Eric Larson
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Constellation Energy
Nuclear Generation Group

July 24, 2009

U. S. Nuclear Regulatory Commission
Washington, DC 20555 - 0001

ATTENTION: Document Control Desk

SUBJECT: **R.E. Ginna Nuclear Power Plant**
Docket No. 50-244

Reply to Request for Additional Information Associated with the Proposed License Amendment Request Regarding Revision of Technical Specification Limiting Conditions of Operation 3.3.2, 3.3.4, and 3.8.1

REFERENCES:

(a) Letter from Mr. J. T. Carlin (Ginna LLC) to Document Control Desk (NRC) dated December 19, 2008, Application to Revise Technical Specification Limiting Conditions of Operation (LCOs) 3.3.2, 3.3.4, and 3.8.1

(b) Letter from Mr. J. T. Carlin (Ginna LLC) to Document Control Desk (NRC) dated January 22, 2009, Amendment to Application to Revise Technical Specification Limiting Conditions of Operation 3.3.2, 3.3.4, and 3.8.1

(c) Letter from Mr. D. V. Pickett (NRC) to Mr. J. T. Carlin (Ginna LLC) dated June 9, 2009, REQUEST FOR ADDITIONAL INFORMATION RE: LOSS OF POWER INSTRUMENTATION SETTINGS AND DIESEL GENERATOR LOAD TEST VALUE (TAC NO. ME0291)

On December 19, 2008, R.E. Ginna Nuclear Power Plant, LLC (Ginna LLC) submitted a License Amendment Request (LAR) seeking to revise Technical Specification (TS) Limiting Conditions of Operation (LCOs) 3.3.2, 3.3.2, and 3.8.1 (References (a) and (b)).

Subsequent to the submittal, the NRC issued a Request for Additional Information (Reference (c)). Attachment (1) contains our response to this request. Attachments (2) through (6) contain supporting information. No new commitments are being made in this submittal. Should you have questions regarding the information in this submittal, please contact Mr. Thomas Harding at (585) 771-5219 or via email at Thomas.HardingJr@constellation.com.

Very truly yours,

Eric A. Larson

A001
NRR

WPLNRC-1002175

STATE OF NEW YORK :
: **TO WIT:**
COUNTY OF WAYNE :

I, Eric Larson, being duly sworn, state that I am Plant General Manager - R.E. Ginna Nuclear Power Plant, LLC (Ginna LLC), and that I am duly authorized to execute and file this request on behalf of Ginna LLC. To the best of my knowledge and belief, the statements contained in this document are true and correct. To the extent that these statements are not based on my personal knowledge, they are based upon information provided by other Ginna LLC employees and/or consultants. Such information has been reviewed in accordance with company practice and I believe it to be reliable.

Subscribed and sworn before me, a Notary Public in and ~~for the~~ State of New York and County of Wayne, this 24th day of July, 2009.

WITNESS my Hand and Notarial Seal:

Notary Public

My Commission Expires:

Oct. 21, 2010
Date

RICHARD A. JOHNSON
NOTARY PUBLIC, STATE OF NEW YORK
No. 01JO6082344
QUALIFIED IN WAYNE COUNTY
MY COMMISSION EXPIRES Oct 21 2010

Attachment 1: Response to Request for Additional Information Regarding Diesel Surveillance License Amendment Request
Attachment 2: VTD-A0500-4002 Undervoltage Relays and Overvoltage Relays
Attachment 3: VTD-A0500-4201 High Accuracy Undervoltage and Overvoltage Relays
Attachment 4: Information Notice 95-05 Evaluation
Attachment 5: Summary of Degraded Undervoltage Relay Testing and Evaluation of Relay Response to Plant Trip Conditions
Attachment 6: Diesel Loading Simulation Results

cc: S. J. Collins, NRC
D. V. Pickett, NRC
Ginna Resident Inspector, NRC
P. D. Eddy, NYSDPS
A. L. Peterson, NYSERDA

ATTACHMENT 1

Response to Request for Additional Information Regarding Diesel Surveillance License Amendment Request

R.E. Ginna Nuclear Power Plant, LLC
July 24, 2009

Request for Additional Information Question #1:
The undervoltage signal logic as shown in TS bases Figure B.3.3.4-1 is different from the one shown in Figure 2 of the Technical Evaluation Report provided as enclosure to license Amendment No. 38, issued by NRC on March 26, 1981. Provide license amendment number in which the revised undervoltage signal logic was approved by NRC.

The signal logic depicted in Figure 2 of the Technical Evaluation Report provided as an enclosure to License Amendment No. 38 shows coincident trip logic for buses 14, 16, 17, and 18. It shows that, for a loss of voltage condition, both loss of voltage relays will drop out and initiate the automatic voltage-restoring scheme. It also shows that, for a degraded voltage condition, the degraded voltage relays will both drop out and initiate the automatic voltage-restoring scheme. These actions are consistent with Technical Specifications (TS) Bases Figure B 3.3.4-1. The difference is that Figure 2 does not specifically reflect the grouping of the individual relays into channels, which TS Bases Figure B 3.3.4-1 does.

Per Section 3.4 of the Technical Evaluation Report for Amendment 38, the proposed changes to Ginna's Technical Specifications reflected five proposed design modifications. One of these proposed changes addressed coincidence logic, and one mentioned limiting conditions for operations when the number of operable channels for undervoltage protection is reduced. This mention is the only one made of the actual channels for undervoltage protection, which are not described elsewhere in the letter. The coincidence logic reflected at Ginna supports the logic depicted in Figure 2, with the added possibility of coincident degraded voltage on one channel and loss of voltage on the other channel starting and loading a diesel, per the relay groupings in each channel.

Request for Additional Information Question #2:
According to Acceptance Criteria 5 and 6 discussed in Section 9.0 (Page 15) of design analysis DA-EE-93-006-08, Revision 5, the degraded voltage and loss of voltage relays are set to prevent actuation during engineered safeguard sequence when the safeguard buses are supplied by emergency diesel generators (EDGs). Explain the function of above relays in case they operate during engineered safeguard sequence when the safeguard buses are supplied by EDGs.

The function of the UV relays is to prevent (1) motor stalling and (2) thermal degradation of the insulation system of the emergency safeguards motors and safety related equipment fed from buses 14, 16, 17 and 18 due to an undervoltage condition. Upon actuation of Safety Injection (SI) coincident with an undervoltage signal, the relays will trip the safeguards buses from their respective offsite power source. Once the associated diesel generator has started and closed in on the affected bus the sequencing of the safeguards loads onto the 480 V buses is initiated.

The relays provide the same level of UV protection during safeguards sequence actuation with loads being fed from offsite power as they do when the loads are fed from onsite emergency diesel generator power.

The voltage setpoints and time delays for the degraded voltage and loss of voltage relays have been selected to prevent relay actuation during recoverable voltage dips when being powered from either offsite or onsite power.

Request for Additional Information Question #3
Provide a copy of the vendor supplied operating curves for Loss of Voltage and Degraded Voltage relays.

The undervoltage relays are manufactured by Asea Brown Boveri (ABB). The vendor technical documents for the undervoltage relays are maintained in the Ginna vendor manual program. There are four undervoltage relay vendor technical documents contained in the vendor manual program: VTD-A0500-4002, VTD- A0500-4201, VTD-I0005-4001 and VTD-I0005-4004 (Note: A0500-4201 and I0005-4004 are identical, A0500-4002 and I0005-4001 are identical). VTD-A0500-4002 and VTD-A0500-4201 are included as Attachments 2 and 3 to this document.

The operating characteristics of the definite time relays are taken directly from the vendor technical documents.

The operating characteristics of the inverse time relays are not provided in the vendor technical documents for the settings utilized at Ginna. For these relays, the operating curves have been derived using the data included in the vendor technical documents along with detailed testing to validate their performance. The derivation is identified in section 5.1 of DA-EE-93-006-08 and the time-voltage characteristic curve is derived in DA-EE-96-068-03 Attachment 12. (Attachment 12 to DA-EE-96-068-03 is provided in the response to question 6 below).

Request for Additional Information Question #4
Attachment 2 to DA-EE-93-006-05 is a section of the operating manual for the Doble (F2000 Family) test equipment. This attachment indicates that the output AC voltage has a total harmonic distortion of 2%. Provide details of the evaluation that accounts for the inaccuracy in relay calibration introduced by the test equipment harmonic content.

DA-EE-93-006-08 does not evaluate for relay calibration inaccuracy due to the Doble test equipment Total Harmonic Distortion (THD). The loss of voltage relays are ABB type 27N with a harmonic filter option. The filter attenuates all harmonics of the 60 Hz input voltage, which allows the relay to operate on the 60 Hz fundamental component of the input voltage.
The test equipment THD has no effect on the 27N relay calibration accuracy.

The degraded voltage relays are ABB type 27. The type 27 vendor manual does not indicate the relay contains an accurate peak detector that is susceptible to harmonic distortion as the type 27N vendor manual indicates. In addition, the Doble test equipment is periodically tested for AC power output THD and has a 0.2% THD at the relay calibration test voltage level. This meets the relay manufacturer (ABB) recommended AC voltage test source with less than 0.3% harmonic distortion as indicated in Information Notice 95-05. Since neither the type 27N with harmonic filter nor type 27 relays are susceptible to THD the DA-EE-93-006-08 analysis does not evaluate for its effect.

Request for Additional Information Question #5
Did the licensee evaluate the NRC Information Notice 95-05, "Undervoltage Protection Relay Settings, Out of Tolerance Due to Test Equipment Harmonics" for any impact on the Ginna nuclear plant? If yes, provide a copy of the evaluation.

Yes, Ginna performed an evaluation, which has been included at the end of this document as Attachment 4.

Request for Additional Information Question #6
Provide a copy of Attachment 12 of design analysis DA-EE-96-068-03 (Offsite Power Load Flow Study) which is discussed on Section 5.1 of the design analysis DA-EE-93-006-08, Revision 5.

A copy of Attachment 12 extracted from DA-EE-96-068-03 (Revision 5) is included at the end of this document as Attachment 5.

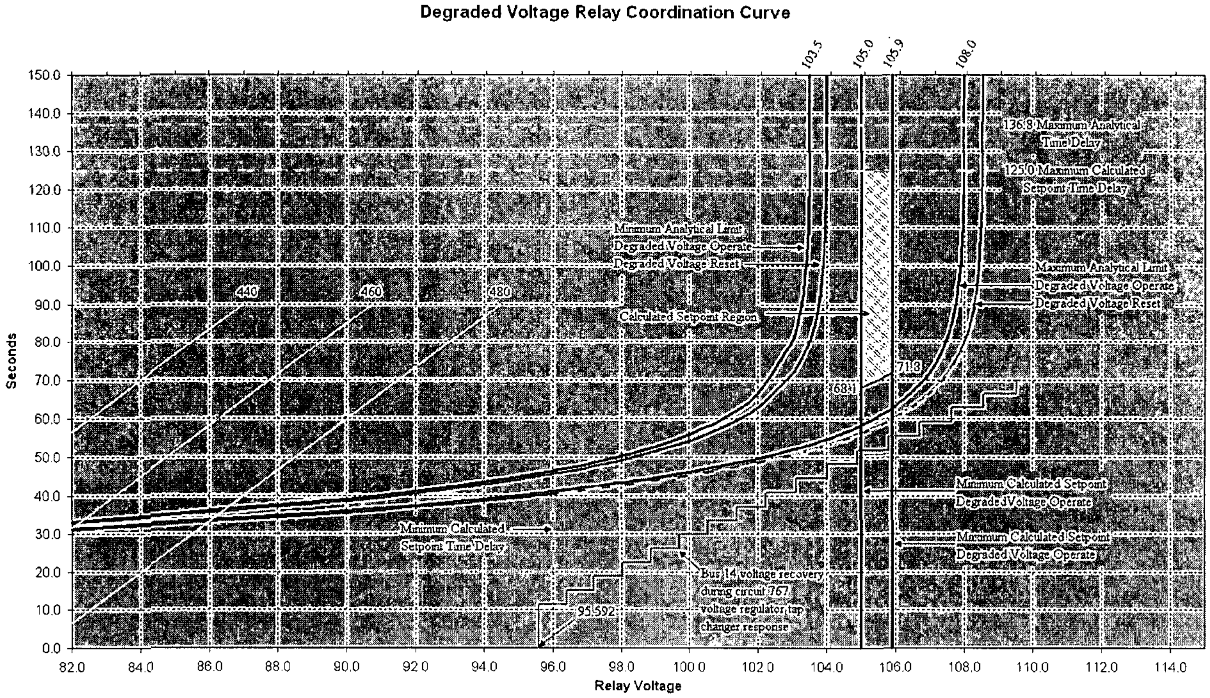
Request for Additional Information Question #7
Provide a copy of the thermal capability curves of 440, 460, and 480 V motors which are discussed in Section 5.5 and shown on Page 45 of design analysis DA-EE-93-006-08, Revision 5.

Section 5.5 clarifies that Ginna does not have vendor supplied thermal capability curves for the 440, 460 and 480 V motors. Guidance contained in ANSI standard C50.41-2000 (American National Standard for Polyphase Induction Motors for Power Generating Stations) was utilized to approximate the thermal damage curves for incorporation in the relay coordination curve. This is also discussed in section 10.3.2 of the analysis.

The specific section of the ANSI criteria which was applied was section 13.3 on momentary operation of motors which states "motors shall be capable of operating at rated load for a minimum of 60 seconds when 75 percent of rated voltage at rated frequency is applied to the motor terminals". Utilizing this guidance, the 440 volt motor thermal damage curve would have an intersecting point at 60 seconds and 82.5 volts [(0.75)(440)/(480/120) = 82.5 volts]. The intersecting points for 460 and 480 volt motors at 60 seconds would be 86.25 volts and 90 volts respectively using a similar calculation.

As stated in section 5.5, an actual thermal damage curve would follow an exponential function; however they are shown as straight lines on the coordination curve contained in the analysis for the reader to visualize the thermal damage curve for voltages above approximately 92 volts where the loss-of-voltage relay would actuate. This is considered a conservative approximation due to manufacturer designed-in margin which would permit longer operation at degraded voltage prior to failure occurring.

While performing a check of the analysis in responding to this question it was noted that the thermal damage curves were incorrectly plotted on the coordination curve contained in DA-EE-96-006-08. Corrective actions have been initiated at Ginna. The corrected coordination curve is below:



Request for Additional Information Question #8

Clarify the base voltage (whether 460 V or 480 V) considered corresponding to the percent voltage shown on Page 35 of design analysis DA-EE-93-006-08, Revision 5.

The graphs contained in section 11.3.1 (Page 35) are depicted in 480 volt base.

Request for Additional Information Question #9

In the license amendment request (LAR) dated December 19, 2008, Enclosure Section 3.2, it is stated that the current Technical Specifications (TS) degraded voltage and loss of voltage relay Limiting Safety System Settings (LSSS) required values do not reflect plant design basis requirements as defined in the plant load flow analysis, DA-EE-96-068-03. Provide an executive summary of the calculation which provides the following information:

a. *Plant design basis requirements and corresponding justification for revising the loss of voltage and degraded voltage relay settings to meet the plant design basis requirements*

DA-EE-93-006-08 was revised due to the discovery that the Technical Specifications contained non-conservative statements that would allow calibration of the undervoltage relays outside the analyzed range which ensures the relays do not actuate during recoverable voltage transients when offsite power is available. This resulted in the establishment of more conservative wording for calibration and testing of the undervoltage relays being incorporated into the site Technical Requirements Manual.

The Technical Specification change was requested to revise Technical Specifications in accordance with the Technical Requirements Manual values for undervoltage relays which are based on design analysis DA-EE-93-006-08 and DA-EE-96-068-03.

As stated in the response to question #2, the function of the UV relays is to prevent (1) motor stalling and (2) thermal degradation of the insulation system of the emergency safeguards motors and safety related equipment fed from buses 14, 16, 17 and 18 due to an undervoltage condition.

b. *Worst case voltage at 480 V safeguard buses (on 480 V bus voltage and 120 V relay voltage bases) versus time preferably in tabular form, when the engineered safeguard buses are sequenced from offsite power sources (instead of EDGs)*

A dynamic analysis of the safeguards sequence loading has not been created for scenarios where offsite power is supplying the 480 volt buses.

Dynamic analysis has been performed for scenarios where offsite power has been lost and the diesel generators are the only mechanism available to provide power to the safety related buses.

DA-EE-96-068-03 contains an analysis of worst case voltages to demonstrate that the undervoltage relays will not inadvertently actuate when offsite power is available. Section 7.8.3 discusses the determination that bus voltage does not fall below the maximum dropout voltage of the loss of voltage relays. Section 7.8.4 discusses the determination that offsite voltages recover through regulator action that will raise bus voltage above the degraded voltage relay reset setpoint.

c. *Details which confirm the worst case voltage at motor control centers (MCCs) will be adequate to pick up the starter contactors during starting of the safeguard loads.*

MCC control power is supplied by the DC distribution system for all motor control centers except MCCL and MCCM. MCCL and MCCM have AC control power supplied from local 480/120 volt transformers, however they are not susceptible to operability concerns during actuation of the safeguards sequenced loads since there are no loads fed from MCCL or MCCM which are part of the sequence.

Request for Additional Information Question #10

Provide details (such as design criteria) which confirm that protective devices at 120 V distribution level are adequately sized and will not result in actuation during start and operation of safeguard equipment for the duration of degraded voltage conditions.

Ginna's undervoltage relays are not connected to 120 VAC power sources which would be susceptible to degraded voltage conditions during start and operation of safeguard equipment. Ginna utilizes the 125 VDC stationary batteries (Battery A – Train A, Battery B – Train B) to provide power to protective relays. The station batteries are designed for a 4 hour coping period during station blackout, therefore they would have adequate capacity to maintain voltage on the DC distribution system during a loss of power to the 480 VAC safeguards buses while the diesel generators are starting.

Request for Additional Information Question #11:
In the LAR dated December 19, 2008, Enclosure Section 3.2.c, it is stated that a one-out-of-two logic in both channels will cause:

Shedding of all bus loads except the containment spray pump, component cooling water pump (if no safety injection signal is present), and safety related MCCs.

Regarding above statement, clarify the followings:

a) *The above statement indicates that none of the safety related MCCs are shed. However, according to the Ginna UFSAR, Revision 21, Section 8.3.1.1.6.6, it appears that all motor centers are shed except MCCs 1C and 1D, which require a manual trip. Clarify which MCCs are shed and which are not shed.*

UFSAR Section 8.3.1.1.6.6 states that MCCC and MCCD are not shed. The design of the Ginna distribution system is such that Train A motor control centers are powered from MCCC and Train B motor control centers are powered from MCCD.

The Train A motor control centers powered from MCCC are: MCCH, MCCK, MCCL and MCCN.

The Train B motor control centers powered from MCCD are: MCCJ, MCCM and MCCP.

Therefore all safety related motor control centers are not shed during actuation of SI and/or undervoltage conditions.

Note: Some non-safety loads on the safety related MCCs are shed on receipt of an SI signal when fed from onsite power (EDGs) by interrupting DC control power to the respective motor starters.

b) *The above statement also indicates that the containment spray pump is not shed. However, Table 8.3-1b of the UFSAR indicates the containment spray pumps may be loaded onto safeguard buses anytime after the buses are energized, which indicates that the containment spray pumps are either not initially running or are shed. Clarify the statement in the LAR that containment spray pump is not shed.*

The containment spray pumps are not load shed. The pumps are treated as variable loads in the load flow analysis of the electrical distribution system. For conservatism, the containment spray pumps are assumed to start coincident with other large loads, representing the worst case loading of the emergency diesel generators.

c) *If the containment spray pumps may be loaded onto safeguard buses anytime after the buses are energized, there is a potential for the containment spray pumps to be loaded simultaneously with another large load. Provide analyses that demonstrate that the EDG is capable of sequencing two (or more) large loads simultaneously and maintain voltage and frequency guidelines provided in Regulatory Guide 1.9.*

Attachment 6 contains individual Diesel Loading Simulation results for A and B Diesel Generator in three different scenarios. For each diesel, a baseline (where the containment spray pump does not come on), a “most likely” and a “worst case” scenario are provided.

> d) *Provide details of any other loads that may be loaded onto the safeguards buses after receiving a permissive from a process signal and the sequencer relays.*

There are no loads which are automatically added during the safeguards sequence other than those listed in Tables 8.3-1a and 8.3-1b of the UFSAR.

Request for Additional Information Question #12
Provide details on any manual loads that may be procedurally loaded on to the EDGs during the events discussed in the analyses documented in DA-EE-92-098-01 and DA-EE-92-120-01 for diesel generator A and B respectively.

There are no loads which are manually added during the safeguards sequence. After the sequence is completed, based on diesel generator loading and the recovery phase which the plant is in, Operations will secure running loads and start other equipment as necessary. Diesel generator loading is monitored during these activities to ensure the capability of the diesel generator is not exceeded. Diesel generator loading level is available on the front and rear sections of the main control board.

ATTACHMENT 2

VTD-A0500-4002 Undervoltage Relays and Overvoltage Relays

R.E. Ginna Nuclear Power Plant, LLC
July 24, 2009

ABB
ASEA BROWN BOVERI

IB 18.4.7-2
Issue E

INSTRUCTIONS

Single-Phase Voltage Relays

UNDERVOLTAGE RELAYS and OVERVOLTAGE RELAYS

TYPE 27, TYPE 27D, TYPE 27H	Catalog Series 211	Standard Case
TYPE 27, TYPE 27D, TYPE 27H	Catalog Series 411	Test Case
TYPE 59D, TYPE 59H	Catalog Series 211	Standard Case
TYPE 59D, TYPE 59H	Catalog Series 411	Test Case

VTD-A0500-4002
Revision 000
VM#A0500-0374 Tab 1

ASEA BROWN BOVERI

TABLE OF CONTENTS

INTRODUCTION

These instructions contain the information required to properly install, operate, and test certain ABB Circuit-Shield™ single-phase undervoltage and overvoltage relays, Types 27, 27D, 27H, 59D, and 59H. See the section on Testing for single-phase voltage relays covered by earlier issues of this instruction book.

