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TAN/LOFT 13.8 KV, 2.4 KV and 480 V RELAY AND CIRCUIT BREAKER COORDINATION STUDY

J. E. Burnett

MASTER

THIS REVISION COMPLETELY SUPERSEDES ALL PREVIOUS ISSUES OF LTR 1310-19.

EG&G Idaho, Inc.

IDAHO NATIONAL ENGINEERING LABORATORY

DEPARTMENT OF ENERGY

IDAHO OPERATIONS OFFICE UNDER CONTRACT EY-76-C-07-1570

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LOFT TECHNICAL REPORT
LOFT PROGRAM

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FORM EG&G-229
(Rev. 12-76)

**Revision
#Addition

TITLE TAN/LOFT 13.8 KV 2.4KV and 480V Relay and Circuit Breaker		REPORT NO. LTR 1310-19, Rev. A
Coordination Study		
AUTHOR J. E. Burnett <i>J.E. Burnett</i>	GWA NO. 52182-800-001	
PERFORMING ORGANIZATION P&CSB/LTSD 6220	DATE May 2, 1978 <i>sh</i>	
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ABSTRACT

The coordination study of 1972 performed by Mr. N. A. Williams of Kaiser Engineers (LTR 1310-3) is examined and updated based on 1977 loads.

Present overcurrent relay settings are presented and evaluated for adequacy in terms of the updated short circuit analysis. Recommendations are made for new relay and trip device settings to improve coordination. Switchgear ratings are examined against available short circuit currents, and recommendations are made where applicable.

Vital MCC-A and B are examined in detail to provide maximum continuity of service for every fault contingency. A recommendation is made to improve the reliability of these buses.

RECOMMENDATIONS

1. The technical recommendations for switchgear modifications and changes in relay settings and logic are given in section VI of this report.
2. It is recommended that all relay settings existing and revised be issued in specification No. ES60238 to provide documentation and means for controlled engineered changes.
3. It is recommended that relay and circuit breaker technical specification surveillance DOPs should be performed in accordance with ES60238. The responsibility for implementing the recommended changes is placed with the LOFT Instrument and Electrical Design Section.

This revision completely supersedes all previous issues of LTR 1310-19.

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TAN/LOFT 13.8 KV 2.4 KV and 480V RELAY
AND CIRCUIT BREAKER COORDINATION STUDY

I. ABSTRACT

The coordination study of 1972 performed by Mr. N. A. Williams of Kaiser Engineers (LTR 13 10-3) is examined and updated based upon 1977 loads.

Present overcurrent relay settings are presented and evaluated for adequacy in terms of the updated short circuit analysis. Recommendations are made for new relay and trip device settings to improve coordination. Switchgear ratings are examined against available short circuit currents, and recommendations are made where applicable.

Vital MCC-A and B are examined in detail to provide maximum continuity of service for every fault contingency. A recommendation is made to improve the reliability of these buses.

II. INTRODUCTION

Since the last study of the LOFT 13.8 KV/2.4 KV/480V power distribution system (LTR 1310-3 circa 1972), several changes have taken place. Circuit breakers have been replaced and relay settings have been adjusted. In addition, motor loads have grown significantly on 480 V MCC's and the PSMG drive motors have been re-rated from 600 to 900 HP. All of these changes created the need for a re-examination of the power system in terms of switchgear interrupt capability and over current coordination. This LTR is in response to that need.

III. DESCRIPTION OF SYSTEM

The LOFT 13.8 KV/ 2.4 KV/480V system is shown on the One Line Diagram of Figure 1. The 138 KV TAN Substation is tied into the INEL transmission loop as shown. Two 7500 KVA, 138KV/13.8 KV transformers step down voltage to the TAN 13.8 KV bus, air circuit breakers 5B-5-A and 5B-5-B protect the LOFT Feeders A & B respectively, the LOFT 13.8 KV buses A & B are tied together through normally closed circuit breaker 5B-T. Circuit breakers 5B-A-2, 5B-A-3, 5B-A-4, 5B-B-3, and 5B-B-4 protect feeders to commercial buses A1, A2, A, B2, and B. The feeder to Vital Power MCC-A is protected

by breakers 5B-A-2, CB-A-M1, CB-A-V, and VB-A-4. The feeder from MCC-A to the vital MG set A is protected by breakers VB-A-3 and VB-A-2.

The MCC-B feeder is protected by 5B-B-2, CB-B-V and VB-B-4. The feeder from MCC-B to vital MG set B is protected by breakers VB-B-2 and VB-B-3.

Administrative control selects either diesel generator power or commercial power to feed MCC-A and/or MCC-B. MCC-A and MCC-B are connected by two normally open molded case circuit breakers, VB-A-T and VB-B-T.

Overcurrent relays provide short circuit protection for the secondary at the TAN substation, LOFT 13.8 kV buses A & B mains and feeders, the mains and feeders of 2.4KV bus A, and feeders of 2.4 KV bus B. Integral trip devices furnish short circuit protection for the mains and feeders of 480V commercial power buses A1 and A2 and B2, both Diesel-Generators and Vital MCC-A and B, as well as Vital MG set A & B. Directional power relays and high speed underfrequency relays at breaker VB-A-4 and VB-B-4 insure that the vital MG sets will not feed power back into the commercial power system under any circumstances.

IV. SWITCHGEAR SHORTCIRCUIT DUTY

One of the first considerations in assessing the adequacy of protection of a power system is the ability of the switchgear to interrupt the expected short circuit current. With this in mind, the coordination study performed by N. A. Williams of Kaiser Engineers (LTR 1310-3) in 1972 was updated using present motor loads and re-rating the primary system MG drive motors from 600 to 900 HP.

In calculating the short circuit currents, the system configuration was assumed to be such that it would maximize short circuit contributions. The total connected motor load was assumed to be "on" even though this may not ever actually occur. Both diesel generator sets were assumed to be on-line at the same time that vital MCC-A and B are being supplied by commercial power.

