engineering Unit

190 PUMP INCIDENT - D REACTOR

On January 15 the number seven electric process pump located in 190-D incurred severe damage within an hour after being placed on the line. The damage, grinding damage to the interstage sleeve and drive shaft was not noticed until after the pump was removed from service. The reason for removal was over-heating of the inboard bearing.

After the pump was removed from service, it was noticed that the interstage sleeve cover was extremely not. Also a loud grinding noise was heard as the pump was being removed from the line. Since the interstage sleeve is in direct contact with process water, the possibility of metal particles flowing into the reactor was eminent. This possibility was realized when about 19 Panellit gauges located on the near side of the reactor indicated partial upstream flow plugging, amounting to 10-30 psi, shortly after the pump was removed from the line.

Action Taken

The plugging problem was discussed on January 18 and a decision was made to continue operation with the added restriction of monitoring all tubes with indicated partial plugging. A recommendation was made to the effect that the reactor was to be shut down if one of the following items occurred:

1. The Panellit pressure of any tube decreased 10 psi or more from the corresponding pressure as recorded on 1/18/60.

2. The Panellit pressure of any tube increased 20 psi or more from the corresponding pressure as recorded on 1/15/60 (8 a.m.).

3. The temperature of any tube increased 5°C or more and this increase could not be ascribed to normal heat shifts or power increases.

On January 25, 1960, additional gauges were observed to indicate partial upstream plugging. In complying with recommendation one above, the reactor was shut down.

Damage Survey

During the outage the reactor flow supply piping on the near side of the reactor was thoroughly flushed and examined. The damaged number seven pump fed only the near side of the pile and all indicated plugging was correspondingly on the near side.

The two screens in the pump discharge lines were removed and cleaned. Steel particles about 1/8-inch diameter among other debris were found in the screens. All near side crossheader screens were removed and cleaned. Small rectangular steel pieces, high carbon alloy steel, about 1/16 inch on a side and stainless steel welding bead particles, about 1/8 inch in diameter were found in the screens. Two crossheader screens, 16 and 18 headers, were found to be severely damaged. It was also found that the crossheader screens did not fit snugly against the screen cover case. The cover was designed for 1/8 inch O-rings, which were not present.

All venturis and orifices, from tubes listed as partially plugged, were removed and the upstream screens cleaned. Small steel, alloy steel, particles 1/16 inch and smaller were found lodged in the screens and cross hairs.

A metallurgical examination of the various particles revealed the two types of material, the high carbon alloy steel and the stainless steel welding beads.

Damage to the pump drive shaft and interstage sleeve was extensive. That the small steel particles, found in the mentioned screens, came from the pump shaft was fairly conclusive from the metallurgical examination discussed above, and the corresponding Panellit pressure drop on various tubes. The cause of the pump failure is unknown and will probably remain so. It is surmised that the trouble was caused by small foreign particles lodging in the small spacing between the rotating shaft and the interstage sleeve.

Conclusions

Since the outage of January 25, 1960, about ten more Panellit gauges have indicated slight upstream plugging. The affected tubes are randomly located in the pile and plugging is very slight. This would seem to indicate that the pile coolant flow system was not completely freed of metal particles. Also, since the near side screens were examined and cleaned, larger particles (greater than 1/16 inch) must be entering the crossheaders by working around the screens.

The following conclusions can be drawn from the investigation to date:

1. Metal particles from the damaged pump shaft did get through and around two sets of 8-mesh screens and entered process tubes.

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GENERAL ELECTRIC
RICHLAND, WASHINGTON

2. The pump discharge line screens and the near crossheader screens do not fit snuggly.

3. Stainless steel welding beads are present in the coolant piping and are or have been continually breaking free.

4. The two header screens that were damaged showed signs of continual internal hammering by large metal particles.

5. The coolant system is not yet free of all metal particles large enough to cause plugging.

6. A further study should be made to explore possible corrections to the coolant flow system and to possibly make a P.M. check of the system mandatory.

J. D. Agar
Process Engineering Unit

JD Agar:md

cc: RW Reid
JD Agar-LB

File ROUGH DRAFT

Section IV

February 18, 1960

S. M. Graves, Supervisor
Process Engineering Unit

190 PUMP INCIDENT - D REACTOR

On January 15, the number seven electric process pump located in 190-D incurred severe damage within an hour after being placed on the line. The damage, grinding damage to the interstage sleeve and drive shaft, was not noticed until after the pump was removed from service. The reason for removal was over-heating of a main bearing.

Since the interstage sleeve is in direct contact with process water, the possibility of metal particles flowing into the reactor was eminent. This possibility was realized when about 19 Panellit gauges located on the near side of the reactor indicated partial upstream flow plugging shortly after the pump was placed on the line.