The relay is housed in a case suitable for conventional semiflush panel mounting. All connections to the relay are made at the rear of the case and are clearly numbered. Relays of the 411B, 411R, and 411C catalog series are similar to relays of the 211B, 211R, and 211C series. Both series provide the same basic functions and are of totally drawout construction; however, the 411B, 411R, and 411C series relays provide integral test facilities. Also, sequenced disconnects on the 411 series prevent nuisance operation during withdrawal or insertion of the relay if the normally-open contacts are used in the application.

Most settings are made on the front panel of the relay, behind a removable clear plastic cover. The target is reset by means of a pushbutton extending through the relay cover.

PRECAUTIONS

The following precautions should be taken when applying these relays:

1. Incorrect wiring may result in damage. Be sure wiring agrees with the connection diagram for the particular relay before energizing. *Important: connections for the 411 catalog series units are different from the 211 series units.*

2. Apply only the rated control voltage marked on the relay front panel. The proper polarity must be observed when the dc control power connections are made.

3. For relays with dual-rated control voltage, withdraw the relay from the case and check that the movable link on the printed circuit board is in the correct position for the system control voltage.

4. High voltage insulation tests are not recommended. See the section on testing for additional information.

5. The entire circuit assembly of the relay is removable. The unit should insert smoothly. Do not use excessive force.

6. Follow test instructions to verify that the relay is in proper working order.

CAUTION: *since troubleshooting entails working with energized equipment, care should be taken to avoid personal shock. Only competant technicians familiar with good safety practices should service these devices.*

PLACING THE RELAY INTO SERVICE

1. RECEIVING, HANDLING, STORAGE

Upon receipt of the relay (when not included as part of a switchboard) examine for shipping damage. If damage or loss is evident, file a claim at once and promptly notify Asea Brown Boveri. Use normal care in handling to avoid mechanical damage. Keep clean and dry.

2. INSTALLATION

Mounting:
The outline dimensions and panel drilling and cutout information is given in Fig. 1.

Connections:
Internal connections are shown on page 7. Typical external connections are shown in Figure 2. *Important: connections are different for 411B, 411R, and 411C series units compared to 211B, 211R, and 211C units.* Control power must be connected in the proper polarity.

For relays with dual-rated control power: before energizing, withdraw the relay from its case and inspect that the movable link on the lower printed circuit board is in the correct position for the system control voltage. (For units rated 110vdc, the link should be placed in the position marked 125vdc.)

Relays rated for use with 120vac control power have an internal isolation transformer connected to relay terminals 7 and 8. Polarity of the ac control power to these terminals need not be observed.

These relays have metal front panels which are connected through printed circuit board runs and connector wiring to a terminal at the rear of the relay case. The terminal is marked "G". In all applications this terminal should be wired to ground.

3. SETTINGS

PICKUP (VOLTS)
The pickup taps are labelled by the actual value of ac input voltage which will cause the relay to operate. Note: operating voltage values other than the specific values provided by the taps can be obtained by means of an internal adjustment potentiometer. See section on testing for setting procedure.

On these relay models there is no adjustment for the differential between the operate and reset voltage values.

TIME DIAL
The time dial taps are identified as 1,2,3,4,5,6. Refer to the time-voltage characteristic curves in the Application section. Time dial selection is not provided on relays with an Instantaneous operating characteristic.

4. INDICATORS

Target:
An operation target is provided. The target is set electronically when the output contacts transfer. The target will retain its indication on loss of dc control power. In order to reset the target, normal dc control power must be present and a "normal" ac voltage condition must exist; in other words, for an undervoltage relay the voltage must be higher than the set point, and for overvoltage relays, lower.

APPLICATION DATA

The ABB Circuit-Shield™ single-phase voltage relays covered by this instruction book provide a wide range of application including undervoltage protection for motors, over and undervoltage protection for generators, and automatic bus transfer. The relays provide good accuracy and repeatability, and have a flat response over a frequency range of 15 to 400 hertz.

Undervoltage Relay, Type 27, catalog series 211B, 211R, 411B, and 411R:

Typical applications include general purpose undervoltage protection for incoming lines, and initiation of transfer in automatic bus transfer schemes.

Typical external connections are shown in Figures 2.

The relay has an inverse time curve as shown in TVC-605817.

Undervoltage Relay, Type 27D, catalog series 211B, 211R, 411B and 411R:

Typical applications include the initiation of transfer in automatic bus transfer schemes.

Typical external connections are shown in Figure 3.

The Type 27D relay has a definite-time characteristic with 2 ranges available: 0.1-1 second and 1-10 seconds, as shown in TVC-605820 and TVC-605821.

Undervoltage Relays, Type 27H, catalog series 211B, 211R, 411B, 411R:

Typical applications include instantaneous undervoltage detection for bus transfer schemes, and for generator intertie schemes. The low range relay is used as a residual voltage detector in motor bus transfer schemes.

Typical connections are shwon in Figure 3.

The relay has an instantaneous operating time as shown in TVC-605819.

Overvoltage Relays, Type 59H and Type 59D, catalog series 211C and 411C:

These instantaneous and definite time overvoltage relays are companions to the Type 27H and Type 27D undervoltage relays, and offer similar characteristics where overvoltage protection is required.

The time voltage characteristic for the Type 59D is given in TVC-605839. For the Type 59H the maximum operating time above 1.05 times pickup is 16 milliseconds.

Notes on the Use of AC Control Power

In general the use of a station battery to provide a reliable source of tripping and control power is preferred. However, many of the relay types described in this IB are available for use with 120 vac control power. The output contacts may be used in a 120 vac circuit or in a capacitor trip circuit where the capacitor voltage is no more than 170 vdc nominal. (Consult factory if the higher rating is required: "-CAP" catalog suffix.) The control power for these relays should never be taken from a capacitor trip circuit as the voltage is too high and the relay will drain the capacitor in the event of loss of AC supply.

Type 27 and Type 27D Undervoltage Relays used with 120 vac control power in the "self-powered" mode, with both signal and control power taken from the same source, will not maintain their timing characteristics if the voltage drops below approximately 65 volts. The relay will trip immediately. If this characteristic is undesirable for a particular application, the Type 27H instantaneous relay should be used followed by a pneumatic timer with time delay on dropout. A contact from the timer would be used to trip. The timer would be picked up by a contact of the Type 27H under "normal" line conditions. With undervoltage or loss of voltage, the timer would time out and close its contact in the tripping circuit. If the voltage loss were momentary, the timer would allow riding through the loss without tripping. This arrangement thus makes the time delay independent of control power and retains the benefits of accurate voltage sensing provided by the Type 27H relay.

SPECIFICATIONS

Input Circuit:

Rating: 160V, 50/60 Hz. continuous.
300V, 10 seconds.

Burden: 1.2 VA, 1.0 pf at 120 volts.

Taps: available models include:

Types 27, -27D, -27H :	60, 70, 80, 90, 100, 110v
Types 27D, -27H:	30, 35, 40, 45, 50, 55v
	15, 18, 21, 24, 27, 30v
Types 59D, -59H:	100, 110, 120, 130, 140, 150v
	60, 65, 70, 75, 80, 90v

Differential between Operate and Reset Voltages:
Type 27: less than 0.5 percent.
Types 27D, -27H, ITE-59D, -59H: approximately 3 percent.

Operating Time: See Time-Voltage characteristic curves that follow.

Output Circuit:

Each contact @ 125 Vdc: 30 ampere tripping duty.
5 ampere continuous.
0.3 ampere break.

Operating Temperature Range: -30 to +70 deg. C.

Control Power:

Models available for 48/125 vdc @ 0.08 A max.
48/110 vdc @ 0.08 A max.
24/ 32 vdc @ 0.08 A max.
120 vac 50/60 Hz. @ 0.08 A.

Allowable variation:

24vdc nominal:	19- 29 vdc
32vdc "	25- 38
48vdc "	38- 58
110vdc "	88-125
125vdc "	100-140
120vac "	95-135 vac

Tolerances:

Operating Voltage: +/- 5%
Operating Time: +/-10%

These tolerances are based on the printed dial markings. By using the calibration procedures given later in this book, the relay may be set precisely to the desired values of operating voltage and delay with excellent repeatability.

Repeatability: variation in operating voltage for a 10 volt variation in control voltage: 0.2 volt, typical.

variation in operating voltage over the temperature range 20-40 deg C: 0.5 volt, typical.

Dielectric Strength:

1500 vac, 50/60 Hz., all circuits to ground.

Seismic Capability:

More that 6g ZPA biaxial broadband multifrequency vibration without damage or malfunction. (ANSI C37.98-1978)

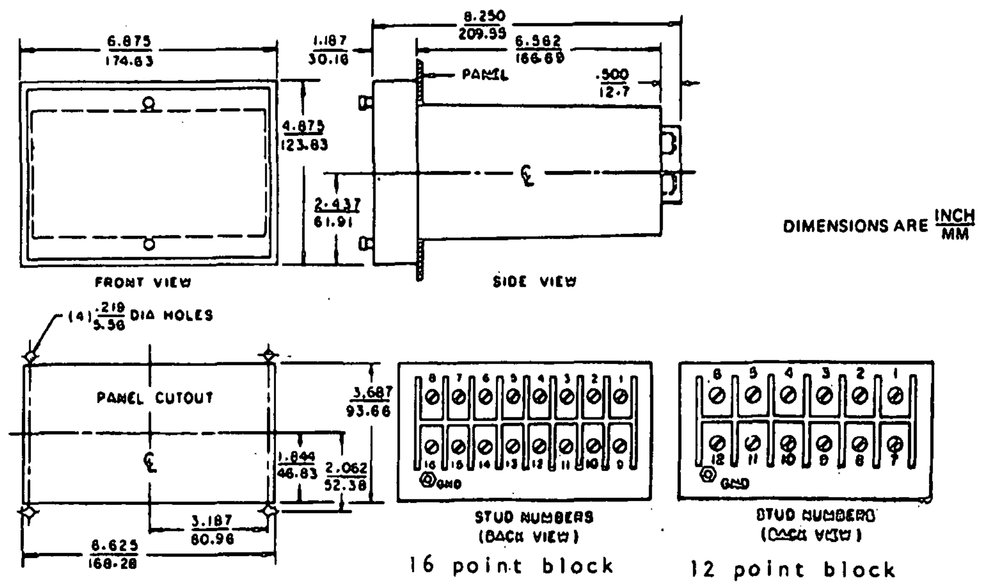


Figure 1: Relay Outline and Drilling

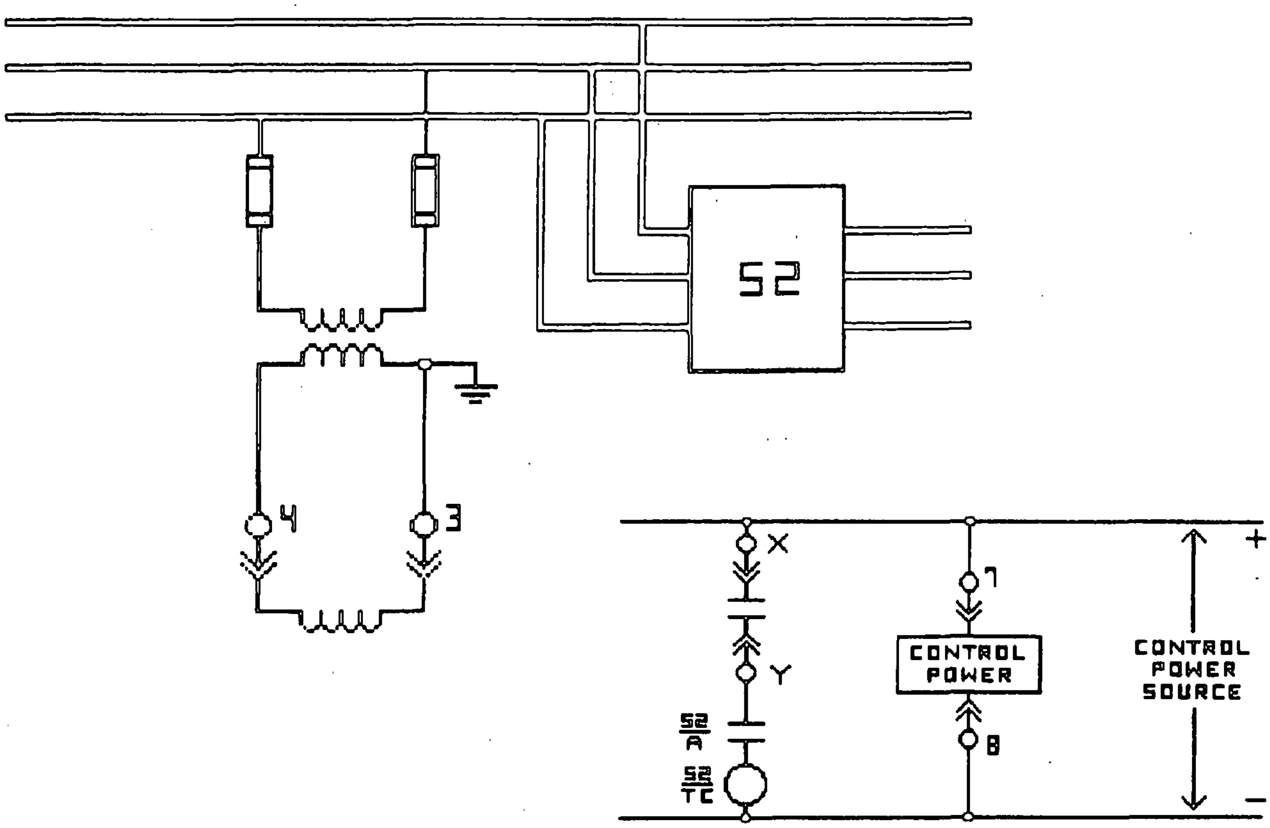


Figure 2: Typical External Connections

Note: Refer to Internal Connection Diagrams and Contact Logic Chart on page 7 to select the specific terminal numbers for the output contact ("X" and "Y") for the particular relay being used. Additionally, a table has been provided on page 15 as a cross-reference.

INTERNAL CONNECTION DIAGRAMS AND OUTPUT CONTACT LOGIC

The following tables and diagrams define the output contact states under all possible conditions of the measured input voltage and the control power supply. "AS SHOWN" means that the contacts are in the state shown on the internal connection diagram for the relay being considered. "TRANSFERRED" means the contacts are in the opposite state to that shown on the internal connection diagram.

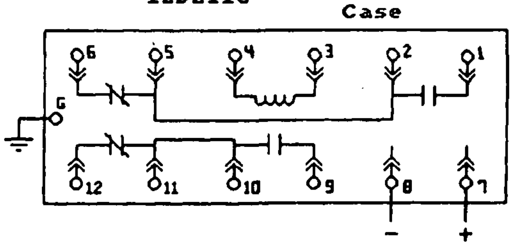
FOR DIAGRAM 12D211C

Condition	Contact State		
Cat. Series:	211Rxxx5	211Bxx65	211Cxxx5
Normal Control Power AC Input Voltage Below Setting	As Shown	As Shown	As Shown
Normal Control Power AC Input Voltage Above Setting	Transferred	Transferred	Transferred
No Control Voltage	Transferred	As Shown	As Shown

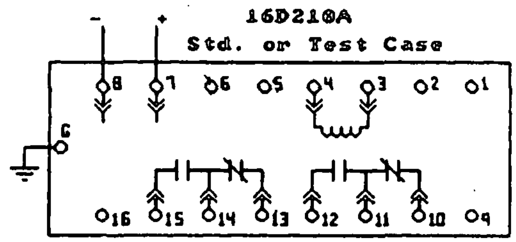
FOR DIAGRAM 16D210A

Condition	Contact State		
Cat. Series:	411Rxxx5	411Bxx65	411Cxxx5
Normal Control Power AC Input Voltage Below Setting	Transferred	Transferred	As Shown
Normal Control Power AC Input Voltage Above Setting	As Shown	As Shown	Transferred
No Control Voltage	As Shown	Transferred	As Shown

Single-Phase Voltage Relays
12D211C Std. Case



Single-Phase Voltage Relays
16D210A
Std. or Test Case



CHARACTERISTICS OF COMMON UNITS

The following chart gives the basic characteristics of various Circuit-Shield™ single-phase voltage relays from their catalog number breakdown. The relay catalog number will always be found on the front panel of the relay. Do not interpret this chart as a way to specify a relay for purchase as not all combinations are available. For new projects refer to current catalog pages for the latest listing of standard relays, or contact the factory.

211 R 1 1 7 5

BASIC FUNCTION AND PACKAGE STYLE

211	Single-phase voltage relay in Standard Case
411	Single-phase voltage relay in Test Case

RELAY TYPE AND FUNCTION

B	TYPES 27, -27D, -27H Undervoltage Relay with Type II contact logic
C	TYPES 59, -59D, -59H Overvoltage Relay
D	TYPE 27/59 Under/Overvoltage Relay (obsolete, replaced by 410D series)
E	TYPE 59G Ground Voltage Relay (obsolete, replaced by 210E/410E series)
L	TYPE 27/59 Undervoltage Relay (obsolete, replaced by TYPE 27N)
Q	TYPE 27G 180 Hz. Undervoltage Relay (obsolete, replaced by 410Q)
R	TYPES 27, -27D, -27H Undervoltage Relay with Type I logic

TIME DELAY CHARACTERISTIC

1	Inverse Time Delay Characteristic
4	Definite Time Characteristic 1-10 second range
6	Definite Time Characteristic 0.1-1 second range
0	Instantaneous Characteristic

VOLTAGE TAP RANGE

1	Standard Range: Types 27,-27D,-27H = 60-110v; Types 59,-59D,-59H = 100-150v; Type 59G = 3-18v
2	Low Range: Types 27D,-27H = 30-55v; Types 59D,-59H = 60-90v, Type 27G = 1-12v; Type 59G = 1-6v
5	Special Range: Types 27D,-27H = 15-30v

CONTROL VOLTAGE

6	120 vac
7	48/125 vdc
9	24/ 32 vdc
0	48/110 vdc

OUTPUT CONTACTS

1	2 normally open
5	2 form C

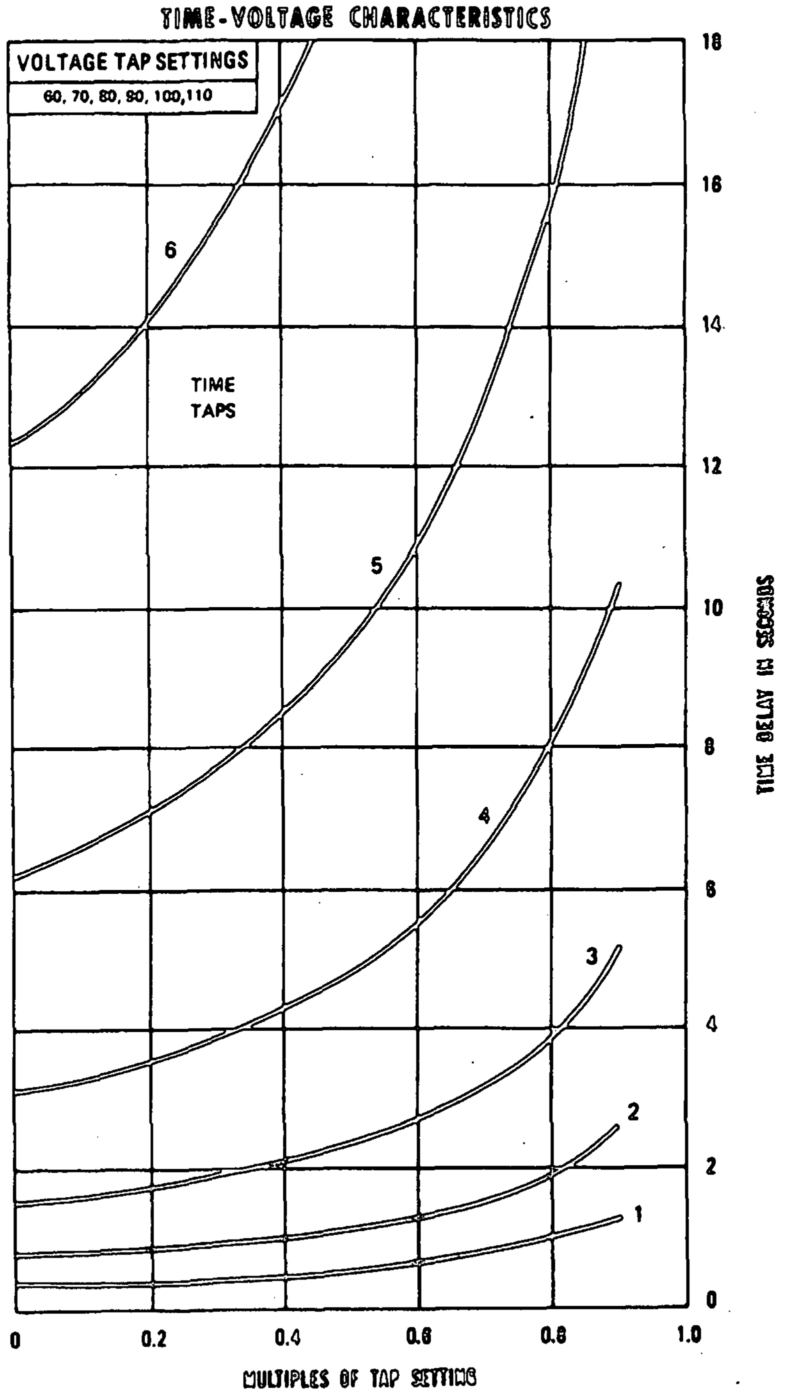


ABB Circuit-Shield™ TYPE 27 UNDERVOLTAGE RELAY

INVERSE (Medium Time)