CALCULATION WORK SHEET

PAGE 1 OF 1 PAGES

SUBJECT TAN/LOFT ONE-LINE DIAGRAM

DATE SEPT. 29, 1977

PREPARED BY J.E. BURNETT

CHECKED _____

WORK REQUEST _____

CALCULATION WORK SHEET

PAGE 1 OF 1 PAGES

SUBJECT TAN/LOFT ONE LINE DIAGRAM W/ MAX. FAULT CURRENTS DATE OCT. 7, 1977

PREPARED BY J.E BURNETT CHECKED WORK REQUEST

FIG 2

LOFT ONE- LINE DIAGRAM
WITH MAXIMUM FAULT CURRENTS (MOMENTARY AMPS RMS)

The LOFT substation tie breaker 5B-T was assumed to be open or closed as necessary to maximize short circuit duty for various switchgear.

Table I shows the calculated momentary and interrupting short circuit duties at each bus, as well as at circuit breakers CB-A-M1, CB-A1-1, CB-A-V and CB-B-V. The interrupting capacity of the respective switchgear is also shown. No serious problems are encountered with the exception of CB-A-V. The available fault current for a short circuit on the load side of CB-A-V is 37,107 A. Its present rating is 30,000 A (symmetrical). Therefore, it should be replaced with a 50,000 A rated breaker (e.g. GE AK-2-50).

Figure 2 shows the calculated maximum momentary current each circuit breaker on the 13.8KV/2.4 KV/480V system is subjected to under different short circuits.

V. OVERCURRENT COORDINATION - Discussion

A. General

The coordination study of an electric power system consists of an organized time - current study of all devices in series from the utilization device to the source. This study is a comparison of the time it takes the individual devices to operate when certain levels of normal or abnormal current pass through the detection devices.

The objective of a coordination study is to determine the characteristics, ratings and settings of overcurrent protective devices which will insure that minimum unfaulted load is interrupted when the protective devices isolate a fault or overload anywhere in the system. At the same time, the devices and settings selected must provide satisfactory protection against overloads on the equipment, and interrupt short circuits as rapidly as possible. It is toward these goals that this study is made.

The existing relay trip device settings for the TAN/LOFT switchgear can be found in Appendix A sheets 1 through 15. A plot of these settings appears in Appendix B, sheets 1 through 10.

B. 13.8 KV Switchgear Coordination

A plot of the existing time-current curves for the overcurrent relays (Appendix B sheet 1) shows several problems. LOFT sub-feeder breakers 5B-B-3 and 5B-A-4 trip curves do not coordinate well with the LOFT mains and tie c.b., the TAN mains, tie and feeder c.b.'s. The TAN feeders 5B-5-A and 5B-5-B and TAN tie c.b. 5B5-12 do not coordinate well with the LOFT mains and tie. Sheet 1A, Appendix B shows the coordination after the recommended relay settings have been made. Coordination is good for all values of fault current.

C. 2.4 KV Bus A Coordination

Appendix B, sheet 2 shows a plot of the existing time-current curves for 2.4 KV Bus A as a solid line. The dotted line represents the recommended setting for the overcurrent relay of breaker 5B-A-4, due to the problems noted in V-B. With this new setting, there are no coordination problems.

D. 2.4 KV Bus B Coordination

Appendix B, sheets 3 and 4 show plots of the existing time current curves for 2.4 KV Bus B. Coordination is good for all values of fault current.

E. 480 V Commercial Power Bus A2 Coordination

The existing time current curves (Appendix B, sheet 5) are shown by a solid line. Coordination is overall good. The bus rating of Switchgear A2 is 1000 AMP, while the long-time setting of CB-A2-1 is 1200 am p. The recommended setting (960A) for CB-A2-1 is shown on sheet 5 as a dotted line.

F. 480 V Bus A1 Coordination

Appendix B sheet 6 shows the existing time - current curves for Bus A1.

* * Coordination is good for all values of fault current.

G. 480 V Diesel Generator A

The existing time-current curves for breakers for diesel generator set A are shown in Appendix B sheet 7. Coordination is examined for the following modes of operation.

- (1) Normal - Commercial power supplying MCC-A through Swgr. VB-A-4, CB-A-V and CB-A-MI
- (2) Abnormal - Diesel - Gen. Power supplying MCC-A through Swgr. VB-A-4 and CB-A-G;
- (3) Abnormal - Diesel - Gen. Power supplying Bus A1 through CB-A-G, CB-A-V (Sheet No. 6)

** { For mode (1), coordination is not obtained between VB-A-4 and CB-A-V. Coordination requirements discussed in paragraph H increase the trip time of VB-A-4 which further aggravates the coordination problem between VB-A-4, CB-A-V and CB-A-MI. Replacement of CB-A-V and CB-A-MI with breakers having ECS trip devices set as shown in figure 7A, would provide adequate coordination.

For mode (2), good coordination is shown for VB-A-4, and CB-A-G. Since the long feeder cable from CB-A-V to DG-A has no protection of its own, it is recommended that an additional circuit breaker CB-A-G2 be added (see figure 1). Due to the large interrupt capacity required it is also recommended that CB-A-V be replaced (See Sec. IV and Table 1). The new trip curves for these breakers is shown on sheet 7A. (For more detail, see Appendix D).

** For mode(3), coordination is shown between 480 V bus A1 and Diesel Generator A through breakers CB-A1-1, CB-A-V, CB-A-G and CB-A-G2. CB-A1-1 (Sh. 6A) is set at a longer time delay than CB-A-V (Sh. 7A), thus providing no coordination for this abnormal mode. Since these two breakers carry the same load, the coordination problem is not considered serious.

H. 480 V MCC-A & B and MG-A&B Switchgear Coordination (For a more detailed discussion refer to MCC-A&B case study - Appendix C)

The existing time-current curves for breakers for MCC-A&B and M-G A&B are shown in Appendix B Sheet 8. Coordination is examined for the following modes of operation.

- (1) Normal - Commercial power supplying MCC-A (or B) and MG-A (or B) through VB-A-4, VB-A-3, and VB-A-2 (or VB-B-4, VB-B-3, and VB-B-2).