Action Taken

The plugging problem was discussed on January 18 and a decision was made to continue operation with the added restriction of monitoring all tubes with indicated partial plugging. A recommendation was made to the effect that the reactor was to be shut down if one of the following items occurred:

1. The Panellit pressure of any tube decreased 10 psi or more from the corresponding pressure as recorded on 1/18/60.
2. The Panellit pressure of any tube increased 20 psi or more from the corresponding pressure as recored on 1/15/60 (8 a.m.).
3. The temperature of any tube increased 5°C or more and this increase could not be ascribed to normal heat shifts or power increases.

On January 25, 1960, additional gauges were observed to indicage partial upstream plugging. In complying with recommendatinn (1) above the reactor was shut down.

Damage Survey

During the outage the reactor flow supply piping on the near side of the reactor was thoroughly flushed and examined. The damaged number seven pump fed only the near side of the pile and all indicated plugging was on the near side.

The two screens in the pump discharge lines were removed and cleaned. Steel particles about 1/8 inch diameter were found in the screens. All near side cross-header screens were removed and cleaned. Small rectangular steel pieces, high carbon alloy steel, about 1/16 inch on a side and stainless steel welding bud particles, about 1/8 inch in diameter were found in the screens. Two crossheader screens, 16 and 18 headers, were found to be severely damaged. It was also found that the screens did not fit snugly because of missing o-rings.

All venturis and orifices, from tubes listed as partially plugged, were removed and the upstream screens cleaned. Small steel, alloy steel, particles 1/16 inch and smaller were found lodged in the screens and cross hairs.

A metallurgical examination of the various particles revealed the two types of material, the high carbon alloy steel and the stainless steel welding buds.

Damage to the pump drive shaft and interstage sleeve was extensive. That the small steel particles came from the shaft was fairly conclusive from the metallurgical examination discussed above. Information points to the fact that the pump failure was cuased by an inherent fault in the design of the pump shaft and interstage seelve.

Conclusions

Since the outage of January 25, 1960, about ten more Panellit gauges have indicated slight upstream plugging. The affected tubes are randomly located in the pile and plugging is very slight. This would seem to indicate that the pile coolant flow system was not completely freed of metal particles. Also, since the near side screens were examined and cleaned, larger particles (greater than 1/16 inch) must be entering the crossheader ... around the screens.

...llowing conclusions can be drawn from the investigation, to date:

1. Metal particles from the damaged pump shaft did get through two sets of 8-mesh screens and entered some process tubes.

2. The pump discharge line screens and the near crossheader screens do not fit snuggly.

3. Stainless steel welding beads are present in the coolant piping and are continually breaking free.

4. The two header screens that were damaged showed signs of continual hammering by large metal particles.

5. The coolant system is not yet free of all metal particles large enough to cause plugging.

6. A further study should be made to explore possible corrections to the coolant flow system and to possibly make a P.M. check of part of the system mandatory.

J. D. Agar

File
Fruger LDBK

cc: SM Graves
RW Reid
JD Agar-File

January 19, 1960

J. T. Baker, Manager (2)
D Processing Operation
D-DR Reactors Operation

190-D PUMP INCIDENT

The following letter refers to the 190-pump failure on the swing shift of 1/15/60 at which time partial plugging was noted in about 19 tubes at D Reactors.

It is evident that the plugging, upstream of the pressure taps, is caused by iron and bronze particles collected in orifice screens.

It is recommended that the reactor continue to operate provided the following steps are taken:

1. All tubes that have 10 psi or more decrease from the Panellit pressures as recorded on 1/15/60 (8 a.m.) should have outlet temperatures and Panellit pressures recorded at least twice a shift.

2. All orifice tubes on the near side of the reactor (from columns 51 thru 74) should have Panellit pressures recorded at least once a shift.

3. The reactor be shut down immediately if any one of the following occurs:

   a. The Panellit pressure of any tube decreases 10 psi or more from the corresponding pressure as recorded on 1/18/60.

   b. The Panellit pressure of any tube increases 20 psi or more from the corresponding pressure as recorded on 1/15/60 (8 a.m.).

   c. The temperature of any tube increases 5°C or more and this increase cannot be ascribed to normal heat shifts or power increases.

The above Panellit pressure stipulations hold only for 7-pump operation. In the event of 6-pump operation a new datum plane must be picked.

The recommendations should hold until 1/22/60 at which time the situation will be revaluated.

All suspect header screens and orifice screens should be flushed and cleaned during the next outage.

Process Engineering Unit
Research and Engineering Section

JD Agar:md

DATE
FILMED
10/18/94

END