MAY 1, 1975

TVC-606817

TIME-VOLTAGE CHARACTERISTICS

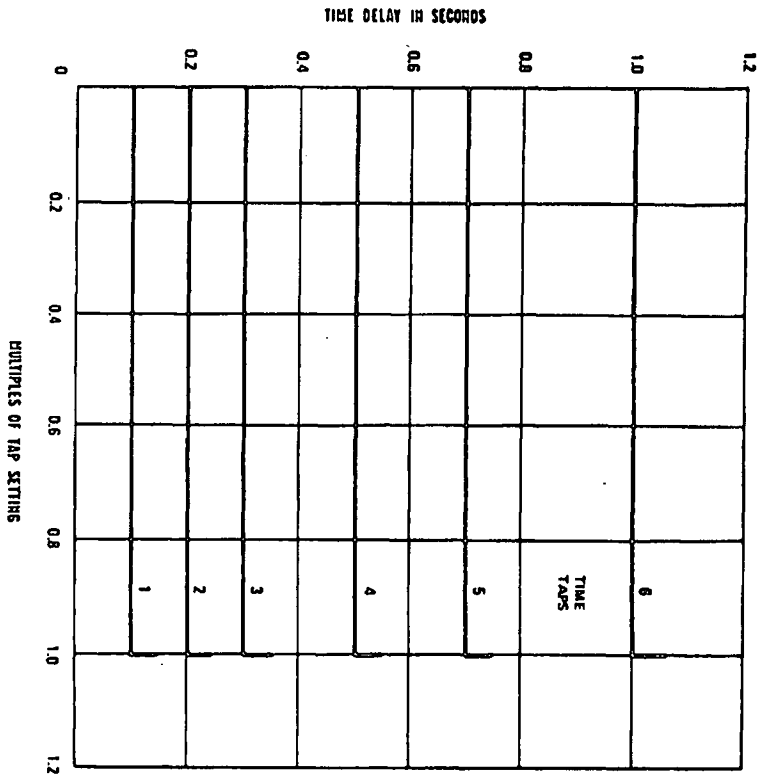


ABB Circuit-Shield™ TYPE 27D UNDERVOLTAGE RELAY
DEFINITE TIME (Short)
Catalog Series 211x6xxx and 411x6xxx

ASEA BROWN BOVERI
Protective Relay Division
35 North Snowdrift Road, Allentown, PA 18106
(215) 395-7333

MAY 1, 1975

TVC-605820

TIME-VOLTAGE CHARACTERISTICS

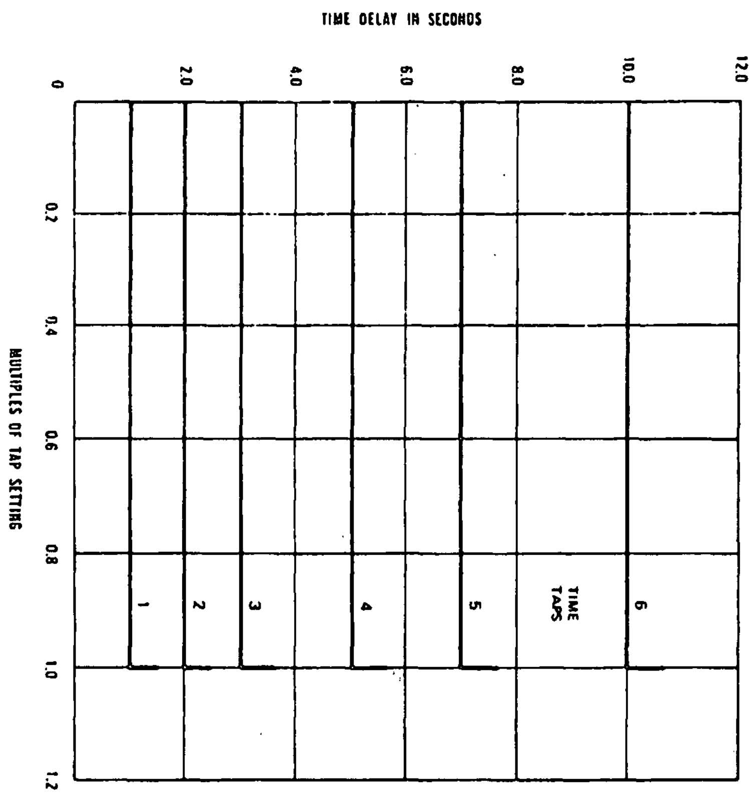


ABB Circuit-Shield™ TYPE 27D UNDERVOLTAGE RELAY
DEFINITE TIME (Medium)
Catalog Series 211x4xxx and 411x4xxx

ASEA BROWN BOVERI
Protective Relay Division
35 North Snowdrift Road, Allentown, PA 18106
(215) 395-7333

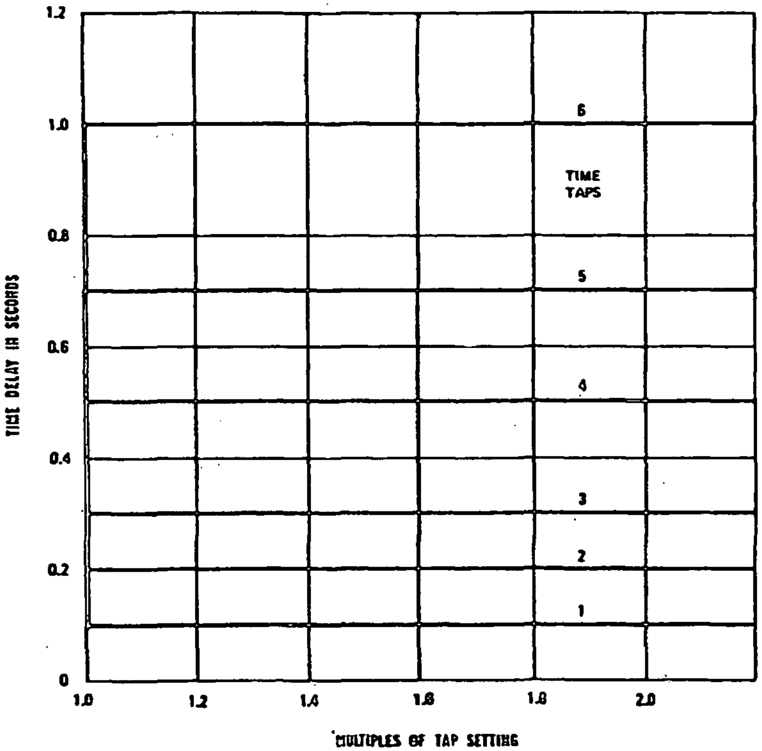
MAY 1, 1975

TVC-605821

OVERVOLTAGE RELAY

TIME-VOLTAGE CHARACTERISTICS

ABB Circuit-Shield™ TYPE 59D OVERVOLTAGE RELAY
DEFINITE TIME



SHORT TIME Catalog Series 211C6xxx and 411C6xxx
TIME DELAY AS SHOWN

MEDIUM TIME Catalog Series 211C4xxx and 411C4xxx
MULTIPLY TIME DELAY SHOWN BY 10

ASEA BROWN BOVERI

MAY 1, 1975 | TVC 605839

TIME-VOLTAGE CHARACTERISTICS

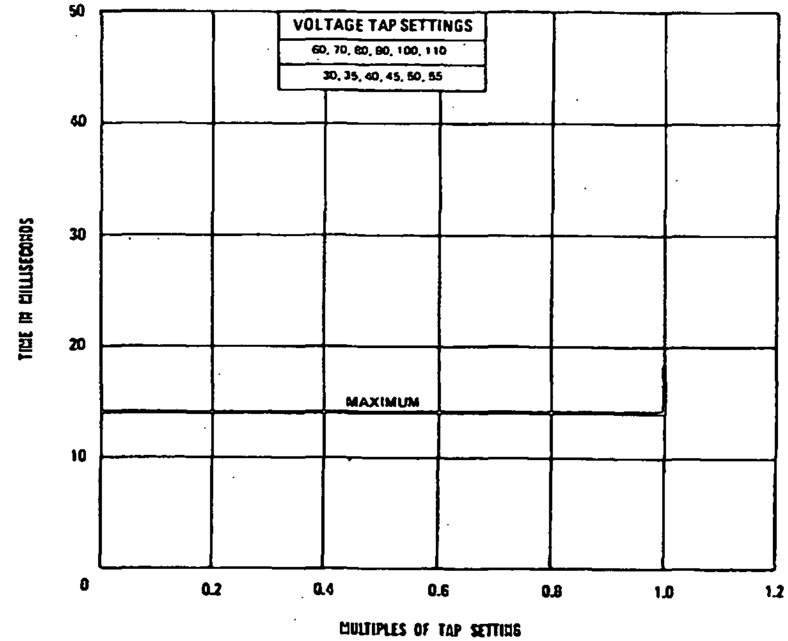


ABB Circuit-Shield™ TYPE 27H UNDERVOLTAGE RELAY
Instantaneous

ASEA BROWN BOVERI

MAY 1, 1975 | TVC-605819

TESTING

1. MAINTENANCE AND RENEWAL PARTS

No routine maintenance is required on these relays. Follow test instructions to verify that the relay is in proper working order. We recommend that an inoperative relay be returned to the factory for repair; however, a schematic diagram, and in some cases a circuit description, can be provided on request. Renewal parts will be quoted by the factory on request.

There are many earlier versions of these single-phase voltage relays which are now obsolete and have been superseded. If you have a relay which has its front panel stamped with Instruction Book IB 18.4.7-2, but which is not covered by this Issue E of the book, you should request Issue D from the factory. Also see paragraph 6 on obsolete relays.

211 Series Units

Drawout circuit boards of the same catalog number are interchangible. A unit is identified by the catalog number stamped on the front panel and a serial number stamped on the bottom side of the drawout circuit board.

The board is removed by using the metal pull knobs on the front panel. *Removing the board with the unit in service may cause an undesired operation.*

An 18 point extender board (cat 200X0018) is available for use in troubleshooting and calibration of the relay.

411 Series Units

Metal handles provide leverage to withdraw the relay assembly from the case. Removing the unit in an application that uses a normally closed contact will cause an operation. The assembly is identified by the catalog number stamped on the front panel and a serial number stamped on the bottom of the circuit board.

Test connections are readily made to the drawout relay unit by using standard banana plug leads at the rear vertical circuit board. This rear board is marked for easier identification of the connection points.

A test plug assembly, catalog 400X0002 is available for use with the 411 series units. This device plugs into the relay case on the switchboard and allows access to all external circuits wired to the case. See Instruction Book IB 7.7.1.7-8 for details on the use of this device.

2. HIGH POTENTIAL TESTS

High potential tests are not recommended. A hi-pot test was performed at the factory before shipping. If a control wiring insulation test is required, partially withdraw the relay unit from its case sufficient to break the rear connections before applying the test voltage.

3. BUILT-IN TEST FUNCTION

Be sure to take all necessary precautions if tests are run with the main circuit energized.

The built-in test is provided as a convenient functional test of the relay and associated circuit. When you depress the button labelled TRIP, the measuring and timing circuits of the relay are actuated. When the relay times out, the output contacts transfer to trip the circuit breaker or other associated circuitry, and the target is displayed. The test button must be held down continuously until operation is obtained. For the undervoltage relays, the timing is equivilent to that for a complete loss of voltage.

4. ACCEPTANCE TESTS

Follow calibration procedures under paragraph 5. On inverse or definite-time relays, select Time Dial #3. For undervoltage relays check timing by dropping voltage from 120 to 0 volts. For overvoltage relays check timing by increasing voltage to 150% of pickup. Tolerances should be within +/-5% for pickup and +/-10% for timing. Calibration may be adjusted to the final settings required by the application at this time.

5. CALIBRATION

A typical test circuit is shown in Figure 3. Connect the relay to a proper source of control voltage to match its nameplate rating and internal plug setting for dual-rated units. The ac test source should be harmonic-free. Sources using ferro-resonant-transformer regulators should not be used due to high harmonic content.

For relays with time delay, the time-dial tap pin should be placed in position #1 (fastest) when checking pickup and dropout voltages. The voltage should be varied slowly to remove the effect of the time delay from the voltage measurements.

Pickup may be varied between the fixed tap values by adjusting the internal pickup calibration potentiometer. For 211 series units the 18 point extender board provides easier access to the internal pots. Place the voltage tap pin in the nearest value and adjust the internal pot, repeating the test until the desired operating voltage is obtained. If the internal pot has insufficient range, move the tap pin to the next closest value and try again. Similarly the time delay may be adjusted higher or lower than the values shown on the time-voltage curves by means of the internal pot.

The internal calibration pots are identified as follows:

Relay Type	Pickup	Time Delay
Type 27, Type 59	R10	R25 *
Types -27D, -27H Types -59D, -59H	R13	R38

* Note: RT can also be used as a secondary means of adjustment.

6. OBSOLETE UNITS

The chart on page 8 indicates that certain of the 211 and 411 series single-phase voltage relays have been replaced by improved versions. The following gives a quick reference to the instruction books for the newer units. Should you need the instruction book for the earlier units that are nameplated to call for IB 18.4.7-2, request issue D from the factory.

Type 59, Inverse-time Overvoltage Relay:
Catalog series 211C11xx replaced by 210C11x5 and 410C11x5 series, see IB 7.4.1.7-1.

Type 59G, Ground Overvoltage Relay:
Catalog series 211E replaced by 210E and 410E series, see IB 7.4.1.7-9.

Type 27G, Third Harmonic Undervoltage Relay:
Catalog series 211Q replaced by 410Q series, see IB 7.4.1.7-9.

Type 27/59, Under/Overvoltage Relay:
Catalog series 211D replaced by 410D series, see IB 7.4.1.7-1.

Types 27/59A, -27/59D, -27/59H Under/Overvoltage Relay:
Catalog series 211L replaced by Type 27N, catalog series 211T and 411T, see IB 7.4.1.7-7. (Note: the 211L relays were not used for overvoltage protection; they were undervoltage relays with adjustable pickup and dropout voltages.)

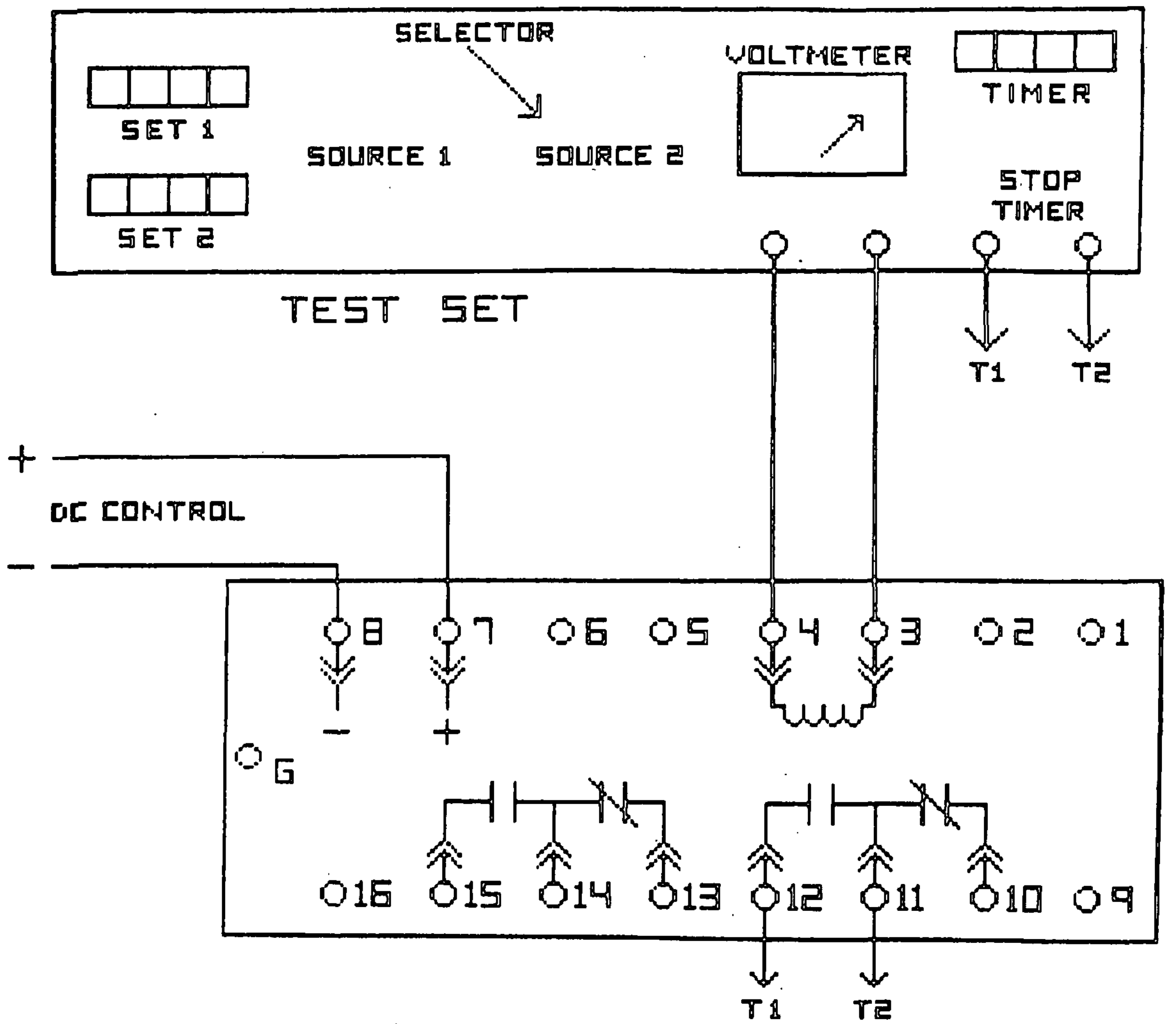


Figure 3: Typical Test Connections

Notes: Test connections shown for a 411C or 411R series unit. For other relays consult the Internal Connection Diagrams and Contact Logic Chart on pg 7 before selecting the output contact to use to stop the timer.

If the test set voltage level adjustment does not have sufficient resolution to properly check and set the pickup voltage, then insert a Variac (adjustable autotransformer) and external voltmeter between the test source and the relay input terminals.

Additional Notes on Figure 2, Typical External Connections:

The note with Figure 2 indicates that the terminal numbers associated with the output contact labelled "X" and "Y" in the diagram must be selected by referring to the internal connection diagram and contact logic chart for the particular relay being considered. As a cross-reference in this selection, the following table lists the terminals associated with the normally-open contacts that close for tripping for the basic relay function. In other words, for an undervoltage relay, the contacts that close for undervoltage, and for an overvoltage relay the contacts that close on overvoltage. An "x" in the catalog number represents any digit ("don't care").

Undervoltage Relays		Contacts that CLOSE on Undervoltage *	
Cat Series	211Rxxx5	5 - 6	11 - 12
	211Bxx65	5 - 6	11 - 12
	411Rxxx5	11 - 12	14 - 15
	411Bxxx5	11 - 12	14 - 15
Overvoltage Relays		**Contacts that CLOSE on overvoltage ***	
Cat Series	211Cxxx5	1 - 2	9 - 10
	411Cxxx5	11 - 12	14 - 15

* (Contact closure is after appropriate time delay.)

ASEA BROWN BOVERI

ABB Power T&D Company Inc.
Protective Relay Division
35 N. Snowdrift Rd.
Allentown, PA. 18106
215-395-7333 Fax 215-395-1055

Issue E (7/88)
Supersedes Issue D
Minor Revisions 11/90

These instructions do not purport to cover all details or variations in equipment, nor to provide for every possible contingency to be met in conjunction with installation, operation, or maintenance. Should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to Asea Brown Boveri.

ATTACHMENT 3

VTD-A0500-4201 High Accuracy Undervoltage and Overvoltage Relays

R.E. Ginna Nuclear Power Plant, LLC
July 24, 2009

ASEA BROWN BOVERI

IB 7.4.1.7-7
Issue D

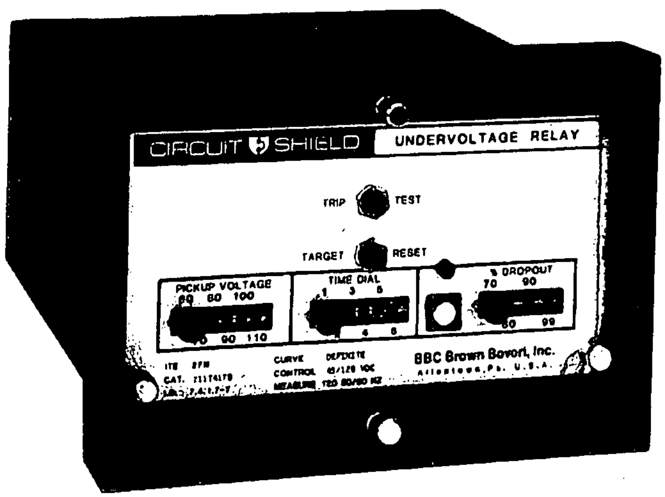
INSTRUCTIONS

Single Phase Voltage Relays

Type 27N HIGH ACCURACY UNDERVOLTAGE RELAY

Type 59N HIGH ACCURACY OVERVOLTAGE RELAY

Type 27N	Catalog Series 211T	Standard Case
Type 27N	Catalog Series 411T	Test Case
Type 59N	Catalog Series 211U	Standard Case
Type 59N	Catalog Series 411U	Test Case



VTD-A0500-4201
Revision 000
VM#A0500-0374 Tab 2

ASEA BROWN BOVERI

TABLE OF CONTENTS

INTRODUCTION

These instructions contain the information required to properly install, operate, and test certain single-phase undervoltage relays type 27N, catalog series 211T and 411T; and overvoltage relays, type 59N, catalog series 211U and 411U.