- (2) Abnormal - An emergency mode where MG-A (or B) supplies power to MCC-A (or B) with switchgear VB-A-4 (or VB-B-4) de-energized.
- (3) Abnormal - An emergency mode where MCC-A (or B) is energized from the tie c.b.'s (VB-A-T and VB-B-T) from MCC-B (or A).

For mode (1), poor coordination is shown between VB-A-4 (VB-B-4), VB-A-3 (VB-B-3) and VB-A-2 (VB-B-2). A fault at the M-G set might result in a loss of the corresponding vital MCC. By changing the time delay of VB-A-4 (VB-B-4) and VB-A-2 (VB-B-2), better coordination is obtained. Faults upstream of VB-A-4 (VB-B-4) (see figure 1) will be cleared by a new instantaneous directional overcurrent relay before either breaker VB-A-2 (VB-B-2) or VB-A-3 (VB-B-3) opens. Thus, for faults on the commercial power system, we are assured of having MCC's A & B energized by their respective MG sets.

For mode (2), the molded case feeder circuit breakers of MCC-A & B coordinate well with the new settings of VB-A-3 (VB-B-3) and VB-A-2 (VB-B-2) from the M-G sets.

For mode (3), the molded case feeder c.b.'s coordinate well with the tie c.b.'s. Poor coordination shows between MG-A (or B) and the tie C.B.'s. Since this is an extreme emergency configuration, the arrangement is considered adequate.

I. 480 V Diesel Generator B

The existing time - current curves for diesel generator set B are shown in Appendix B sheet 9. Coordination is discussed for three modes of operation.

- (1) Normal - Commercial power supplying MCC-B through switchgear VB-B-4 and CB-B-V.
- (2) Abnormal - Diesel - generator power supplying MCC-B through switchgear VB-B-4 and CB-B-G.
- (3) Abnormal - Diesel Gen. power supplying well pumps from 13.8 KV buses A, B through switchgear 5B-A-1, 5B-B-1, 5B-T, 5B-B-2, CB-B-V and CB-B-G.

For all three modes described above, coordination of breakers CB-B-G, VB-B-4, and CB-B-V is marginal to poor. However, in each mode there is only one load served. Therefore, the only consequence of the poor coordination is not being able to pinpoint the fault location.

J. 480 V Bus B-2 Coordination

Appendix B, Sheet 10 shows the time-current curves for 480 V bus B-2. Coordination, for the most part is good. Feeder C.b. CB-B2-6 overlaps transformer secondary c.b. CB-B2-1. The recommended setting of CB-B2-1 provides good coordination at bus B-2. The recommended setting for the over current relay of breaker 5B-B-3 is also shown. It does not interfere with the coordination of B-2 circuit breakers.

VI. SUMMARY OF RECOMMENDATIONS

- A. TAN 13.8 KV Bus - Change time dial settings for overcurrent relays in accordance with the following table:

DEVICE	PRESENT SETTING	RECOMMENDED SETTING
5B-5-A overcurrent relay	TD-4	TD-10
5B-5-B overcurrent relay	TD-4	TD-10
5B-5-1 overcurrent relay	TD-4	TD-10
5B-5-2 overcurrent relay	TD-4	TD-10
5B-5-12 overcurrent relay	TD-2.5	TD-10

- B. LOFT 2.4 KV Bus A

Change time dial setting for overcurrent relay for breaker 5B-A-4 from TD-10 to TD-3

- C. LOFT 2.4 KV Bus B

No Change

- D. LOFT 480 V Bus A2

Change long time setting of CB-A2-1 integral trip devices from 1200 A to 960 amps.

E. LOFT 480 V Bus A1

Change breaker CB-A-M1 from GE AK-2-50S with EC-1 trip device to GE AKR-2-50 with ECS solid state trip (long time - 1600 A max; short time 6400 A max.)
Change breaker CB-A1-1 from GE 203F to a GE AKR-2-50 with ECS solid state trip (long time - 1200A int; short time 4800 A int.)

F. LOFT 480 V diesel - Generator A Feeder

Change CB-A-V from a GE AK-2-25-1 to a GE-AKR-2-50 with an ECS solid state trip (long time - 840 A, max; short time 3360 A, int.)

{ Change CB-A-M1 trip device from an EC-1 (long time 1600A, 1B, short time 6400A, 2B) to an ECS (long time 1600 A, max; short time 6400A, max).

** { Add new circuit breaker CB-A-G2(GE AK-2-50S) with EC1 integral trip (long time 800 A, 1C; short time 3000 A, 2C).

Set CB-A-G at LTD 1000A max STD 5000 A Max.

G. LOFT 480 V Motor Control Centers A & B

Change solid state trip unit (Westinghouse Amptector ^(R)) short time delay from 0.18 sec to 0.33 sec on both main breakers VB-A-4 and VB-B-4.

Change magnetic trip unit (ITE OD-5) short time delay from intermediate to minimum on M-G breakers VB-A-2 and VB-B-2.

Add 3 directional over current relays (GE 12JBC54E) to each trip circuit of VB-A-4 and VB-B-4. New relays will require 3-600/5 C.T.'s, 2 .480/120 V P.T.'s and be set at 10A tap (over current) and 5A pick-up (instantaneous).

H. LOFT 480 V Diesel - Generator B Feeder

No Change

I. LOFT 480V Bus B-2

Change the time dial setting for overcurrent relay for breaker 5B-B-3 from TD5 to TD2. Turn down short time delay setting of CB-B2-6 from 3600A to 3,000 A.