The relay is housed in a case suitable for conventional semiflush panel mounting. All connections to the relay are made at the rear of the case and are clearly numbered. Relays of the 411T, and 411U catalog series are similar to relays of the 211T, and 211U series. Both series provide the same basic functions and are of totally drawout construction; however, the 411T and 411U series relays provide integral test facilities. Also, sequenced disconnects on the 410 series prevent nuisance operation during withdrawal or insertion of the relay if the normally-open contacts are used in the application.

Basic settings are made on the front panel of the relay, behind a removable clear plastic cover. Additional adjustment is provided by means of calibration potentiometers inside the relay on the circuit board. The target is reset by means of a pushbutton extending through the relay cover.

PRECAUTIONS

The following precautions should be taken when applying these relays:

1. Incorrect wiring may result in damage. Be sure wiring agrees with the connection diagram for the particular relay before energizing.

2. Apply only the rated control voltage marked on the relay front panel. The proper polarity must be observed when the dc control power connections are made.

3. For relays with dual-rated control voltage, withdraw the relay from the case and check that the movable link on the printed circuit board is in the correct position for the system control voltage.

4. High voltage insulation tests are not recommended. See the section on testing for additional information.

5. The entire circuit assembly of the relay is removable. The unit should insert smoothly. Do not use excessive force.

6. Follow test instructions to verify that the relay is in proper working order.

CAUTION: ***since troubleshooting entails working with energized equipment, care should be taken to avoid personal shock. Only competant technicians familiar with good safety practices should service these devices.***

PLACING THE RELAY INTO SERVICE

1. RECEIVING, HANDLING, STORAGE

Upon receipt of the relay (when not included as part of a switchboard) examine for shipping damage. If damage or loss is evident, file a claim at once and promptly notify Asea Brown Boveri. Use normal care in handling to avoid mechanical damage. Keep clean and dry.

2. INSTALLATION

Mounting:
The outline dimensions and panel drilling and cutout information is given in Fig. 1.

Connections:
Typical external connections are shown in Figure 2. Internal connections and contact logic are shown in Figure 3. Control power must be connected in the proper polarity.

For relays with dual-rated control power: before energizing, withdraw the relay from its case and inspect that the movable link on the lower printed circuit board is in the correct position for the system control voltage. (For units rated 110vdc, the link should be placed in the position marked 125vdc.)

These relays have an external resistor wired to terminals 1 and 9 which must be in place for normal operation. The resistor is supplied mounted on the relay.

These relays have metal front panels which are connected through printed circuit board runs and connector wiring to a terminal at the rear of the relay case. The terminal is marked "G". In all applications this terminal should be wired to ground.

3. SETTINGS

PICKUP
The pickup voltage taps identify the voltage level which the relay will cause the output contacts to transfer.

DROPOUT
The dropout voltage taps are identified as a percentage of the pickup voltage. Taps are provided for 70%, 80%, 90%, and 99% of pickup, or, 30%, 40%, 50%, and 60% of pickup.

Note: operating voltage values other than the specific values provided by the taps can be obtained by means of an internal adjustment potentiometer. See section on testing for setting procedure.

TIME DIAL
The time dial taps are identified as 1,2,3,4,5,6. Refer to the time-voltage characteristic curves in the Application section. Time dial selection is not provided on relays with an Instantaneous operating characteristic. The time delay may also be varied from that provided by the fixed tap by using the internal calibration adjustment.

4. OPERATION INDICATORS

The types 27N and 59N provide a target indicator that is electronically actuated at the time the output contacts transfer to the trip condition. The target must be manually reset. The target can be reset only if control power is available, AND if the input voltage to the relay returns to the "normal" condition.

An led indicator is provided for convenience in testing and calibrating the relay and to give operating personnel information on the status of the relay. See Figure 4 for the operation of this indicator.

Units with a "-L" suffix on the catalog number provide a green led to indicate the presence of control power and internal power supply voltage.

APPLICATION DATA

Single-phase undervoltage relays and overvoltage relays are used to provide a wide range of protective functions, including the protection of motors and generators, and to initiate bus transfer. The type 27N undervoltage relay and type 59N overvoltage relay are designed for those applications where exceptional accuracy, repeatability, and long-term stability are required.

Tolerances and repeatability are given in the Ratings section. Remember that the accuracy of the pickup and dropout settings with respect to the printed dial markings is generally not a factor, as these relays are usually calibrated in the field to obtain the particular operating values for the application. At the time of field calibration, the accuracy of the instruments used to set the relays is the important factor. Multiturn internal calibration potentiometers provide means for accurate adjustment of the relay operating points, and allow the difference between pickup and dropout to be set as low as 0.5%.

The relays are supplied with instantaneous operating time, or with definite-time delay characteristic. The definite-time units are offered in two time delay ranges: 1-10 seconds, or 0.1-1 second.

An accurate peak detector is used in the types 27N and 59N. Harmonic distortion in the AC waveform can have a noticible effect on the relay operating point and on measuring instruments used to set the relay. An internal harmonic filter is available as an option for those applications where waveform distortion is a factor. The harmonic filter attenuates all harmonics of the 50/60 Hz. input. The relay then basically operates on the fundamental component of the input voltage signal. See figure 5 for the typical filter response curve. To specify the harmonic filter add the suffix "-HF" to the catalog number. Note in the section on ratings that the addition of the harmonic filter does reduce somewhat the repeatability of the relay vs. temperature variation. In applications where waveform distortion is a factor, it may be desirable to operate on the peak voltage. In these cases, the harmonic filter would not be used.

CHARACTERISTICS OF COMMON UNITS

Type	Pickup Range	Dropout Range	Time Delay Pickup	Time Delay Dropout	Catalog Numbers Std Case	Catalog Numbers Test Case
27N	60 - 110 v	70% - 99%	Inst	Inst	211T01x5	411T01x5
			Inst	1 - 10 sec	211T41x5	411T41x5
			Inst	0.1 - 1 sec	211T61x5	411T61x5
	70 - 120 v	70% - 99%	Inst	Inst	211T03x5	411T03x5
			Inst	1 - 10 sec	211T43x5	411T43x5
			Inst	0.1 - 1 sec	211T63x5	411T63x5
	60 - 110 v	30% - 60%	Inst	Inst	211T02x5	411T02x5
			Inst	1 - 10 sec	211T42x5	411T42x5
			Inst	0.1 - 1 sec	211T62x5	411T62x5
59N	100 - 150 v	70% - 99%	Inst	Inst	211U01x5	411U01x5
			1 - 10 s	Inst	211U41x5	411U41x5
			0.1 - 1 s	Inst	211U61x5	411U61x5

IMPORTANT NOTES:

1. Each of the listed catalog numbers for the types 27N and 59N contains an "x" for the control voltage designation. To complete the catalog number, replace the "x" with the proper control voltage code digit:

   48/125 vdc 7
   250 vdc 5
   220 vdc 2
   48/110 vdc 0

2. To specify the addition of the harmonic filter module, add the suffix "-HF". For example: 411T4175-HF. Harmonic filter not available on type 27N with instantaneous delay timing characteristic.

SPECIFICATIONS

Input Circuit:

Rating: type 27N 150v maximum continuous.
type 59N 160v maximum continuous.

Burden: less than 0.5 VA at 120 vac.

Frequency: 50/60 Hz.

Taps: available models include:

Type 27N: pickup - 60, 70, 80, 90, 100, 110 volts.
70, 80, 90, 100, 110, 120 volts.
dropout- 60, 70, 80, 90, 99 percent of pickup.
30, 40, 50, 60 percent of pickup.

Type 59N: pickup - 100, 110, 120, 130, 140, 150 volts.
dropout- 60, 70, 80, 90, 99 percent of pickup.

Operating Time: See Time-Voltage characteristic curves that follow.
Instantaneous models: 3 cycles or less.

Reset Time: 27N: less than 2 cycles; 59N: less than 3 cycles.
(Type 27N resets when input voltage goes above pickup setting.)
(Type 59N resets when input voltage goes below dropout setting.)

Output Circuit: Each contact

@ 120 vac	@ 125 vdc	@ 250 vdc	
30 amps.	30 amps.	30 amps.	tripping duty.
5 amps.	5 amps.	5 amps.	continuous.
3 amps.	1 amp.	0.3 amp.	break, resistive.
2 amps.	0.3 amp.	0.1 amp.	break, inductive.

Operating Temperature Range: -30 to +70 deg. C.

Control Power:

Models available for	Allowable variation:	
48/125 vdc @ 0.05 A max.	48 vdc nominal	38- 58 vdc
48/110 vdc @ 0.05 A max.	110 vdc "	88-125 vdc
220 vdc @ 0.05 A max.	125 vdc "	100-140 vdc
250 vdc @ 0.05 A max.	220 vdc "	176-246 vdc
	250 vdc "	200-280 vdc

Tolerances: (without harmonic filter option, after 10 minute warm-up)

Pickup and dropout settings with respect to printed dial markings (factory calibration) = +/- 2%.

Pickup and dropout settings, repeatability at constant temperature and constant control voltage = +/- 0.1%. (see note below)

Pickup and dropout settings, repeatability over "allowable" dc control power range: +/- 0.1%. (see note below)

Pickup and dropout settings, repeatablility over temperature range:
-20 to +55°C +/- 0.4% -20 to +70°C +/-0.7%
0 to +40°C +/- 0.2% (see note below)

Note: the three tolerances shown should be considered independent and may be cumulative. Tolerances assume pure sine wave input signal.

Time Delay: Instantaneous models: 3 cycles or less.
Definite time models: +/- 10 percent or +/-20 millisecs. whichever is greater.

Harmonic Filter: (optional) All ratings are the same except:
Pickup and dropout settings, repeatability over temperature range:
0 to +55°C +/- 0.75% -20 to +70°C +/-1.5%
+10 to +40°C +/- 0.40%

Dielectric Strength: 2000 vac, 50/60 Hz., 60 seconds, all circuits to ground.

Seismic Capability: More than 6g ZPA biaxial broadband multifrequency vibration without damage or malfunction. (ANSI C37.98-1978)

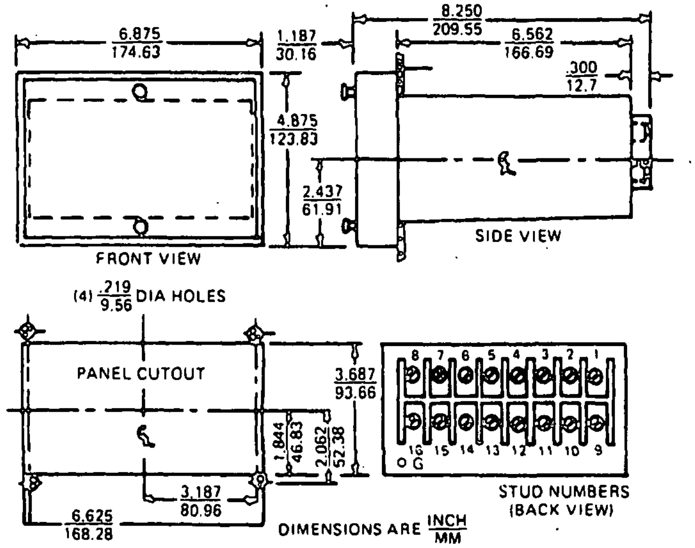


Figure 1: Relay Outline and Panel Drilling

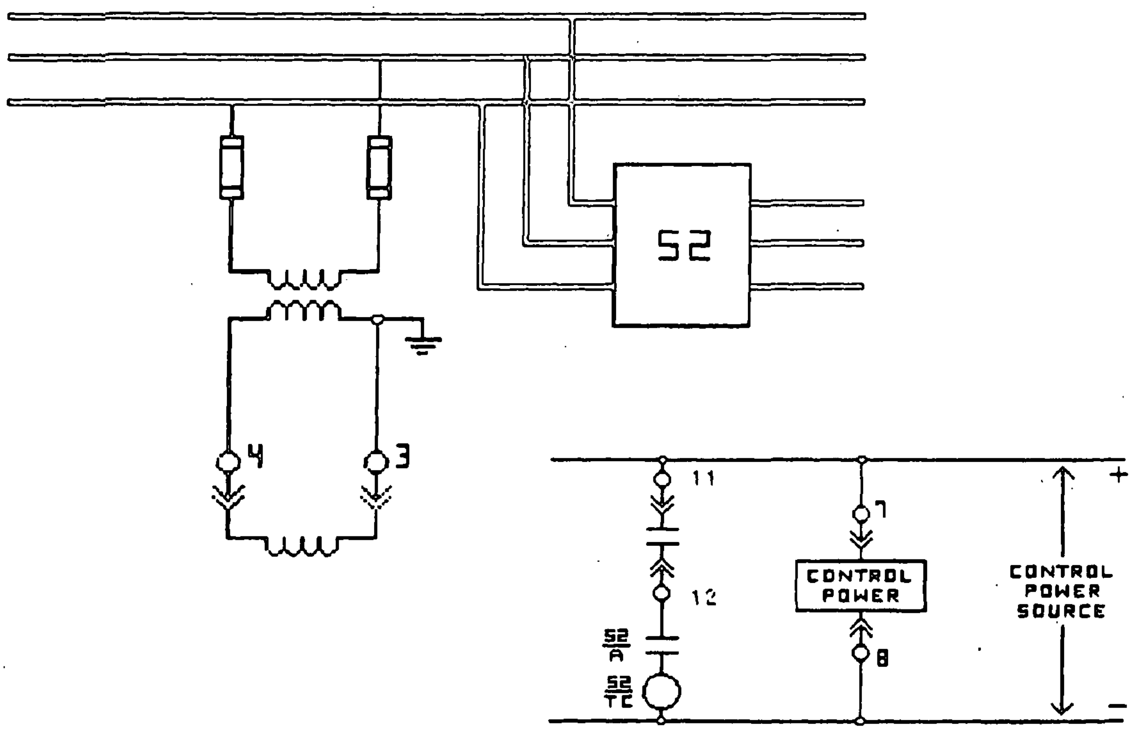
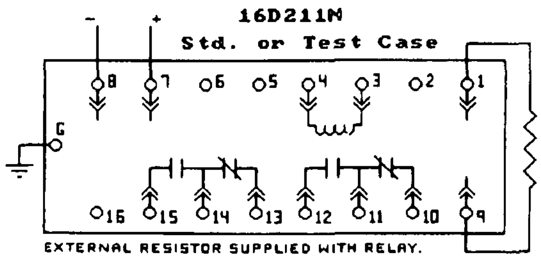


Figure 2: Typical External Connections

Figure 3: INTERNAL CONNECTION DIAGRAM AND OUTPUT CONTACT LOGIC

The following table and diagram define the output contact states under all possible conditions of the measured input voltage and the control power supply. "AS SHOWN" means that the contacts are in the state shown on the internal connection diagram for the relay being considered. "TRANSFERRED" means the contacts are in the opposite state to that shown on the internal connection diagram.

Condition	Contact State	
	Type 27N	Type 59N
Normal Control Power AC Input Voltage Below Setting	Transferred	As Shown
Normal Control Power AC Input Voltage Above Setting	As Shown	Transferred
No Control Voltage	As Shown	As Shown



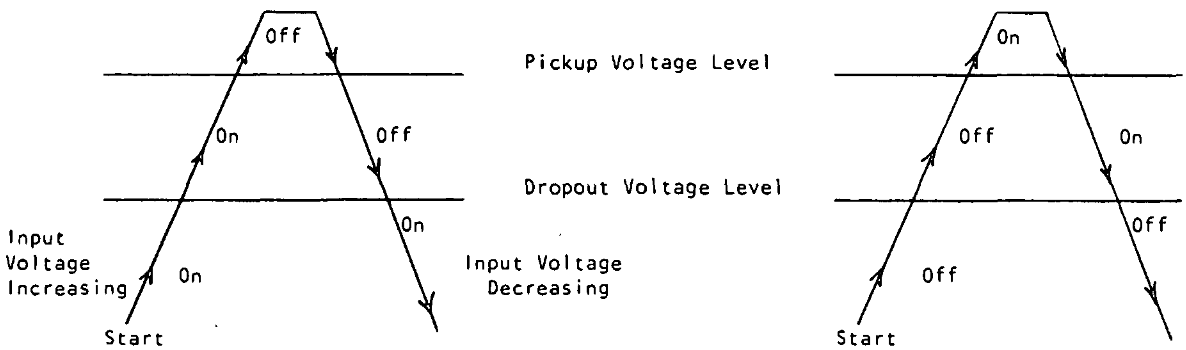
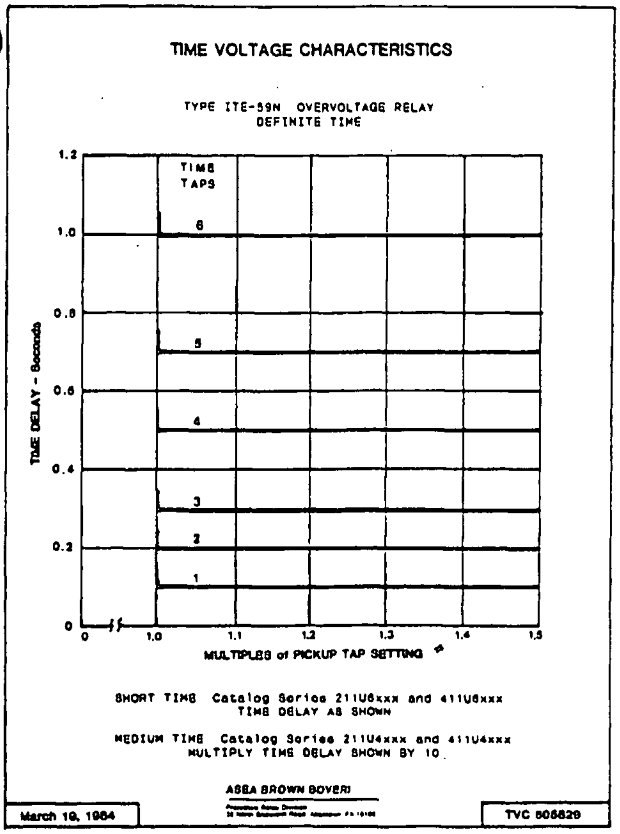
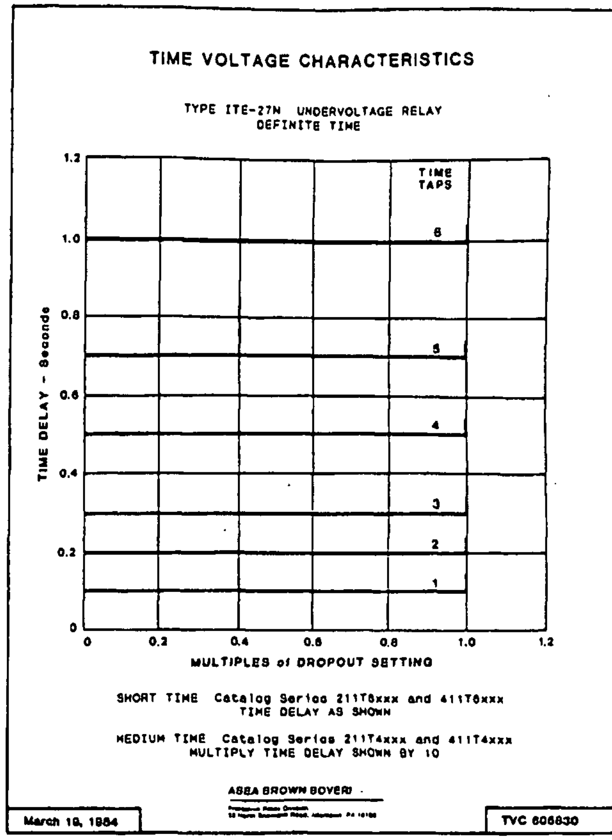


Figure 4a: ITE-27N Operation of Dropout Indicating Light

Figure 4b: ITE-59N Operation of Pickup Indicating Light

Figure 4: Operation of Pickup/Dropout Light-Emitting-Diode Indicator





* NOT TO EXCEED INPUT RATING

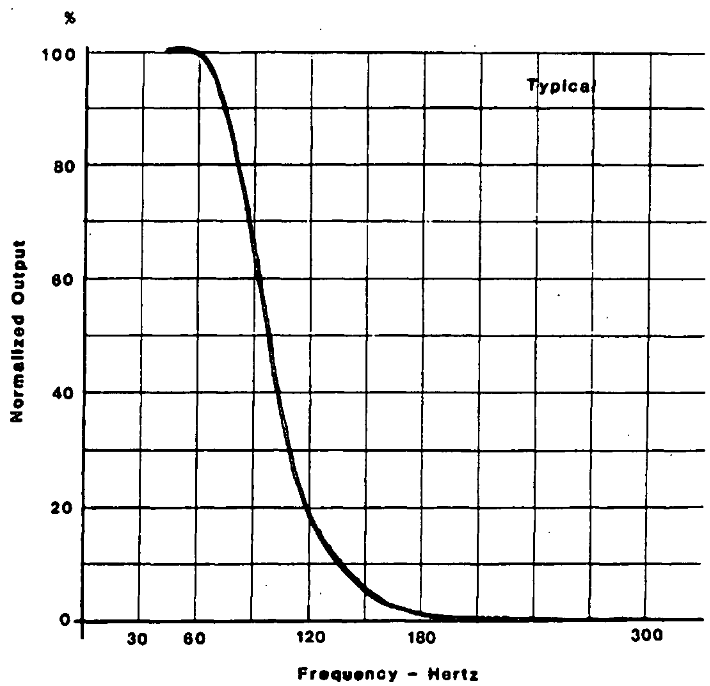


Figure 5: Normalized Frequency Response - Optional Harmonic Filter Module

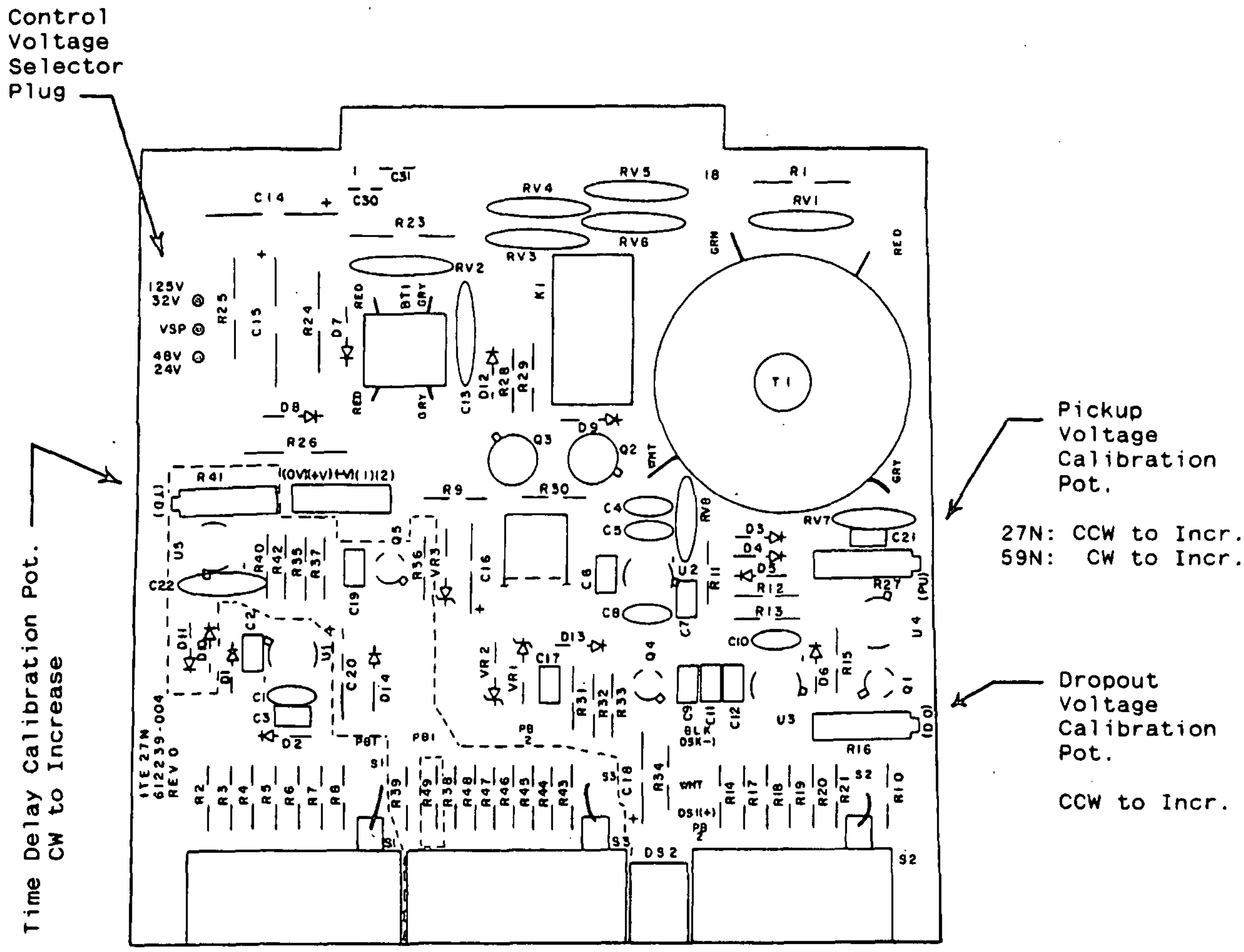


Figure 6: Typical Circuit Board Layouts, types 27N and 59N

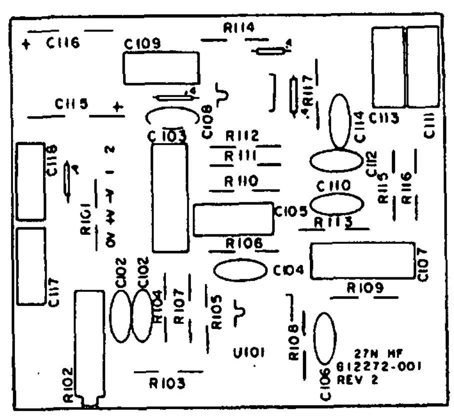


Figure 7: Typical Circuit Board Layout - Harmonic Filter Module

TESTING

1. MAINTENANCE AND RENEWAL PARTS

No routine maintenance is required on these relays. Follow test instructions to verify that the relay is in proper working order. We recommend that an inoperative relay be returned to the factory for repair; however, a circuit description booklet CD7.4.1.7-7 which includes schematic diagrams, can be provided on request. Renewal parts will be quoted by the factory on request.

211 Series Units

Drawout circuit boards of the same catalog number are interchangible. A unit is identified by the catalog number stamped on the front panel and a serial number stamped on the bottom side of the drawout circuit board.

The board is removed by using the metal pull knobs on the front panel. *Removing the board with the unit in service may cause an undesired operation.*

An 18 point extender board (cat 200X0018) is available for use in troubleshooting and calibration of the relay.

411 Series Units

Metal handles provide leverage to withdraw the relay assembly from the case. Removing the unit in an application that uses a normally closed contact will cause an operation. The assembly is identified by the catalog number stamped on the front panel and a serial number stamped on the bottom of the circuit board.

Test connections are readily made to the drawout relay unit by using standard banana plug leads at the rear vertical circuit board. This rear board is marked for easier identification of the connection points.

Important: these relays have an external resistor mounted on rear terminals 1 and 9. In order to test the drawout unit an equivilent resistor must be connected to terminals 1 & 9 on the rear vertical circuit board of the drawout unit. The resistance value must be the same as the resistor used on the relay. A 25 or 50 watt resistor will be sufficient for testing. If no resistor is available, the resistor assembly mounted on the relay case could be removed and used. ***If the resistor from the case is used, be sure to remount it on the case at the conclusion of testing.***

Test Plug:

A test plug assembly, catalog number 400X0002 is available for use with the 410 series units. This device plugs into the relay case on the switchboard and allows access to all external circuits wired to the case. See Instruction Book IB 7.7.1.7-8 for details on the use of this device.

2. HIGH POTENTIAL TESTS

High potential tests are not recommended. A hi-pot test was performed at the factory before shipping. If a control wiring insulation test is required, partially withdraw the relay unit from its case sufficient to break the rear connections before applying the test voltage.

3. BUILT-IN TEST FUNCTION

Be sure to take all necessary precautions if the tests are run with the main circuit energized.

The built-in test is provided as a convenient functional test of the relay and associated circuit. When you depress the button labelled TRIP, the measuring and timing circuits of the relay are actuated. When the relay times out, the output contacts transfer to trip the circuit breaker or other associated circuitry, and the target is displayed. The test button must be held down continuously until operation is obtained.

4. ACCEPTANCE TESTS

Follow the test procedures under paragraph 5. For definite-time units, select Time Dial #3. For the type 27N, check timing by dropping the voltage to 50% of the dropout voltage set (or to zero volts if preferred for simplification of the test). For the type 59N check timing by switching the voltage to 105% of pickup (do not exceed max. input voltage rating.) Tolerances should be within those shown on page 5. If the settings required for the particular application are known, use the procedures in paragraph 5 to make the final adjustments.

5. CALIBRATION TESTS

Test Connections and Test Sources:
Typical test circuit connections are shown in Figure 8. Connect the relay to a proper source of dc control voltage to match its nameplate rating (and internal plug setting for dual-rated units). Generally the types 27N and 59N are used in applications where high accuracy is required. The ac test source must be stable and free of harmonics. A test source with less than 0.3% harmonic distortion, such as a "line-corrector" is recommended. Do not use a voltage source that employs a ferroresonant transformer as the stabilizing and regulating device, as these usually have high harmonic content in their output. The accuracy of the voltage measuring instruments used must also be considered when calibrating these relays.

If the resolution of the ac test source adjustment means is not adequate, the arrangement using two variable transformers shown in Figure 9 to give "coarse" and "fine" adjustments is recommended.

When adjusting the ac test source do not exceed the maximum input voltage rating of the relay.

LED Indicator:
A light emitting diode is provided on the front panel for convenience in determining the pickup and dropout voltages. The action of the indicator depends on the voltage level and the direction of voltage change, and is best explained by referring to Figure 4.

The calibration potentiometers mentioned in the following procedures are of the multi-turn type for excellent resolution and ease of setting. For catalog series 211 units, the 18 point extender board provides easier access to the calibration pots. If desired, the calibration potentiometers can be resealed with a drop of nail polish at the completion of the calibration procedure.

Setting Pickup and Dropout Voltages:
Pickup may be varied between the fixed taps by adjusting the pickup calibration potentiometer R27. Pickup should be set first, with the dropout tap set at 99% (60% on "low dropout units"). Set the pickup tap to the nearest value to the desired setting. The calibration potentiometer has approximately a +/-5% range. Decrease the voltage until dropout occurs, then check pickup by increasing the voltage. Readjust and repeat until pickup occurs at precisely the desired voltage.

Potentiometer R16 is provided to adjust dropout. Set the dropout tap to the next lower tap to the desired value. Increase the input voltage to above pickup, and then lower the voltage until dropout occurs. Readjust R16 and repeat until the required setting has been made.

Setting Time Delay:
Similarly, the time delay may be adjusted higher or lower than the values shown on the time-voltage curves by means of the time delay calibration potentiometer R41. On the type 27N, time delay is initiated when the voltage drops from above the pickup value to below the dropout value. On the type 59N, timing is initiated when the voltage increases from below dropout to above the pickup value. Referring to Fig. 4, the relay is "timing out" when the led indicator is lighted.

External Resistor Values: The following resistor values may be used when testing 411 series units. Connect to rear connection points 1 & 9.

Relays rated	48/125 vdc:	5000 ohms;	(-HF models with harmonic filter 4000 ohms)
	48/110 vdc:	4000 ohms;	(-HF models with harmonic filter 3200 ohms)
	250 vdc:	10000 ohms;	(-HF models with harmonic filter 9000 ohms)
	220 vdc:	10000 ohms;	(-HF models with harmonic filter 9000 ohms)

ASEA BROWN BOVERI

ABB Power Transmission Inc.
Protective Relay Division
35 N. Snowdrift Rd.
Allentown, Pa. 18106
215-395-7333

Issue D (2/89)
Supersedes Issue C

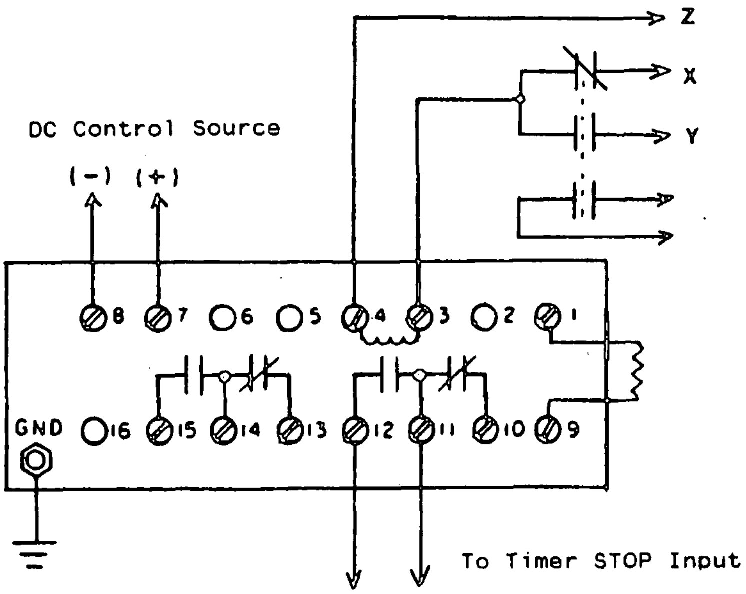


Figure 8: Typical Test Connections

T1, T2	Variable Autotransformers	(1.5 amp rating)
T3	Filament Transformer	(1 amp secondary)
V	Accurate AC Voltmeter	

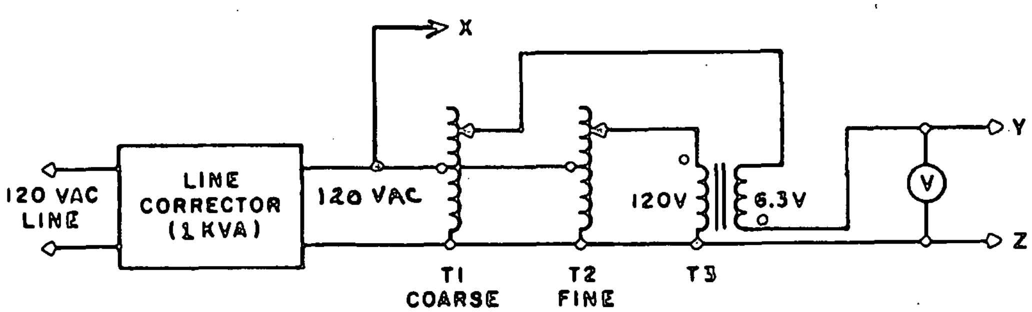


Figure 9: AC Test Source Arrangement

These instructions do not purport to cover all details or variations in equipment, nor to provide for every possible contingency to be met in conjunction with installation, operation, or maintenance. Should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to Asea Brown Boveri.

ATTACHMENT 4

Information Notice 95-05 Evaluation

ROCHESTER GAS & ELECTRIC CORPORATION

INTER-OFFICE CORRESPONDENCE

April 17, 1995

Subject: NRC Information Notice 95-05 Undervoltage Protection Relay Settings Out of Tolerance Due to Test Equipment Harmonics CATS ID# RO4747

To: Frank Puddu

Concern A involves determining if ABB model ITE type 27N or 27H relays are used at Ginna, and if applicable, consider using harmonic filters on type 27N relays.

Concern B involves including digital voltmeter test equipment in a routine calibration program to test output characteristics annually.

References Included:

- Vendor Manual VTD-I005-4004/RG&E VM# I005-0087.02 ABB Instructions IB 7.4.1.7-7 Issue D for Single Phase Voltage Relays type 27N and 59N
- PR-1.1 Protective Relay Calibration 480V Undervoltage and Ground Alarm Scheme for Buses 14, 16, 17 & 18
- PR-7 Protective Relay Calibration 4KV Bus Relaying
- DA-EE-93-006-08 Rev. 0 Design Analysis 480 Volt Undervoltage Relay settings and test Acceptance Criteria
- LTP-2000 Rev. 0 Laboratory Test Procedure for Doble F2000 Series test Instrument Calibrations
- PT-9.1.14 Undervoltage Protection - 480 Volt Safeguard Bus 14

CONCERN A:

ABB Model ITE-27 and ITE-27N relays are used at Ginna. Model ITE-27 are used in undervoltage circuits 27/14, 27/16, 27/17, 27/18, 27B/14, 27B/16, 27B/17, and 27B/18 for degraded voltage protection. Model ITE-27N relays, with the harmonic filter option, are used in "dead bus" undervoltage circuits 27D/14, 27D/16, 27D/17, 27D/18, 27DB/14, 27DB/16, 27DB/17 and 27DB/18. Model ITE-27N relays, without the harmonic filter option, are used in undervoltage circuits 27-1/12A, 27-1/12B, 27-2/12A and 27-2/12B.

The safeguards Bus Undervoltage relays on Bus 14, 16, 17, and 18 were investigated per Design Analysis DA-EE-93-006-08. The associated 27D circuit relays were replaced in 1993, with Model ITE-27N relays with the harmonic filter option. The associated PR-1.1 and PT-9.1.14, PT-9.1.16, PT-9.1.17 and PT-9.1.18 480 Volt Safeguards procedures were changed to reflect trip setpoints which accounted for expected "uncertainties" in the trip relays and associated electrical circuitry.

CONCERN B:

The relays are calibrated with Doble F2000 series test equipment. The accuracy is ± 0.125% of associated range for voltage and current, ± 0.125 degree for phase angles, ± 0.0025 Hz, for frequency and ± 0.25% total harmonic distortion at the base frequency of 60 Hz, for the standard used to calibrate the Doble. The annual calibration per procedure LTP-2000 includes current source amplitude checks to ensure maximum total harmonic distortion (THD) is less than 1%. Additionally the computerized test equipment will ABORT the test if the power source indicates faults on the incoming 60 Hz sinewave. See the attached CEO.

Results and Test also uses Doble F2000 series test equipment, which is also calibrated using LTP-2000. As described, the Doble maintains the current amplitude "clean" with an insignificant amount of THD. Installed digital volt meters provide RMS values of voltage for indicators only. Output contacts on the 27N relay are used to verify trip setpoint accurately, as opposed to "Target" or LED indicators. Concern B is adequately addressed by present testing and calibration methods.

Thank you,

Bob Popp

Bob Popp
Manager, Electrical/I&C Maintenance

Wayne J Miller

Wayne Miller
Relay & Test Foreman

Attachment
xc: Dave Alder
Gregg Joss
Bob Calus

ATTACHMENT 5

Summary of Degraded Undervoltage Relay Testing and Evaluation of Relay Response to Plant Trip Conditions

R.E. Ginna Nuclear Power Plant, LLC
July 24, 2009

Attachment XII
Summary of Degraded Undervoltage Relay Testing and Evaluation of Relay Response to Plant Trip Conditions

Relay Test Dates: 1/9/07 and 1/11/07
Relay Tested: Circuit Shield UV Relay Type 27 Cat 411R1175, ABB, SN=17582
Test Source: Pulsar (Calibrated)
Recording Equipment: Metrosonics – Not calibrated against Pulsar source
Personnel: Ted Miller, Billy Roettger, Sean O'Donnell and John Haberkorn

Purpose of Test

To determine how the 27 relay responds to an increasing voltage profile that occurs after the relay has dropped out and is in the process of timing out. This initial voltage dip followed by an increasing voltage profile reflects what is expected to occur after a Ginna trip and subsequent LTC action associated with the 767 regulator and/or the #7 transformer. The degraded undervoltage relays monitor the 480 volt safety related buses at Ginna and if the relays trip, they will isolate the safety related buses from the offsite power source and transfer all necessary loads to the emergency diesel generators.

The scope of the test also included determining if the relays trip characteristic would be affected by anticipated steady state variations in DC and/or AC voltage levels.

Once the characteristics of the relays have been determined, a mathematical model of the relay will be developed. Several voltage profiles (voltage vs. time) which are reflective of the worst case conditions associated with plant trips will be established and used as input into the relay model. The response of the relay to these profiles will then be determined.

Approach

Two relays were obtained from Nine Mile stock. The relays had a "non-safety" classification since the paper work associated with the relays had been lost. Only one of the two relays was tested. The relay was calibrated in accordance with PR-1.1. The DC control voltage was set to 134 Volts DC for all of the tests unless specifically noted otherwise. The tap setting plug was in the "100" hole for all tests.

Subsequent to relay calibration, the relay was subjected to a voltage vs. time profile (repeated 5 times). The triggering of this voltage profile was done manually so each of the tests resulted in slightly different profiles. The actual profile that the relay was subjected to was recorded with the Metrosonics. The target voltage profile that was attempted to be sent to the relay each time is tabulated below:

Voltage Profile 1 (100/0)	
Time (sec)	**Relay Volts**
11.46	94.96
3.67	95.77
3.67	96.59
3.67	97.42
3.67	98.26
3.67	99.10
3.67	99.95
3.67	100.81
3.67	101.68
3.67	102.55
3.67	103.44
3.67	104.34
3.67	105.25
3.67	106.16
3.67	107.10
3.67	108.04
3.67	108.98

The above target profile represents an approximation to the voltage profile that the relay at Bus 14 is expected to see if Ginna were to experience a LOCA event and the subsequent tripping of the Ginna generator would result in the Station 13A voltage falling to its Alarm level of 108.9 kV (power system assumed to be aligned 100/0). For the voltage profile tests, the relay was allowed to stabilize at 120 volts and then the voltage was stepped down to 94.96 volts where it remained for 11.46 seconds after which the voltage was stepped up to 95.77 volts where it remained for 3.67 seconds and so on down the table.

In addition to the above described tests, which were performed on 1/9/07, the relay was tested again on 1/11/07. The 1/11/07 tests reconfirmed the relays voltage time characteristics, exposed the relay to simple one-step voltage improvements (after an initial dip), and evaluated the impact of DC control voltage and AC source voltage variations on the relays performance.

Measured Relay Performance

Drop Out Determination

After adjusting the relay, the "drop out test" resulted in the "As-Left volts" being recorded as 105.7 Note: the intent of the adjustments was to have the value as close to the upper range (105.2 – 105.7) as possible. The drop out test is performed with the time plug in the "1" hole (time lever 1) and the tap setting plug in the "100 volt" hole.