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FORM INEL-1592
(Rev. 4-76)

CALCULATION WORK SHEET

PAGE 1 OF 1 PAGESSUBJECT SUMMARY OF SWITCHGEAR DUTY ON LOFT SYSTEMDATE OCT. 3, 1977PREPARED BY J.E. BURNETT

CHECKED _____

WORK REQUEST _____

TABLE 1

3-PHASE FAULT LOCATION	INTERRUPTING DUTY		MOMENTARY DUTY	CIRCUIT BKR.
	MVA	AMPS (RMS SYM.)	AMPS (RMS ASYM.)	INTERRUPT. CAP.
I LOFT TIE C.B. "OPEN"				
13.8 KV TAN BUS	174.0	7278	11,645	18,000 A - OK
13.8 KV LOFT A	88.5	3702	5,923	18,000 A - OK
INCOMING SWGR 5B-A-1	72.9	3050	4,880	18,000 A - OK
13.8 KV LOFT B	82.5	3451	5,521	18,000 A - OK
INCOMING SWGR 5B-B-1	70.7	2959	4,735	18,000 A - OK
II LOFT TIE C.B. "CLOSED"				
13.8 KV TAN BUS	173.3	7249	11,598	18,000 A - OK
13.8 KV LOFT A	121.7	5093	8,148	18,000 A - OK
INCOMING SWGR 5B-A-1	48.7	2038	3,260	18,000 A - OK
13.8 KV LOFT B	121.7	5093	8,148	18,000 A - OK
INCOMING SWGR 5B-B-1	45.9	1,920	3,073	18,000 A - OK
2.4 KV BUS A	19.5	4,692	7,506	10,500 A - INT - OK
2.4 KV BUS B	16.1	3,873	4,409	20,000 A - MOM - OK
480 V BUS A1	17.2	20,743	20,743 A (RMS SYM.)	10,500 A - INT - OK
480 V BUS A2	13.5	16,298	16,298	20,000 A - MOM - OK
480 V BUS B2	19.2	23,094	23,094	30,000 A - OK
CB-A-M1	28.2	33,919	33,919	30,000 A - OK
CB-A1-1	37.3	44,889	44,889	50,000 A - OK
CB-A-V	30.9	37,107	37,107	30,000 A - RECOMMEND
480 V MCC-A	14.0	16,839	16,839	REPLACE W/ 50,000 A
480 V MCC-B	11.6	13,904	13,904	22,000 A - OK

VII. CONCLUSIONS:

With the recommended relay and trip device settings effected, coordination for the LOFT 13.8 kV/2.4kV/480 V system is good. A few cases arise where radial feeders are protected by poorly coordinated circuit breakers (see Sec. V.). In these cases, however, only one load is fed from one source, and the coordination problem is reduced to one of not being able to pinpoint the exact location of the fault. This consequence is not considered serious.

The switchgear interrupting capacity was found to be adequate for the available short circuit currents, with one exception (CB-A-V). The recommended replacement breaker will eliminate that problem.

The vital MCC's A&B were found to have a reliability problem. The existing system configuration was found to be inadequate to protect the MCC's from all fault contingencies. The addition of new directional over current relays assures that the MCC's will be energized by either commercial power or the respective M-G set for all fault locations (with the obvious exception of a fault at the MCC-bus).

APPENDIX A

RELAY AND TRIP DEVICE SETTINGS - TAN/LOFT 13.8KV/2.4KV/480V SYSTEM

Switchgear <u>2 7500 KVA</u>	PROTECTIVE RELAY DATA & SETTINGS	
Volts <u>13.8KV</u>	For <u>U.S. DEPT. OF ENERGY</u>	Job No. _____ Sh. No. <u>1</u> of <u>15</u>
Location <u>TANI SUBSTATION-OUTDOOR</u>	At <u>IDAHO FALLS, IDAHO</u>	Ref. Dwg. <u>71D26BA1</u> R-1

Swgr. Unit No.	Circuit Designation	PT or CT Ratio	Relay						Remarks
			Device	Q	Mfr. Cat. No.	Range	Settings	Calibration	
5B5-1	MAIN INC FROM TRANS BT5-1 7500 KVA	600/5	51	3	W C01271071-A	4-15A, 1/2-11TD	5A TAP, 4TD	10A., 2.0 SEC	
		600/5	67	3	W CRI271493	4-15A, 115V, 5A	4A TAP, 1/2 TD		
		600/5 100/5	87	3	W CA1271007		5/5.5 RES 50% SLOPE	—	
5B-5A 4	FEEDER A	300/5	50/51	3	W C01338958-A	4-15A., 20-80A 1/2-11TD	5A TAP, 4 TD 53A INST	15A., 1.0 SEC	
5B5-12	TIE CB	600/5	51	3	W C01271071A	4-15A, 1/2-11TD	5A TAP 2 1/2 TD	10A., 1.9 SEC	
5B5-2	MAIN INC FROM TRANS BT5-2 7500 KVA	600/5	51	3	W C01271071-A	4-15A, 1/2-11TD	5A TAP 3.75 TD	10A., 1.3 SEC	
		600/5	67	3	W CRI271493	4-15A., 115V, 5A INSTR L 41-285	4A TAP, 1/2 TD		
		600/5 100/5	87	3	W CA1271007		5/5.5 RES. 50% SLOPE	—	
5B-5B	FEEDER B	300/5	50/51	3	W C01956141-A	2-5A, 20-80A 1/2-11 TD	5A TAP 4TD 53A INST	15A 1.0 SEC	

A-2

LTR 1310-19 REV A

Switchgear <u>13.8 KV BUS A</u>	PROTECTIVE RELAY DATA & SETTINGS	
Volts <u>13.8 KV</u>	For <u>U.S. DEPT. OF ENERGY</u>	Job No. _____ Sh. No. <u>2</u> of <u>15</u>
Location <u>LOFT NORTH SUBSTATION</u>	At <u>IDAHO FALLS, IDAHO</u>	Ref. Dwg. <u>LOFT 401-32</u>