Without making any further adjustments, subsequent drop out tests were performed with the time plug in the "6" hole (time lever 6). The results of these tests are summarized below:

Table 1 – Drop Out Test, Time lever 6, tap = 100

Initial Voltage (Vac RMS)	Final Voltage (Vac RMS)	Time Required to Trip (sec)
120	105.6	95.01
120	105.7	92.14
120	105.8	94.2
120	105.9	97.2
120	106.0	108.3
120	106.1	Did not trip (300 sec test)

It should be noted that even though the relay had been determined to have a 105.7 volt drop out characteristic, it actually would drop out at 106 volts. In order to test the repeatability of this 106.0 drop out the following tests were performed (Tap = 100, Time Lever = 6).

Table 2 - 106.0 Volt Drop Out Repeatability Test, Time Lever = 6, Tap = 100

Initial Voltage (Vac RMS)	Final Voltage (Vac RMS)	Time Required to Trip (sec)
120	106.0	100.38
120	106.0	102.16
120	106.0	100.64

In order to evaluate the impact associated with time plug position, the following tests were performed with the time plug in hole 1 (time lever 1).

Table 3 - Drop Out Test, Time Lever = 1, Tap = 100

Initial Voltage (Vac RMS)	Final Voltage (Vac RMS)	Time Required to Trip (sec)
120	106.0	91.52
120	106.1	Did not trip (300 sec test)

The operating time of the relay at 92 V and 104.2 volts was also determined as summarized in the following table:

Table 4 - Relay operating time, Time lever = 6, Tap = 100

Initial Voltage (Vac RMS)	Final Voltage (Vac RMS)	Time Required to Trip (sec)
120	92	39.94
120	104.2	72.04

Finally after the relay dropped out, the voltage was increased until the relay reset. This was repeated several times and the relay was resetting at 106.3 volts.

The following additional tests were performed on 1/11/07

Table 5 - Detailed Relay Operating Time, Time lever = 6, Tap = 100, DC = 134 Volts

Initial Voltage (Vac RMS)	Final Voltage (Vac RMS)	Time Required to Trip (sec)
120	0	13.96
120	0	13.84
120	0	13.83
120	60	22.91
120	60	22.80
120	60	22.80
120	92	39.92
120	92	39.92
120	92	39.88
120	104.2	70.19
120	104.2	70.12
120	104.2	69.52
120	105.2	78.44
120	105.2	78.54
120	105.2	78.24

The operating points shown in the above two tables (Tables 4 and 5) are plotted below in Figure 4.

Table 6 - Relay Operating Time - One Step Voltage Dip and One Voltage Rise, Time lever = 6, Tap = 100

Initial Voltage (Vac RMS)	Intermediate Voltage (Vac RMS)	Time at Intermediate Voltage (Sec)	Final Voltage (Vac RMS)	Time Required to Trip (sec)
120	0	5	60	20.91
120	60	5	92	39.15
120	92	5	104.2	71.41
120	104.2	5	105.2	82.41
120	0	10	60	17.87
120	60	10	92	36.97
120	92	10	104.2	70.41
120	104.2	10	105.2	81.98

It should be noted from the above table that increasing the initial voltage dip duration from 5 seconds to 10 seconds did not significantly reduce the relay operating time. Also if we expose the relay to an initial voltage dip to 60 volts and then after 5 seconds let the voltage recover to 92 volts, the relay operating time (39.15 seconds, Table 6) is similar to the relay operating time for the case where we just expose to relay to a voltage dip to 92 volts (39.88 seconds, Table 5). The reasons for this will be discussed in more detail in a later section.

The impact of steady state AC voltage variations are documented in the following three tables:

Table 7 - Detailed Relay Operating Time, Time lever = 6, Tap = 100, 125 V Initial Voltage

Initial Voltage (Vac RMS)	Final Voltage (Vac RMS)	Time Required to Trip (sec)
125	0	13.87
125	0	13.89
125	0	13.78
125	60	22.98
125	60	22.80
125	60	22.88
125	92	39.89
125	92	39.81
125	92	39.84
125	104.2	69.40
125	104.2	69.63
125	104.2	69.36
125	105.2	78.29
125	105.2	78.35
125	105.2	78.25

Table 8 - Detailed Relay Operating Time, Time lever = 6, Tap = 100, 115 V Initial Voltage

Initial Voltage (Vac RMS)	Final Voltage (Vac RMS)	Time Required to Trip (sec)
115	0	13.82
115	60	22.77
115	92	39.93
115	104.2	69.54
115	105.2	78.51

The following table compares relay operating times in Tables 7 and 8 with Table 5:

Table 9 - Impact of AC Variations on Relay Operating Time

	"115 V AC"	"120 V AC"	"125 V AC"		
Final Voltage (Vac RMS)	Time Required to Trip (sec)	Average Time Required to Trip (sec)	Average Time Required to Trip (sec)	Max Delta for AC variations (sec)	Max Delta at 120 VAC (sec)
0.00	13.82	13.88	13.85	0.06	0.13
60.00	22.77	22.84	22.89	0.12	0.11
92.00	39.93	39.91	39.85	0.08	0.04
104.20	69.54	69.94	69.46	0.48	0.67
105.20	78.51	78.41	78.30	0.21	0.30

The above table indicates that the relays trip characteristics are not noticeably affected by AC steady state voltage variations in the range between 115 and 125 V AC RMS. The variations in relay operating time, when the initial AC voltage is varied, are comparable to or even less than the repeatability variations when the initial pre-dip AC voltage is held constant at 120 V AC. It is also noted that the time variation associated with the dip down to 92 volts (0.08 seconds) is small in comparison to the tolerance band of 2.0 seconds given in the relay calibration procedure (PR 1-1). The 115 V – 125 V relay voltage range corresponds to a safety related bus voltage range of 460 V to 500 V AC RMS. A review of the historical voltage range of the safety related buses indicates that they almost always operate within this range.

The impact of steady state DC control voltage variations are documented in the following three tables:

Table 10 - Detailed Relay Operating Time, Time lever = 6, Tap = 100, DC = 139V (Equalization)

Initial Voltage (Vac RMS)	Final Voltage (Vac RMS)	Time Required to Trip (sec)
120	0	13.95
120	0	13.81
120	0	13.78
120	60	22.82
120	60	22.75
120	60	22.76
120	92	39.81
120	92	39.68
120	92	39.63
120	104.2	68.85
120	104.2	69.24
120	104.2	69.08
120	105.2	77.82
120	105.2	76.88
120	105.2	77.07

Table 11 - Detailed Relay Operating Time, Time lever = 6, Tap = 100, DC = 125V (Lost Battery Charger)

Initial Voltage (Vac RMS)	Final Voltage (Vac RMS)	Time Required to Trip (sec)
120	0	13.87
120	60	22.83
120	92	39.89
120	104.2	70.62
120	105.2	80.36

The following table compares relay operating times in Tables 10 and 11 with Table 5:

Table 12 - Impact of DC Variations on Relay Operating Time

	"125 V DC"	"134 V DC"	"139 V DC"		
Final Voltage (Vac RMS)	Time Required to Trip (sec)	Average Time Required to Trip (sec)	Average Time Required to Trip (sec)	Max Delta for DC variations (sec)	Max Delta at 134 VDC (sec)
0.00	13.87	13.88	13.85	0.03	0.13
60.00	22.83	22.84	22.78	0.06	0.11
92.00	39.89	39.91	39.71	0.20	0.04
104.20	70.62	69.94	69.06	1.56	0.67
105.20	80.36	78.41	77.26	3.10	0.30

The above table indicates that the relays trip characteristics are somewhat affected by DC steady state voltage variations. For severe voltage dips (down to 0, 60 or 92 V AC) the operating time is largely unaffected by DC variations however for the less severe dips, the operating time tends to increase with decreasing DC control voltage. The deviation for a voltage dip down to 92 V AC is 0.2 seconds which is still small in comparison to the tolerance band of 2.0 seconds given in the relay calibration procedure (PR 1-1).

A DC control voltage of 125 V DC corresponds to the anticipated voltage if a battery charger has tripped off-line. For this scenario, the plant goes into a 2 hour LCO so the amount of time that the plant would be potentially exposed to a slight increase in the degraded undervoltage relay operating time is quite small. While the degraded relay may take a few more seconds to operate for a dip down to 105.2 V AC, that voltage level corresponds to a bus voltage of 91.5% of 460 volts and most loads would be able to operate continuously at this voltage level. Therefore the slightly longer relay operating times associated with a DC voltage of 125V DC are expected to be inconsequential.

A DC control voltage of 139 V DC corresponds to the anticipated voltage during a battery re-equalization event. In order to minimize wear and tear on the batteries, this activity is usually only done during a refueling outage. In addition the operating margin associated with the inadvertent tripping of this relay, which is quantified in a later section of this document, is sufficient to accommodate the slight reduction in relay operating time due to a 139 V DC control voltage.

Voltage vs Time profile testing

The five different voltage profiles that the relay was exposed to (1/9/07), along with the target profile, are summarized in the following two figures:

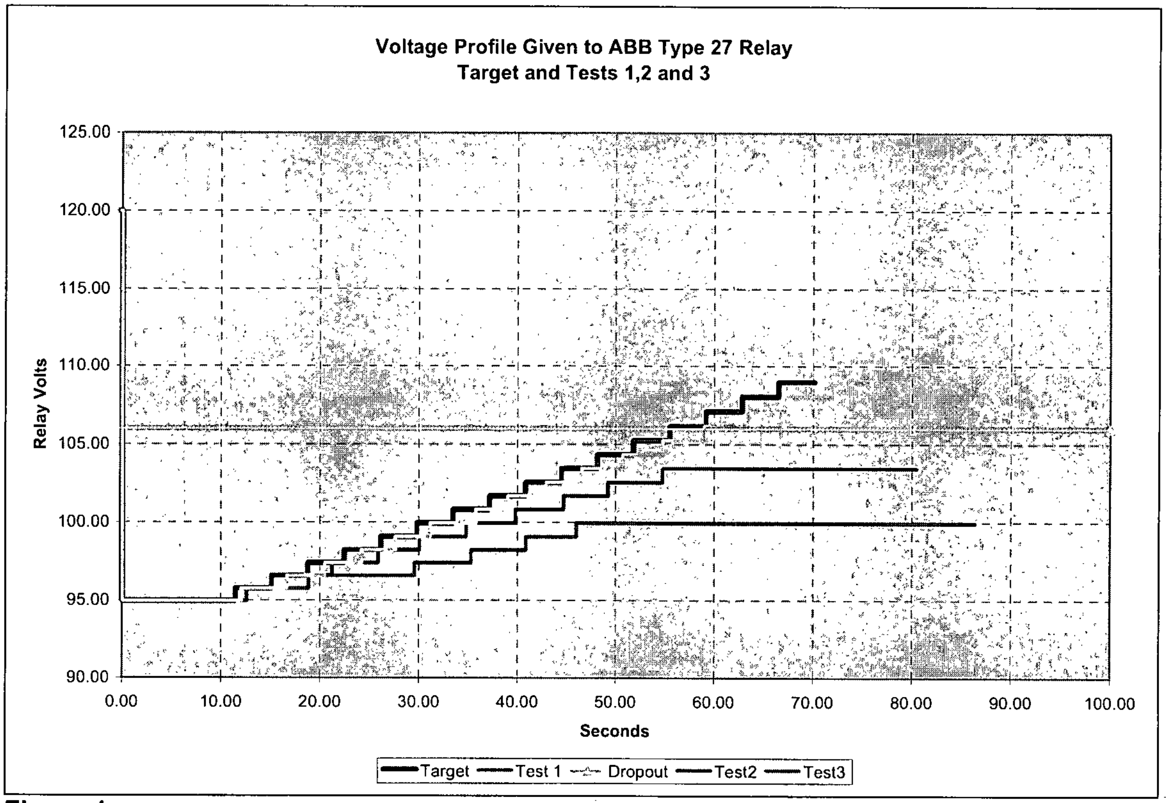


Figure 1

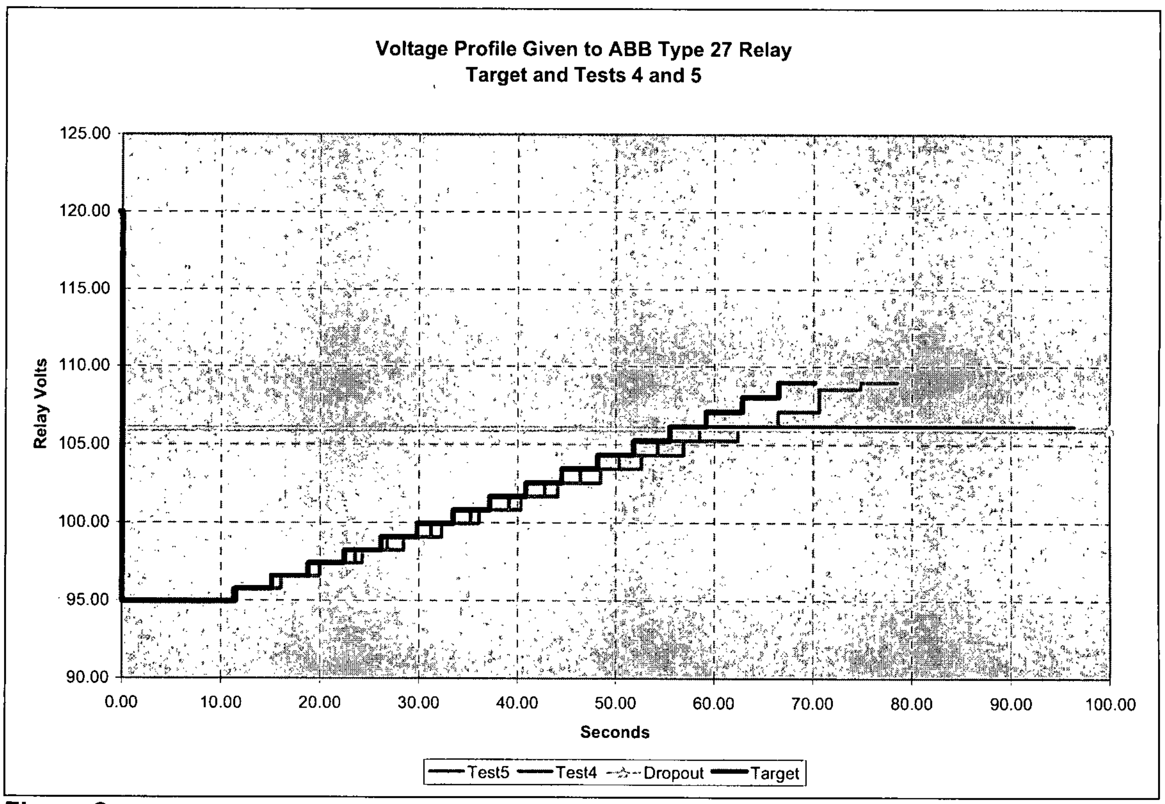


Figure 2

It should be noted that the horizontal line in the above two figures represents the relay dropout value of 106 volts. Tests 1 and 2 resulted in the relay operating while tests 3 and 4 did not result in the relay operating. For test 2, the relay tripped at time = 56.02 seconds. The trip time was not recorded for test 1 but it is thought to have tripped around 48.5 seconds. The relay tripped at 148.9 seconds for test 5.

Analysis

The relays voltage-time characteristics, as provided in a curve, were found to correlate to a mathematical equation as shown in the following figure.

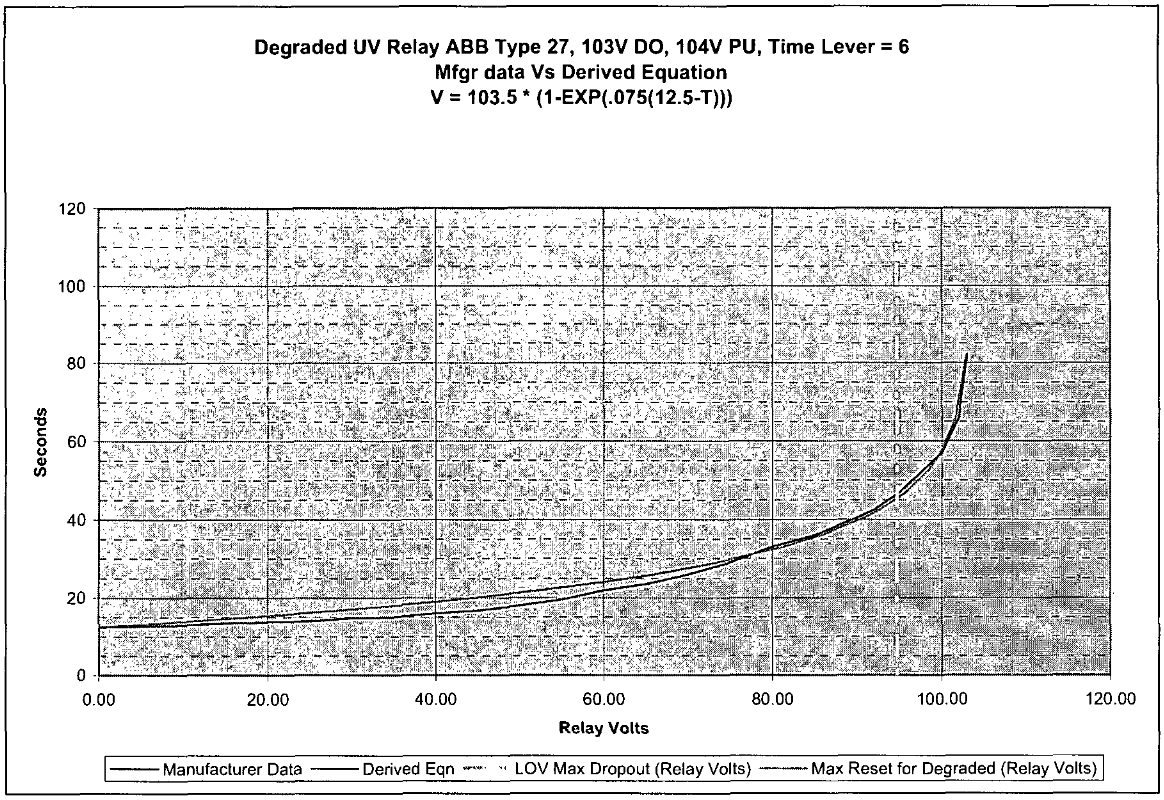


Figure 3

The most important region of the curve is that area above the loss of voltage trip setting (indicated by the maximum dropout (yellow/dashed) vertical line). The maximum dropout for the loss of voltage relay is 94.7 volts. The other vertical line shown on the above curve is the maximum reset value for the degraded undervoltage relay which is at 108.3 volts. The performance of the degraded undervoltage relay for voltages below the loss of voltage relay setting is somewhat of a moot point since the loss of voltage relay will operate.

The first coefficient (103.5) in the above equation is going to be a function of the dropout and reset values. The second and third coefficients (.075 and 12.5) are related to the time lever setting.

The relay calibration procedure determines the dropout and reset setting for the relay which allows the first coefficient to be determined. The procedure also determines two additional dropout operating points on the curve (92 volts and 104.2 volts). The coefficients of the equation were changed in order to match the characteristics of our test relay as shown in the following figure:

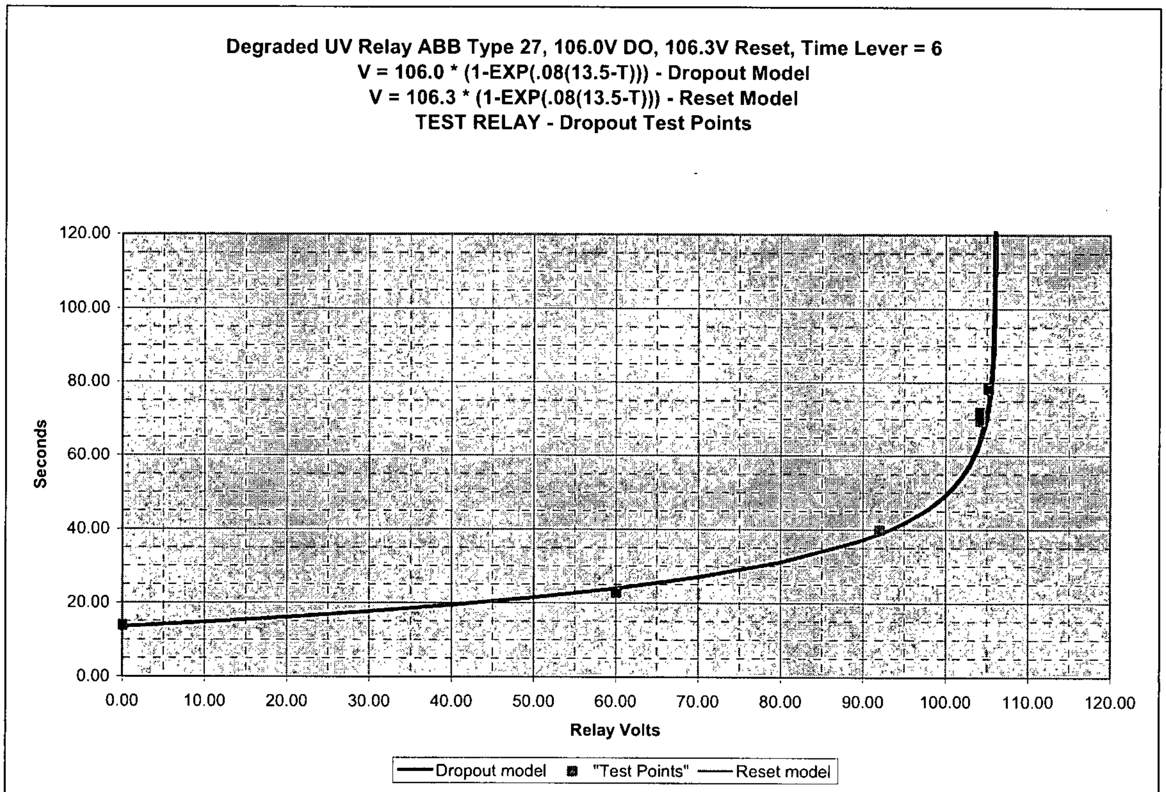


Figure 4

The above figure shows two nearly identical models, one using the dropout value of 106 volts as the first coefficient and the other using the reset value of 106.3 as the first coefficient. When matching the dropout test points, it is more appropriate to use the model based on the dropout value but when trying to determine if the relay will dropout prior to resetting, it is more appropriate (and conservative) to use the reset model.