Swgr. Unit No.	Circuit Designation	PT or CT Ratio	Relay						Remarks
			Device	Q	Mfr. Cat. No.	Range	Settings	Calibration	
5B-A-1 2	INCOMMING MAIN LOFT SUB FDR	200/5	51	3	GE 12IAC53B1D1A	4-16A., 1/4-10TD	7A TAP, 4TD	21A., 2.3SEC	INST 40
	A FROM TAN	480/112D	67	3	GE 12JBC53KZA	4-16A., 20-80A	4A TAP, 1TD 25A INST		
		100/5	SDG	1	GE 12PJC11AV3A	2-8A.	2A.	2A. P.U.	
5B-A-2 3	FEEDER, TRANS TP-24 FOR BUS A1 (480V)	100/5	50/51	3	GE 12IAC53B1D1A	4-16A., 1D-4DA. 1/2-1D TD.	1DA TAP, 2.5TD	2DA., 3.43EC	DISABLE INST
5B-A-3 4	FEEDER, TRANS TP-20, FOR BUS A2 (480V)	100/5	50/51	3	GE 12IAC53B1D1A	4-16A., 1D-4DA. 1/2-1D TD.	4A TAP, 5TD 35A. INST	12A. 2.9 SEC	
5B-A-4 5	FEEDER, TRANS TP-22, FOR BUS A (2400V)	100/5	50/51	3	GE 12IAC53B1D1A	4-16A., 1D-4DA. 1/2-1D TD	8A TAP 1D TD	16A., 17.5 SEC.	DISABLE INST
5B-T 6	TIE	150/5	3		GE 12IAC53B1D1A	4-16A., 1D-4DA. 1/2-1D TD	7A TAP, 5TD	21A., 2.9 SEC	

LTR 1310-19 REV A

Switchgear <u>13.8KV BUS B</u> Volts <u>13.8KV</u> Location <u>LDFT-SOUTH SUBSTATION</u>	PROTECTIVE RELAY DATA & SETTINGS For <u>U.S. DEPT. OF ENERGY</u> At <u>IDAHO FALLS, IDAHO</u>	Job No. _____ Sh. No. <u>3</u> of <u>15</u> Ref. Dwg. <u>LDFT 401-32</u>
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Swgr. Unit No.	Circuit Designation	PT or CT Ratio	Relay						Remarks
			Device	Q	Mfr. Cat. No.	Range	Settings	Calibration	
5B-B-1	INCOMING MAIN LDFT SUB	200/5	51	3	GE 12IAC53B101A	4-16A, 10-40A 1/2-ID TD	7A.TAP, 4TD 40 A INST.	21A., 2.2 SEC	
	FEEDER B FROM TAN	480/120	67	3	GE 12JBC53K2A	4-16A, 10-40INST	4A.TAP, 1TD 25A. INST		
		100/5	50G	1	GE 12PJG11AV3A	2-8A.	2A.	2A. P.U.	
5B-B-2	FEEDER, TRANS TP-23 FDR VITAL POWER B	100/5	50/51	3	GE 12IAC53B101A	4-16A, 10-40A 1/2-ID TD	4A.TAP, 5TD 35 A INST	12A. 2.9 SEC.	RM 224
5B-B-3	FEEDER, TRANS TP-21 FDR	100/5	51	2	GE 12IAC51A2A	1.5-6A	5A.TAP, 5TD	20A. 2. SEC	φ's A & C, N/D INST
	BUS B2 (480V)	100/5	51	1	GE 12IAC51A1A	4-16A	5A.TAP, 5TD	20A. 2. SEC	φ B ONLY
5B-B-4	FEEDER, TRANS TP-1B FDR	100/5	50/51	3	FPE CDG13A30B	4-12A, 1/2-IDTD	4A.TAP, 5TD	12A., 3.05 SEC	
	BUS B (2400V)	600/5	50G	1	FPE CDG13A10B	.5-2A	1A TD 1	5A. .25 SEC	ON 2.4KV NEUTRAL

LTR 1310-19 REV A

Job No. _____ Sh. No. 4 of 15
Ref. Dwg. LOFT 401-33

LTR 1310-19 REV A

Switchgear <u>1000 KVA TP-10 BUS B</u> Volts <u>2.4 KV</u> Location <u>LOFT AREA 6</u>	PROTECTIVE RELAY DATA & SETTINGS For <u>U.S. DEPT. OF ENERGY</u> At <u>IDAHO FALLS, IDAHO</u>	Job No. _____ Sh. No. <u>5</u> of <u>15</u> Ref. Dwg. <u>LOFT 40-33</u>
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Swgr. Unit No.	Circuit Designation	PT or CT Ratio	Relay						Remarks
			Device	Q	Mfr. Cat. No.	Range	Settings	Calibration	
NOC-B 4	INCDMMING TP-10 1000 KVA	2400/120	27	2	GE 12NGV13A11A	120V: 70-100V	96V	CONT 'A' OPEN IN .01 SEC AT 10V	
2B-B-3 3	FEEDER. SPARE	100/5	51	3	GE 12IAC53A101A	4-16A. 1/2-10TD	-		
		100/5	50G	1	GE 12PJC11A11A	.5-2A	-		
2B-B-1 2	FEEDER SPARE	100/5	49/50	2	GE 12TMC11B1A 90-110%	2.42A, 10-40A INST F.L. 2.01/2.2A			
		100/5	50G	1	GE 12PJC11A11A	.5-2A			
2B-B-2 1	FEEDER. SEC COOL. FDWTR PUMP.	200/5	49/50	2	GE 12TMC11B3A	2.92A, 10-40A INST F.L. 2.41-2.65	110%. 36A INST 8.76A-37 SEL		
	450 HP MAIN FEEDWATER	100/5	50G	1	GE 12PJC11A11A	.5-2A	1A	1A, .P.U.	