While the above figure and associated mathematical equations describes the relay performance for a single voltage drop down to a specific value, it does not describe the performance for voltage drop followed by series of step voltage improvements. The performance of the relay to such a series will be developed in the next section.

Derivation of UV Relay Performance

The electrical circuit diagram for the relay was reviewed (Reference 1). The corresponding description for the timing circuit, shown below, was also reviewed.

> **TIMING CIRCUIT**
>
> The timing circuit is comprised of an RC network and a level detector. The time is contingent on the output voltage of U1, the values of the timing resistors (R29, R30, R31, R32, R33, R34, RT), the timing capacitors (CT1, CT2) and the voltage level at D7. D9 and D8 limits the reverse voltage across CT1 and CT2. R67, R68, R69 provide a bias level at the inverting junction of U4. The non-inverting junction of U4 senses the voltage across CT1 and CT2. R66 couples the voltage across CT1 and CT2 to U1.

Based upon the above description and the relay performance summarized in Table 6 above, the following relay timing functionality was determined:

Relay Timing Functionality

The relays time delay characteristics are controlled by an RC timing circuit. It appears that if the AC voltage falls below the dropout setting, a capacitor RC circuit is energized with a voltage source equal to the reset setting and when the capacitor voltage reaches the AC voltage level, the relay operates. The impact of an improving AC voltage level is limited to changing the threshold detection level. This means that a voltage profile consisting of 0 volts for 5 seconds followed by an improvement to 60 volts for 5 seconds is equivalent to a voltage profile of 60 volts for 10 seconds provided that 0 volts for 5 seconds is not sufficient to operate the relay.

The above relay functionality, coupled with a mathematical description of the relay voltage time characteristics allows us to predict the relays response to any voltage dip followed by a series of voltage improvement steps. The following table compares the actual results from table 6 with the mathematically predicted results.

Table 13 - Relay Operating Time - One Step Voltage Dip and One Voltage Rise, Time lever = 6, Tap = 100 (Dropout Model Used)

Initial Voltage (Vac RMS)	Intermed-iate Voltage (Vac RMS)	Time at Intermed-iate Voltage (Sec)	Final Voltage (Vac RMS)	Time Requir-ed to Trip (sec)	Trip Time predict-ed by Model (sec)	Time error (Actual – Model) (sec)
120	0	5	60	20.91	23.93	-3.02
120	60	5	92	39.15	38.80	0.35
120	92	5	104.2	71.41	64.45	6.96
120	104.2	5	105.2	82.41	74.58	7.83
120	0	10	60	17.87	23.93	-6.06
120	60	10	92	36.97	38.80	-1.83
120	92	10	104.2	70.41	64.45	5.96
120	104.2	10	105.2	81.98	74.58	7.40

In reviewing the above table it should be noted that a positive time error indicates that the dropout model is more conservative (model predicts a trip earlier than in real life). The fact that the model predicts the same operating time for both the 5 second and 10 second cases (final voltage is the same) and that the time errors for those two scenarios is very similar suggests that the basic premise of the model is correct. By changing the model coefficients, in order to better match the field results (Figure 4), it would be possible to minimize the error and/or always make the error in the conservative direction. It should also be noted that the large negative errors in the above table are associated with a very extreme voltage dip profile that is not characteristic of the type of profile that will be experienced during a Ginna Trip / Accident scenario. Those more typical types of voltage profiles are discussed next.

Further testing of the model was carried out by applying each of the actual five voltage time profiles as well as the target profile to the relay model. The corresponding performance of the relay dropout model is quantified in the following six exhibits.

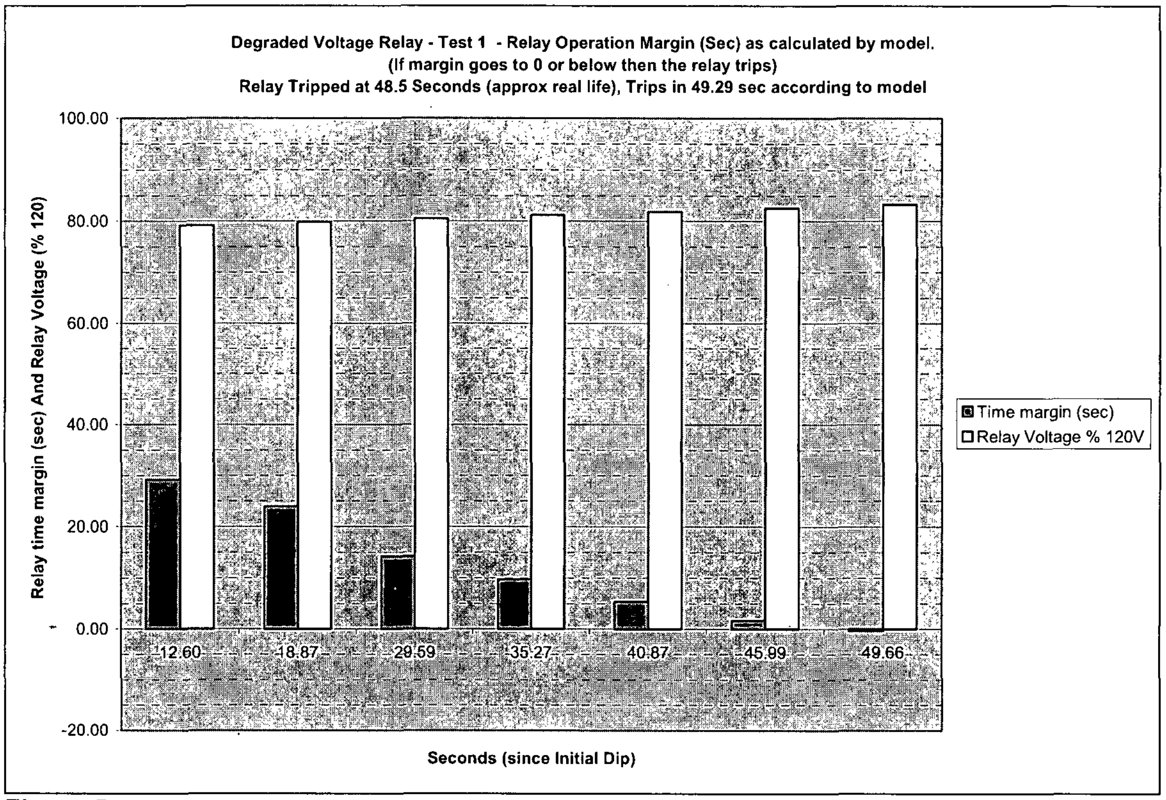


Figure 5

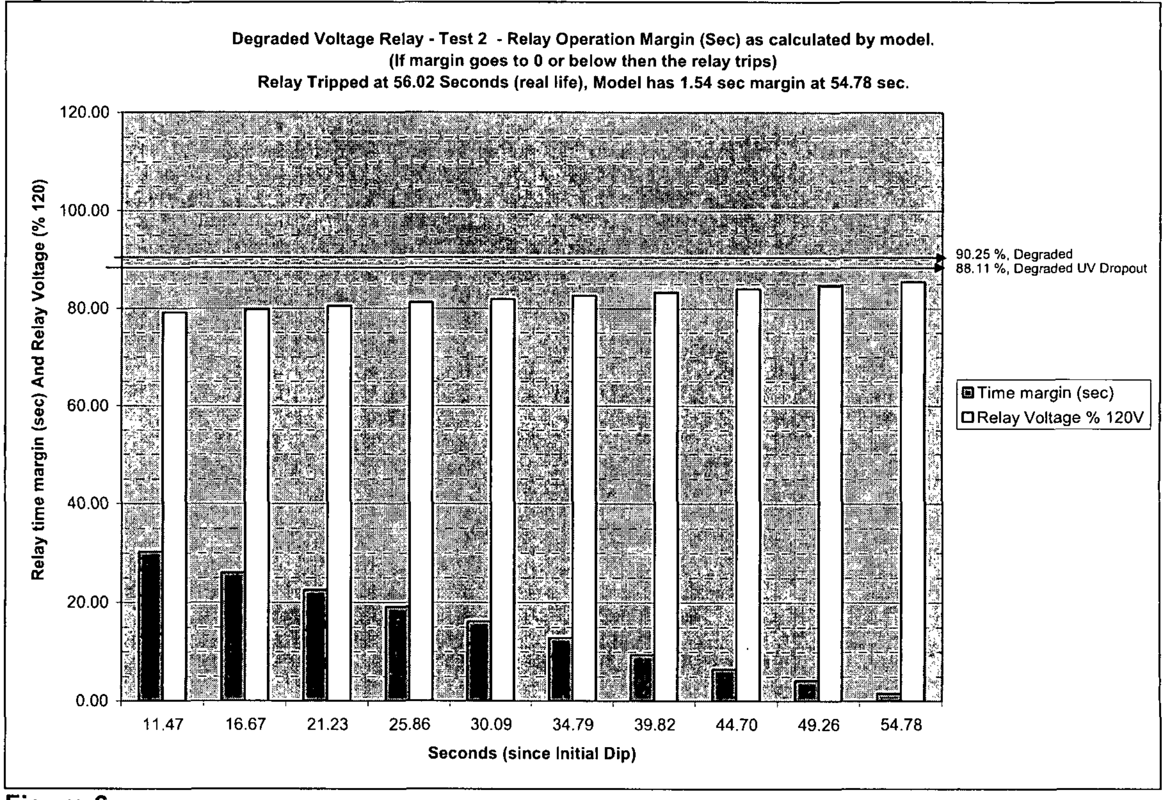


Figure 6

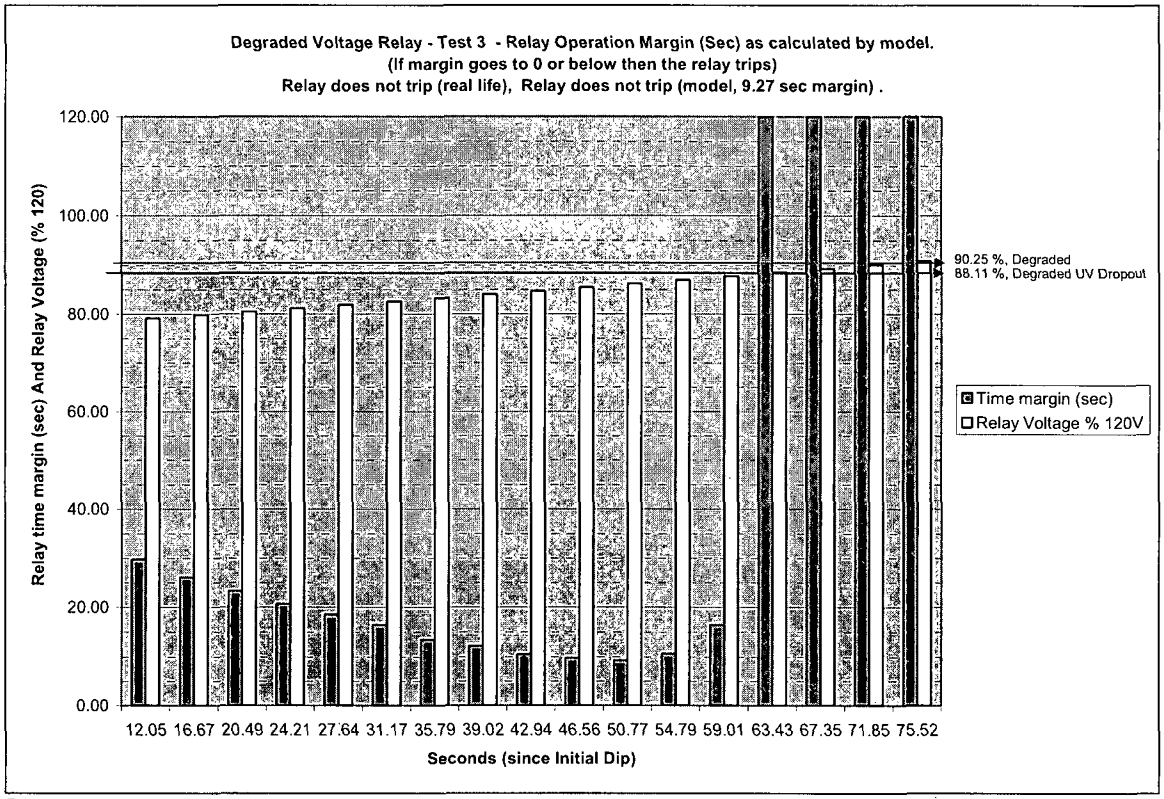


Figure 7

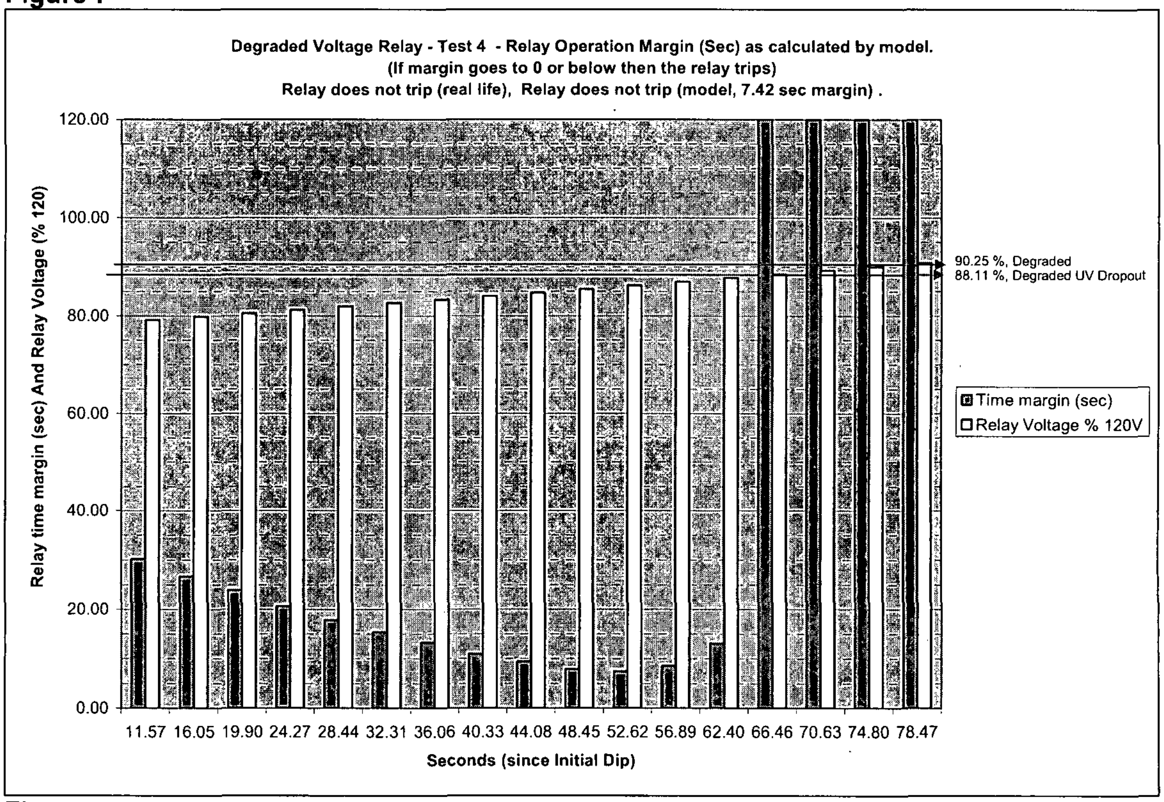


Figure 8

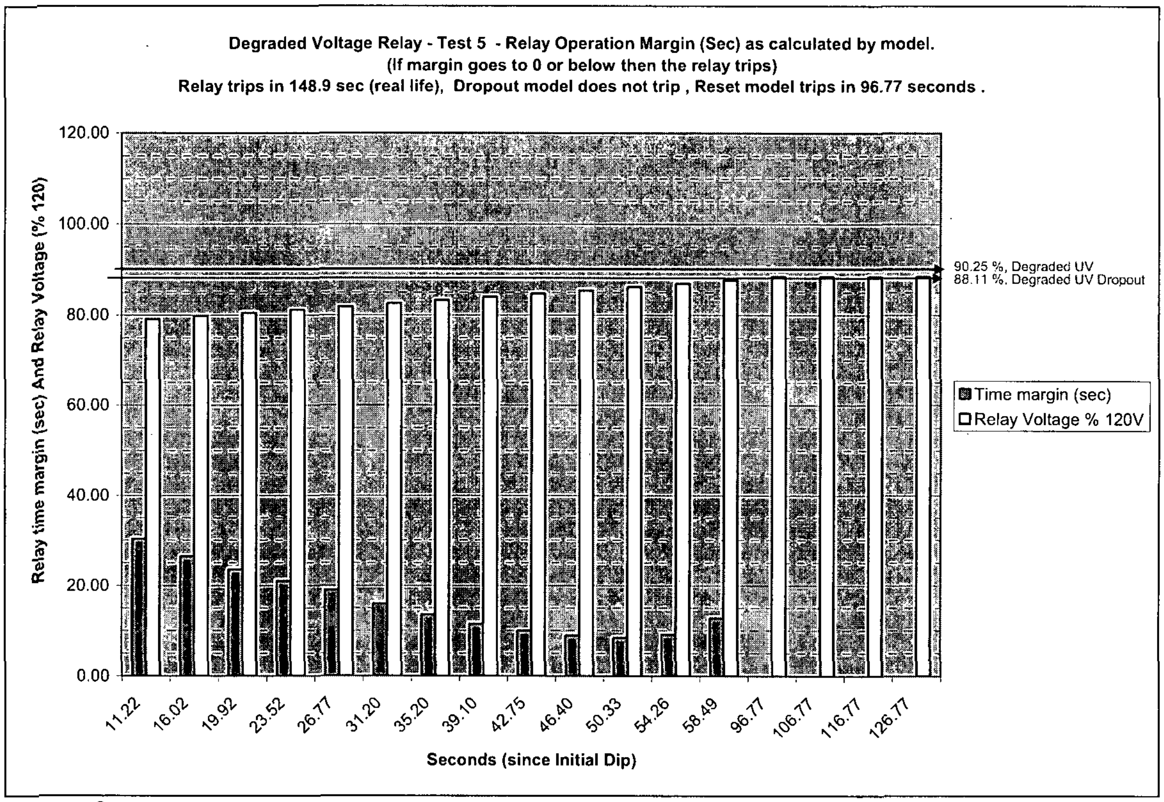


Figure 9

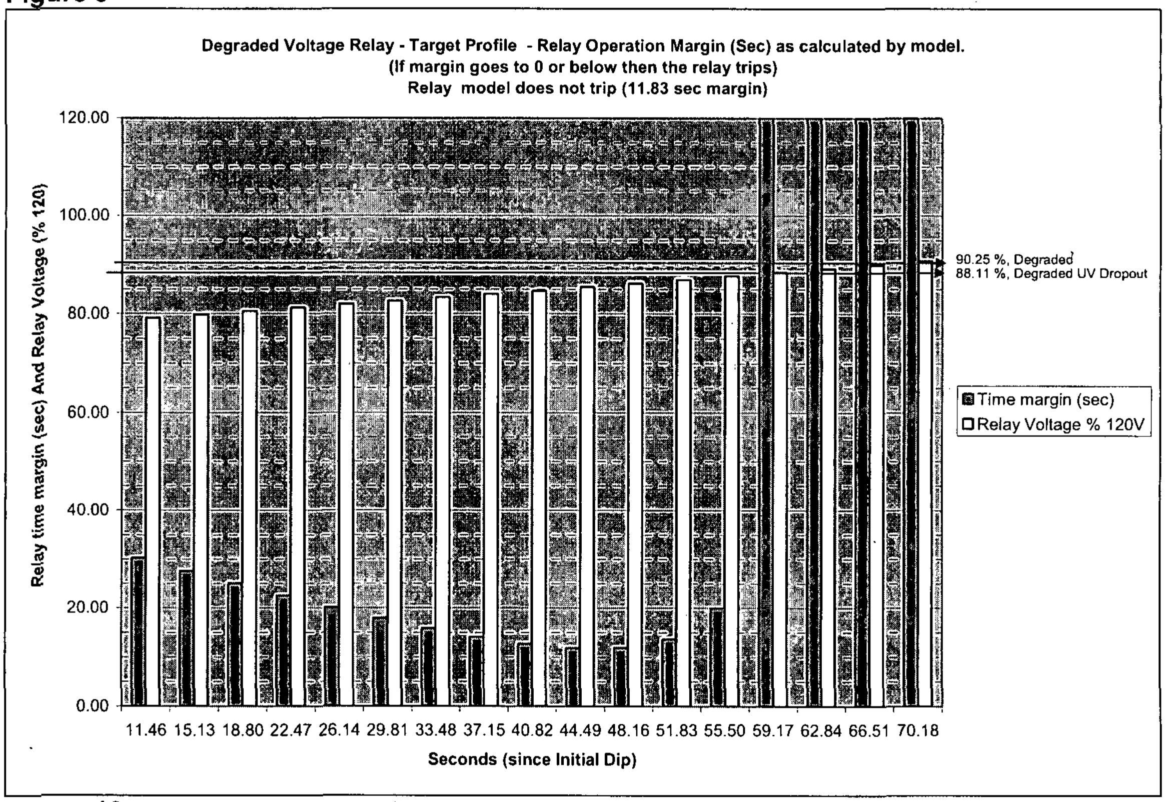


Figure 10

The results of the voltage profile tests, along with the model predicted results are summarized in the following table. In test # 1, the dropout model was a little slower to trip than the actual relay but the dropout model still predicted a trip and the time differential is related to the quality of the match shown in Figure 4.