A-6

LTR 1310-19 REV A

Switchgear 2000 KVA TP-24
 Volts 480 V
 Location LOFT

PROTECTIVE RELAY DATA & SETTINGS

For U.S. DEPT. OF ENERGY

At IDAHO FALLS, IDAHO

Job No. _____ Sh. No. 6 of 15

Ref. Dwg. _____

Swgr. Unit No.	Circuit Designation	PT or CT Ratio	Relay						Remarks
			Device	Q	Mfr. Cat. No.	Range	Settings	Calibration	
CBA-V 1B	FEEDER, FROM TP-24, 2000KVA	600/5 480/120	32	1	GE 12ICW51A3A	1/2-10 TD 50-200 VV	50W TAP 3 TD		
	TD MCC-A (RM224)	600/5 480/120	81	1	GE 12CFF13A1A	55-59.5 HZ TD 6-30C.	58 HZ 20CTD	OPERATE AT 58 HZ	
		600/5 480/120	47	1	GE 12ICR54A1A	120V, 90-120V	L 90% , 108V R 80% , 96V	L OPENS AT 108V R CLOSES AT 96V	.17 SEC. TIME (R)
A-7 CBA-G	DG-A DIESEL GEN SET 500 KW, (TAN 629)								
		480/120	59	1	GE 1A VS1A1A	55-140V, 115V.	140V TL 2	168V, 6.4 SEC	
		750/5	32G	1	W CRN-1 290B038A09	5A, 120V.	TL 2	120V 2.8 SEC	
		480/120	81-1	1	GE 12IIFS1B2A	55-59.5 HZ 6-30 SEC	58 HZ		
		480/120	27	1	FPE VDG13B3DB1	55-99V	88V TL1	70.4V, 1.375 SEC.	
BA-4 1C	INCOMING TO MCC-A (B201)	600/5 480/120	32	1	GE 12CCF13D4A		5% REV POWER	0.25 A.	
		600/5 480/120	47	1	GE 12ICR54A1A	90-120 V	L 90% R 80%	L OPENS AT 108V R CLOSE AT 96V	.17 SEC. TIME (R)
		600/5 480/120	81	1	W KF 671B287A15	55-59.5 HZ 6-30 SEC	56.7 HZ 10CTD		
		480/120	62	1	GE 12IAVS1A1A	55-140V, 115V	55V, TL 1/2	77V 0.4 SEC	TIME DELAY DAILY

LTR 1310-19 REV A

Switchgear <u>750 KVA TP-23</u> Volts <u>480V</u> Location <u>LOFT</u>	PROTECTIVE RELAY DATA & SETTINGS For <u>U.S. DEPT OF ENERGY</u> At <u>IDAHO FALLS, IDAHO</u>	Job No. _____ Sh: No. <u>7</u> of <u>15</u> Ref. Dwg. _____
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Swgr. Unit No.	Circuit Designation	PT or CT Ratio	Relay						Remarks
			Device	Q	Mfr. Cat. No.	Range	Settings	Calibration	
CB-B-V 15A	FEEDER FROM TP-23 750 KVA	480/120	81-1	1	WV KF 671B287A15	55-59.5 HZ. 6-300	58 HZ. 20 CTD		
	TO MCC-B (B102)	480/120	47	1	GE 12ICR541A1	90-120V	L 90% 108V R 80% 96V	L OPENS AT 108V R CLOSE AT 96V	.17 SEC TIME (R)
		600/5	32	1	GE ICW51A2A	25-100 W	50 W TL 2.5	250 W. 1.5 SEC	
CB-B-G 16A	DG-B DIESEL GENERATOR		64	1	GE 12IAV51D3A	345V			GROUND DECT. FOR BUS B2
	1000 KW (RM B102)	1500/5 1500/5	87	3	GE 12IJD52A11A	5A MIN 10% SLIDE	FACTORY SETTING	P.U. .02 RATED	
		480/120	32	1	W GRN-1 290B038A09	55-140V	2 TL .2 TAP	120V 3 SEC	
VB-B-4 1C	INCOMING TO MCC-B (B201)	600/5 480/120	32	1	GE 12CCP13D4A	115V, 5A	5% REY POWER	.025 A.	
		600/5 480/120	47	1	GE 12ICR54A1A	90-120V	L 90% 108V R 80% 96V	L OPENS AT 108V R CLOSE AT 96V	.17 SEC TIME (R)
		600/5 480/120	81-2	1	WV KF 671B287A15	55-59.5 HZ. 6-300	56.7 HZ 10 CTD		
		120/120	62	1	GE 12IAV51A1A	55-140V	55 V TL 1/2	77V, 0.4 SEC	TD FOR REV PA

A-8

 LTR 1310-19
 REV A

Location LOFT B102

For U.S. DEPT. OF ENERGY

At IDAHO FALLS, IDAHO

Job No. _____ Sh. No. 2 of 15

Ref. Dwg. _____

[illegible]

A-9

REV A

Switchgear: 750 KVA TP-20 BUS-A2

Volts: 480 V

Location: LOFT ROOM 224

L. V. CIRCUIT BREAKER DATA & SETTINGS

For: U. S. DEPT. OF ENERGY

At: IDAHO FALLS, IDAHO

Job. No.

Sh.No. 9 of 15

Ref. Dwg. LOFT 401-34 SH.3 OF 3

Swgr. Unit No.	Circuit Designation	Air Circuit Bkr.		Overcurrent Tripping Device & Range						Tripping Settings				Remarks	
		Mfg. Type	Frame Size	Coil Rat'g	LTD		STD		Inst.	LTD		STD			Inst.
					Range	Time	Range	Time		Set	Time	Set	Time		
1 A	PT'S CPT														
CB-A2-1 2 B	MAIN INCOMING	GE AK-1-50	1600	1200	80-160%	1 B	2-5X	2A		1200	1B	3000	2A		EC-1
IC	SPACE		1600												
CB-A2-3 1A	MCC-7	GE AK-1-25-9	600	500	80-160%	1B	4-10X	2C		600	1B	2000	2C		EC-1
CB-A2-4 1B	MCC-11	GE AK-1-25-9	600	300	80-160%	1B	3-7X	2B		300	1B	900	2B		EC-1
CB-A2-5 1C	MCC-12	GE AK-1-25-9	600	200	80-160%	1B	3-7X	2B		200	1B	600	2B		EC-1
CB-A2-6 1D	OUTDOOR LIGHTING BLD 630 TEMP.	GE AK-2-25-2	600	100						120%	1B3				EC-2A

LTR 1310-19
REV A

LTR 1310-19
REV A

wthgear: 750KVA TP-20 BUS-A2
 olts: 480V
 ocation: LOFT ROOM 224

L. V. CIRCUIT BREAKER DATA & SETTINGS
 For: U.S. DEPT. OF ENERGY
 At: IDAHO FALLS, IDAHO

Job. No. Sh.No. 10 of 15
 Ref. Dwg. LOFT 401-34 SHT 1 OF 3.

wgr. nit No.	Circuit Designation	Air Circuit Bkr.		Overcurrent Tripping Device & Range						Tripping Settings				Remarks	
		Mfg. Type	Frame Size	Coil Rat'g	LTD		STD		Inst.	LTD		STD			Inst.
					Range	Time	Range	Time		Set	Time	Set	Time		
CB-A-11 2B	MAIN SECONDARY FROM TP-24	GE AK-2-50S	1600	1600	80-160%	1B	2-5X	2B		1600	1B	<u>6400</u> **	2B		EC-1
CB-AI-1 2A	MAIN INC. BUS AI	GE 203F	1000		70-100%					100%					
A-11 2B	REACTOR .01A														1000A.
CB-AI-3 1A	MCC-8	GE AK-2-25-2	600	600	80-160%	1B	4-10X	2C		480	1B	2400	2C		EC-1
CB-AI-4 1B	MCC-9	GE AK-2-25-2	500	300	80-160%	1B	2-5X	2C		300	1B	900	2C		EC-1
CB-AI-5 1C	MCC-13	GE AK-2-25-2	600	300	80-160%	1B	2-5X	2C		300	1B	900	2C		EC-1
CB-AI-6 1D	WATER CHILLER CH-2 150 HP	GE AK-2-25-2	600	250						200					EC-2
CB-A-V 2C	FEEDER DG-A AND MCC-A	GE AK-2-25-1	600	600	80-160%	1C	3-7X	2C		840	1C	3000	2C		EC-1

LTR 1310-19
REV A

LTR 1310-19
 REV A

Location: LOFT ROOM B201

At: IDAHO FALLS, IDAHO

4
SHT 1 OF 3.

[illegible]

REV A

Switchgear: 750KVA TP-23
 Voltage: 480 V
 Location: LOFT ROOM B102

L. V. CIRCUIT BREAKER DATA & SETTINGS
 For: U.S. DEPT. OF ENERGY
 At: IDAHO FALLS, IDAHO

Job. No. Sh. No. 12 of 15
 Ref. Dwg. 401-4 SHT 4
 401-34 SHT 2 OF 3

Gr. it No.	Circuit Designation	Air Circuit Bkr.		Overcurrent Tripping Device & Range					Tripping Settings					Remarks	
		Mfg. Type	Frame Size	Coil Rat'g	LTD		STD		Inst.	LTD		STD			Inst.
					Range	Time	Range	Time		Set	Time	Set	Time		
CB-B-V 11C	MAIN INCOMING FROM TP-23	GE AK-1-25	600	600	80-160%	1A	3-7X	2B		960	1A	3600	2B	EC-1	
CB-B-G 16B	FEEDER DG-3 1000 KW	GE AK-1-50	1600	1600	80-160%	1B	2-5X	2A		1500	1B	3200	2A	EC-1	
VB-B-4 1B	MAIN INC MCC-B COMM. POWER (RM B201)	WV DS 206	600	600	50-125%	4-36SEC	4-10X	18-55SEC		750	8SEC	2400	18SEC	AMPTECTOR	
VB-B-3 1C	INC. MCC-B VITAL MG-B (ROOM B201)	WV DS 206	600	600	50-125%	4-36SEC	4-10X	18-55SEC		600	4SEC	2400	18SEC	AMPTECTOR	
VB-B-2 B	VITAL MG-B	ITE K 600	600	600	80-160%	MAX. INT. MIN.	4-10X	MAX. INT. MIN.	5-15X	600	INT.	2400	INT.	6000	OD-5
VB-B-T	TIE TO MCC-A	WV 53-E-9330	600	600	MOLDED CASE					600				2400	

LTR 1310-19
REV A

LTR 1310-19
 REV A

Switchgear: 1500 KVA TP-21 BUS B2
 Volts: 480 V
 Location: LDFT ROOM B102

L. V. CIRCUIT BREAKER DATA & SETTINGS
 For: U.S. DEPT. OF ENERGY
 At: IDAHO FALLS, IDAHO

Job. No. Sh.No. 13 of 15
 Ref. Dwg. G30-E-301 401-34 SH 30F3

Swgr. Unit No.	Circuit Designation	Air Circuit Bkr.		Overcurrent Tripping Device & Range					Tripping Settings					Remarks
		Mfg. Type	Frame Size	Coil Rat'g	LTD		STD		Inst.	LTD		STD		
					Range	Time	Range	Time			Set	Time	Set	Time
9A	PT													
CB-B2-1 15C	MAIN INCOMMIN6 FRDM TP-21	GE AK-2-75	3000	2000	80-160%	INT	2-5X	MAX		1600	1B3	4000	2AA	EC-1B
9C	CPT													
CB-B2-5 12A	MCC-2	GE AK-1-25	600	400	80-160%	1B	2-5X	2B		320	1B	1200	2B	EC-1
12-B	FIRE PUMP FP 21B	GE AK-1-25	600	600	80-160%					600	1B	2500	2C-3	EC-1
CB-B2-3 12C	MCC-5	GE AK-1-25	600	300	80-160%					160%		3600		3600 EC-2
12D	SPARE													NOT EQUIPPED
CB-B2-6 13A	LDP-1, PDP-3	GE AK-1-25-9	600	600	80-160%	1B3			4-9X	600	1B	(100%)	3600	EC-2

LTR 1310-13
REV A

LTR 1310-19
 REV A

Location: LOFT ROOM B102

L. V. CIRCUIT BREAKER DATA & SETTINGS

For: U.S. DEPT OF ENERGY

At: IDAHO FALLS, IDAHO

Job. No.

Sh.No. 14 of 15

Ref. Dwg. G50-E-301

401-34 SH 3 OF 3

[illegible]

REV A

Sh.No. 15 of 15

REV A

APPENDIX B

TIME CURRENT CURVES FOR TAN/LOFT 13.8KV, 2.4KV, & 480V SYSTEMS

TAN/LOFT 13.8 KV SWITCHGEAR - EXISTING SETTINGS

TAN/LOFT 13.8KV SWITCHGEAR

SH. 1A OF 10

LOFT 2.4 KV BUS A SWITCHGEAR

SH. 2 OF 10

LOFT 2.4 KV BUS B SWITCHGEAR

SH. 3 OF 10

LOFT 2.4KV BUS B SWITCHGEAR SH 4 OF 10

LOFT 480V BUS A-2 SWITCHGEAR

SH 5 of 10

SH. 6 OF 10

LOFT 480V BUS A-1 SWITCHGEAR (EXISTING SETTINGS)

LOFT 480V BUS A-1 SWITCHGEAR
(RECOMMENDED SETTINGS)

SH 6A OF 10

LOFT 480V DIESEL-GEN A SWITCHGEAR
(EXISTING SETTINGS)

B-10

SH 7 OF 10

LOFT 480V DIESEL-GEN.A SWITCHGEAR
(RECOMMENDED SETTINGS)

SH 7A OF 10

INEL-B-5433

LOFT 480V DIESEL-GEN. B SWITCHGEAR

SH 9 OF 10

LOFT 480V BUS B-2 SWITCHGEAR

SH 10 of 10

APPENDIX C

PROTECTION OF VITAL POWER MCC-A & MCC-B

CALCULATION WORK SHEET

PAGE 1 OF 2 PAGES

SUBJECT MCC-AE'B BREAKER COORDINATION

DATE SEPT. 22, 1977

PREPARED BY J. E. BURNETT

CHECKED _____

WORK REQUEST _____

EXAMINATION OF MCC-A WITH RECOMMENDED TRIP SETTINGS (SEE APP. B SH. 8)

FAULT 1: EITHER VB-A-2 OR VB-A-3 OPENS BEFORE VB-A-4 OR CB-A-V, THUS, THE FAULT IS CLEARED & MCC-A IS ENERGIZED BY COMMERCIAL POWER.

FAULT 2: VB-A-3 CLEARS FAULT, MCC-A IS ENERGIZED BY COMMERCIAL POWER.

FAULT 3: VB-A-4 OR CB-A-V OPENS AND VB-A-3 OPENS CLEARING THE FAULT AT MCC-A. MCC-A DE-ENERGIZED.

FAULT 4: CB-A-V AND VB-A-3 OPEN, ISOLATING THE FAULT AND MCC-A. BETTER RELIABILITY WILL BE OBTAINED WITH AN INSTANTANEOUS DIRECTIONAL OVERCURRENT RELAY SET TO TRIP VB-A-4 FOR ANY FAULT UPSTREAM. WITH THIS RELAY, FAULT 4 WOULD BE CLEARED BY CB-A-V & VB-A-4. MCC-A WOULD BE ENERGIZED BY THE VITAL M-G SET.

CALCULATION WORK SHEET

SUBJECT PROTECTION OF MCC-A & B PAGE 2 OF 2 PAGES
 PREPARED BY J.E. BURNETT DATE SEPT. 22, 1977
 CHECKED _____ WORK REQUEST _____

CALCULATING VB-A-4 CURRENT FOR VARIOUS UPSTREAM FAULTS

FAULT 1

$$\frac{1}{2.86} + \frac{1}{23.04} = \frac{1}{MVA^1}$$

$$MVA^1 = 2.55$$

$$I_M^1 = 3060 A$$

FAULT 2 (CONSIDERING ONLY THE CURRENT SEEN BY VB-A-4)

$$\frac{1}{2.55} + \frac{1}{37.8} = \frac{1}{MVA^2}$$

$$MVA^2 = 2.39$$

$$I_M^2 = 2873 A$$

FAULT 3 (CONSIDERING ONLY THE CURRENT SEEN BY VB-A-4)

$$\frac{1}{2.55} + \frac{1}{23.04} = \frac{1}{MVA^3}$$

$$MVA^3 = 2.30$$

$$I_M^3 = 2762 A$$

Use 3- (ge) 12JBC54E w/ instantaneous unit
 Set, $\frac{600}{5}$ C.T. 480/120 P.T.

Time O.C. 4/16 tap set @ 10 x tap

Inst. O.C. 4-16 range set @ 5A pick-up
 $\frac{2762 A}{600/5} = 23 A = 4.6 \times \text{pick-up i.p.u. in approx.}$
 $0.027 \text{ sec. (5\% voltage)}$
 $\frac{44,625 A}{600/5} = 372 A - \text{ok for coil rating } 150A @ 1 \text{ sec.}$
 C-3

APPENDIX D

PROTECTION OF DIESEL GENERATOR A FEEDER

CALCULATION WORK SHEET

PAGE 1 OF 1 PAGESSUBJECT PROTECTION & COORDINATION OF DG-A FEEDERDATE OCT. 3, 1977PREPARED BY J.E. BURNETT

CHECKED _____

WORK REQUEST _____

PROPOSED NEW BREAKER CB-A-G2
 G.E. AK-2-50S 1600 A. FRAME
 1200 A ECS SOLID STATE TRIP
 LTD 840 INTERMEDIATE
 STD 3360 " "

BREAKER CURRENT - AMPS. (SYM)

FAULT NO.	CB-A-V	CB-A-G2	VB-A-4	TRIP SEQUENCE
1	37,107	7,518	3060	OK
2	↓	40,167	3060	VB-A-4 TRIPS & CB-A-G2 TRIPS
3	↓	7,518	44,625	OK
4	11,136	2,256	13,351	OK

TRIP SEQUENCES ARE ACCEPTABLE WITH THE EXCEPTION OF FAULT 2. FOR THIS CONDITION, IT WOULD BE DESIREABLE TO TRIP CB-A-G2 FIRST, LEAVING MCC-A ON COMMERCIAL POWER. A DIRECTIONAL OVERCURRENT RELAY WAS LOOKED INTO, BUT IT WOULD HAVE TO BE MADE FASTER THAN D.O. RELAY FOR VB-A-4. FOR A FAULT 2, LOCATION THIS WOULD BE DIFFICULT TO ACCOMPLISH WITH A HIGH DEGREE OF RELIABILITY. IT WAS DECIDED THAT THE BENEFITS OF A D.O. RELAY FOR CB-A-G2 WERE NOT JUSTIFIED.