In test # 2 the relay tripped at 56.02 seconds and the dropout model was showing a 1.54 second margin at time = 54.78 seconds. The dropout model eventually trips at time = 60.04 seconds.

Test 3 and 4 indicated consistent results between the dropout model and the actual relay however there was no way to determine if the amount of margin predicted by the dropout model was consistent with the margin in the actual relay.

Test 5 resulted in the relay tripping in 148.9 seconds. The dropout model did not trip because the final voltage was above 106 volts. The reset model did trip at 96.77 seconds.

The models response to the target profile, while not duplicated with an actual test, showed that the degraded undervoltage relay would not experience an inadvertent trip (11.83 second margin with dropout model and 10.53 second margin with the reset model)

Table 14 - Summary of Voltage Profile Tests

Test	**Actual Result**	**Predicted Result (Dropout Model)**
Test 1 – Figure 5	Trip (48.5 sec, est.)	Trip (49.29 seconds)
Test 2 – Figure 6	Trip (56.02 sec)	Trip (60.04 seconds)
Test 3 – Figure 7	No Trip	No Trip (9.27 sec margin)
Test 4 – Figure 8	No Trip	No Trip (7.42 sec margin)
Test 5 – Figure 9	Trips (148.9 sec)	Dropout model does not trip - Reset model Trips (96.77 seconds)
Target Profile for Bus 14 (LOCA, Station 13A at 108.9 kV, 100/0) – Figure 10	NA	No Trip (Dropout model has 11.83 sec margin)

Relay Reset Model (Worst Case)

The above testing suggests that the relays reset characteristics, when the relay is set on time lever 6, can be modeled mathematically with the following equation:

$$V = V_{Reset} * (1 - e^{0.08*(13.5-T)})$$

The maximum analytical limit for the reset has been determined to be 108.54 volts (DA-EE-93-006-08). The testing also suggests that the relay will not operate after it is picked up as long as the voltage recovery profile does not touch the relay reset characteristic.

Relay Response to Accident Voltage Profiles

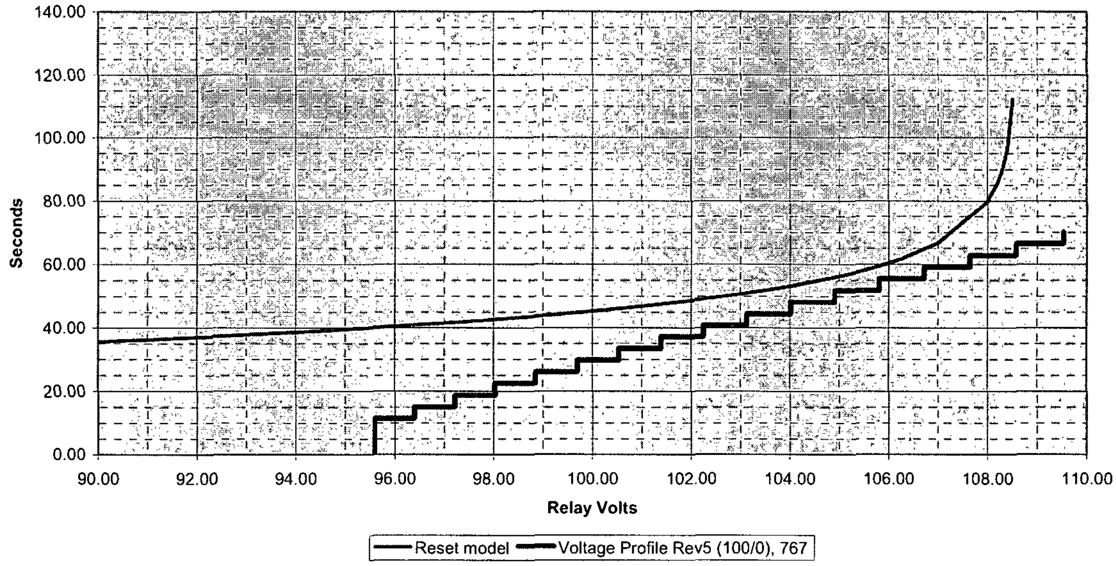
The basic relay reset model that was developed in the previous section will be exposed to voltage profiles representative of accident conditions when the Station 13A voltage is assumed to be at the offsite operability alarm level of 108.9 kV. The following two profiles represent anticipated conditions for the 100/0 and 0/100 alignment configurations.

Voltage Profile Rev5 (100/0), 767		
Time (sec)	**Relay Volts (% 120V)**	**Relay Volts**
11.46	79.66	95.59
3.67	80.33	96.40
3.67	81.01	97.21
3.67	81.69	98.03
3.67	82.38	98.86
3.67	83.08	99.70
3.67	83.78	100.54
3.67	84.49	101.39
3.67	85.21	102.25
3.67	85.94	103.13
3.67	86.68	104.02
3.67	87.42	104.90
3.67	88.17	105.80
3.67	88.93	106.72
3.67	89.7	107.64
3.67	90.48	108.58
3.67	91.27	109.52

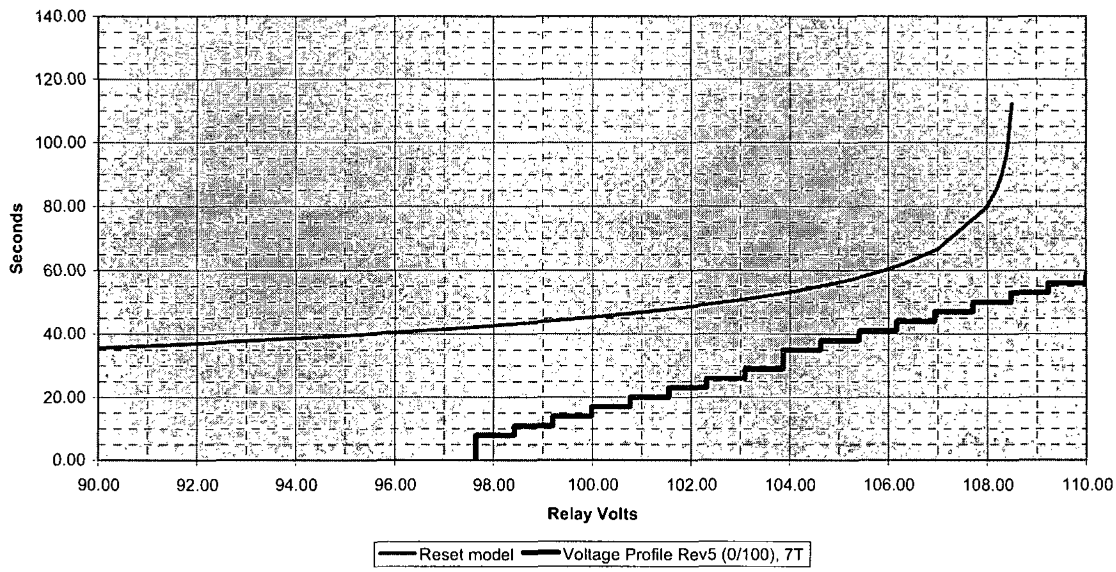
Voltage Profile 2 Rev 5 (0/100), 7T		
Time (sec)	**Relay Volts (% 120)**	**Relay Volts**
8.00	81.37	97.64
3.00	82.02	98.42
3.00	82.67	99.20
3.00	83.32	99.98
3.00	83.97	100.76
3.00	84.62	101.54
3.00	85.26	102.31
3.00	85.91	103.09
6.00	86.55	103.86
3.00	87.19	104.63
3.00	87.84	105.41
3.00	88.47	106.16
3.00	89.11	106.93
3.00	89.75	107.70
3.00	90.39	108.47
3.00	91.02	109.22
3.00	91.66	109.99
3.00	92.29	110.75
3.00	92.93	111.52

The following two figures depict the margin between the degraded undervoltage characteristics and the anticipated voltage profiles.

Case 116L Voltage Profile Vs Relay Reset Characteristics (100/0)
Degraded UV Relay ABB Type 27, Reset = 108.54 Volts Time Lever = 6
V = 108.54 * (1-EXP(.08(13.5-T)))



Case 117L Voltage Profile Vs Relay Reset Characteristics (0/100)
Degraded UV Relay ABB Type 27, Reset = 108.54 Volts Time Lever = 6
V = 108.54 * (1-EXP(.08(13.5-T)))



Conclusions

1. An ABB type 27 relay that was calibrated in accordance with established procedures was determined to have a drop out setting of 105.7 volts however it was found to actually drop out at 106.0 volts after being exposed to 106.0 volts for 108.3 seconds (time lever 6). It did not drop out when exposed to 106.1 volts for 300 seconds.

2. The ABB type 27 relay's voltage time characteristic can accurately be described by an exponential equation whose coefficients are a function of the drop-out and reset setting as well as the time lever setting.

3. The relays voltage-time characteristic appear to be largely independent of AC voltage variations over the voltage range of 115 V AC to 125V AC

4. The relays voltage-time characteristic appear to be slightly affected by DC voltage variations over the voltage range of 125 V DC to 139V DC, however these slight deviations have been determined to be inconsequential.

5. The relays time delay characteristics are controlled by an RC timing circuit. It appears that if the AC voltage falls below the dropout setting, a capacitor RC circuit is energized with a voltage source equal to the reset setting and when the capacitor voltage reaches the relays AC voltage level, the relay operates. The impact of an improving AC voltage level appears to be limited to changing the threshold detection level. This means that a voltage profile consisting of 0 volts for 5 seconds followed by an improvement to 60 volts for 5 seconds is equivalent to a voltage profile of 60 volts for 10 seconds provided that 0 volts for 5 seconds is not sufficient to operate the relay.

6. The relays response to an initial voltage dip followed by an improving voltage profile can be predicted by comparing the total elapsed time since the initial voltage dip to the relay operating time associated with each voltage level in the voltage profile.

7. The worst case voltage profile associated with a LOCA event, assuming Station 13A is at 108.9kV (alarm setpoint) and the system is aligned 100/0 will not result in an inadvertent trip of the degraded undervoltage relays.

References

1. Circuit Description ITE-27 Undervoltage Relay – Microfilm record 01248.1692, RG&E VM# 1005-0087.01, VTD-I005-4002, BBC

ATTACHMENT 6

Diesel Loading Simulation Results

7.5.1 Case DGA_FU1

7.5.1.1 Simulation Description

This case quantifies the "A" diesel generator loading sequence during the "Injection phase" for the case where the Containment Spray pump does not come on. The timing sequence will be set up to simulate a LOOP after a LOCA. The purpose of this simulation is to identify a baseline case that will be used as the basis for establishing worst case simulations.

Upon SI all of the safeguard loads would be sequenced onto the buses (offsite power available) and start the EDG. A LOOP after LOCA event would result in all loads being tripped with the exception of the MCC's. Then after approximately a 1.3 second time delay the EDG breakers would close and the loads would be resequenced on. A key point associated with this simulation is that the EDG has achieved a steady state condition (ie. V= 1.0 pu) prior to the first load being applied. A simultaneous LOOP LOCA simulation would typically have a less severe initial voltage dip since the first loads are applied prior to the EDG settling out to 1.0 per unit. Field results for a simultaneous LOOP LOCA indicate the EDG initially overshoots and is above 1.1 per unit when the EDG breaker is closed (ie MCC load connected). The simultaneous LOOP LOCA simulation is covered later in this report (case DGA_FU6).

7.5.1.2 Simulation Timer Settings

At time = 0.1 second corresponds to the point in time when the Diesel Generator Breaker closes and is therefore connected to MCC C. The MCC breaker is not tripped by the undervoltage relays (LOOP condition). The breaker associated with SI1A closes at time = 0.35 seconds. This 0.25 second delay after the closing of the diesel generator breaker is due to the time delays associated with the resetting of the undervoltage relays and breaker closing and was measured during testing. All of the Agastat timers were assumed to be at their nominal setting. The complete load sequencing for this simulation is as follows:

Time(sec)	Breaker Closes
0.100	Diesel Generator (both bus 14 and 18)
0.350	SI 1A
3.850	SI 1C
8.850	RHR 1A
13.850	SW 1A
18.850	CF 1A
23.850	CF 1D
28.850	AFWP 1A

The computer simulation is not an exact representation of the stated scenario because the transients and effects associated with the loads being first sequenced on to the offsite source have been ignored. Ignoring these transients is conservative because many of the valves would have operated to their required state and therefore the MCC load would be less than what was modeled. Ignoring this effect is not considered overly conservative because the voltage dip associated with the MCC loads is not that significant in either magnitude or duration when compared to the motor loads. In addition, the SI1A may still be spinning at about 45% (See attachment A) of rated speed when it is resequenced. While this won't change the magnitude of the initial voltage dip, it should shorten the duration of the dip.

The SI1A motor may have a small amount of residual voltage left when it is reconnected. This residual voltage could cause the voltage dip to be slightly better or worse depending on the exact instant of closure. This effect is considered small since the SI1A motor has an open circuit time constant of about 1.4 second, ref. 4.4.15, and the "dead time" is expected to approach 1.7 seconds (1.3 second timer delay, .25 second delay indicated above and .15 second delay for D/G breaker closing and associated relay operation).

7.5.1.3 Simulation Results

The complete set of input data for this simulation is contained in Attachment J1 along with the initial (time = 0-) load flow solution. The dynamics of the system as it goes from the initial load flow solution to the final load flow solution is summarized in Figures 1 - 3 of Attachment J1. The minimum voltage was 83.97% and the minimum frequency was 58.98 Hz. Both of these are well above the 75% and 57 Hz criteria. Figure 2 is a plot of the generator power (internal losses included) as a function of time. The peak power capability (2.3 MW) of the engine is above the peak value (2.02 MW) obtained in this simulation. It is evident from each of the figures that all motors successfully accelerate.

The results of this simulation can be used to help determine the worst point in time for the Containment Spray to come on. This "worst case time" scenario will then be incorporated into the DGA_FU3 simulation.

7.5.2 Case DGA_FU2

7.5.2.1 Simulation Description

This case is a repeat of DGA_FU1 with the single exception that the Containment Spray pump comes on with MCC C. This is the most likely time for Spray to come on since the scenario assumes the accident has been in progress for over 1 minute. The Containment Spray breaker will not be tripped by a LOOP condition and therefore the MCC and Spray will come on simultaneously once the EDG breaker closes.

7.5.2.2 Simulation Timer Settings

Time(sec)	Breaker Closes
0.100	Diesel Generator and CS1A
0.350	SI 1A
3.850	SI 1C
8.850	RHR 1A
13.850	SW 1A
18.850	CF 1A
23.850	CF 1D
28.850	AFWP 1A

7.5.2.3 Simulation Results

The complete set of input data for this simulation is contained in Attachment J2 along with the initial (time = 0 -) load flow solution. The dynamics of the system as it goes from the initial load flow solution to the final load flow solution is summarized in Figures 1 - 3 of Attachment J2. The minimum voltage was 80.36% and the minimum frequency was 58.91 Hz. Both of these are well above the 75% and 57 Hz criteria. Figure 2 is a plot of the generator power (internal losses included) as a function of time. The peak power capability (2.3 MW) of the engine is above the peak value (2.2 MW) obtained in this simulation. The final steady state load out of the EDG for this simulation is 2.0 MW which is in close agreement with the steady state analysis (Reference 4.3.2). It is evident from each of the above figures that all motors successfully accelerate.

7.5.3 Case DGA_FU3

7.5.3.1 Simulation Description

This case is a repeat of DGA_FU1 with the Containment Spray pump coming on with SW1A. This was determined to be the worst possible time for this random load to come on since this is when the voltage is at a minimum (See Figure 1 of Attachment J1).

7.5.3.2 Simulation Timer Settings

Time(sec)	Breaker Closes
0.100	Diesel Generator (both bus 14 and 18)
0.350	SI 1A
3.850	SI 1C
8.850	RHR 1A
13.850	SW 1A and CS1A
18.850	CF 1A
23.850	CF 1D
28.850	AFWP 1A

7.5.3.3 Simulation Results

The complete set of input data for this simulation is contained in Attachment J3 along with the initial (time = 0 -) load flow solution. The dynamics of the system as it goes from the initial load flow solution to the final load flow solution is summarized in Figures 1 - 3 of Attachment J3.

The minimum voltage was 75.79% and the minimum frequency was 58.1 Hz. Both of these are well above the 75% and 57 Hz criteria. Figure 2 is a plot of the generator power (internal losses included) as a function of time. The peak power capability (2.3 MW) of the engine is above the peak value (2.2 MW) obtained in this simulation. The final steady state load out of the EDG for this simulation is 2.0 MW which is in close agreement with the steady state analysis (Reference 4.3.2). It is evident from each of the above figures that all motors successfully accelerate.

7.5.1 Case DGB_FU1

7.5.1.1 Simulation Description

This case quantifies the "B" diesel generator loading sequence during the "Injection phase" for the case where the Containment Spray pump does not come on. The timing sequence will be set up to simulate a LOOP after a LOCA. The purpose of this simulation is to identify a baseline case that will be used as the basis for establishing worst case simulations.

Upon SI all of the safeguard loads would be sequenced onto the buses (offsite power available) and start the EDG. A LOOP after LOCA event would result in all loads being tripped with the exception of the MCC's. Then after approximately a 1.3 second time delay the EDG breakers would close and the loads would be resequenced on. A key point associated with this simulation is that the EDG has achieved a steady state condition (ie. V= 1.0 pu) prior to the first load being applied. A simultaneous LOOP LOCA simulation would typically have a less severe initial voltage dip since the first loads are applied prior to the EDG settling out to 1.0 per unit. Field results for a simultaneous LOOP LOCA indicate the EDG initially overshoots and is above 1.1 per unit when the EDG breaker is closed (ie MCC load connected). The simultaneous LOOP LOCA simulation is covered later in this report (case DGB_FU6).

7.5.1.2 Simulation Timer Settings

At time = 0.1 second corresponds to the point in time when the Diesel Generator Breaker closes and is therefore connected to MCC D. The MCC breaker is not tripped by the under voltage relays (LOOP condition). The breaker associated with SI1B closes at time = 0.35 seconds. This 0.25 second delay after the closing of the diesel generator breaker is due to the time delays associated with the resetting of the under voltage relays and breaker closing and was measured during testing. All of the agastat timers were assumed to be at their nominal setting. The complete load sequencing for this simulation is as follows:

Time(sec)	Breaker Closes
0.100	Diesel Generator (both Bus 16 and 17)
0.350	SI 1B
5.850	SI 1C
10.850	RHR 1B
15.850	SW 1D
20.850	CF 1B
25.850	CF 1C
30.850	AFWP 1B

The computer simulation is not an exact representation of the stated scenario because the transients and effects associated with the loads being first sequenced on to the offsite source have been ignored. Ignoring these transients is conservative because many of the valves would have operated to their required state and therefore the MCC load would be less than what was modeled. Ignoring this effect is not considered overly conservative because the voltage dip associated with the MCC loads is not that significant in either magnitude or duration when compared to the motor loads. In addition, the SI1B may still be spinning at about 45% (See attachment A) of rated speed when it is resequenced. While this won't change the magnitude of the initial voltage dip, it should shorten the duration of the dip.

The SI1B motor may have a small amount of residual voltage left when it is reconnected. This residual voltage could cause the voltage dip to be slightly better or worse depending on the exact instant of closure. This effect is considered small since the SI1B motor has an open circuit time constant of about 1.4 second, ref. 4.4.15, and the "dead time" is expected to approach 1.7 seconds (1.3 second timer delay, .25 second delay indicated above and .15 second delay for D/G breaker closing and associated relay operation).

7.5.1.3 Simulation Results

The complete set of input data for this simulation is contained in Attachment J1 along with the initial (time = 0 -) load flow solution. The dynamics of the system as it goes from the initial load flow solution to the final load flow solution is summarized in Figures 1 - 3 of Attachment J1. The minimum voltage was 81.12% and the minimum frequency was 58.80 Hz. Both of these are well above the 75% and 57 Hz criteria. Figure 2 is a plot of the generator power (internal losses included) as a function of time. The peak power capability (2.3 MW) of the engine is above the peak value (2.06 MW) obtained in this simulation. It is evident from each of the figures that all motors successfully accelerate.

The results of this simulation can be used to help determine the worst point in time for the Containment Spray to come on. This "worst case time" scenario will then be incorporated into the DGB_FU3 simulation.

7.5.2 Case DGB_FU2

7.5.2.1 Simulation Description

This case is a repeat of DGB_FU1 with the single exception that the Containment Spray pump comes on with MCC D. This is the most likely time for Spray to come on since the scenario assumes the accident has been in progress for over 1 minute. The Containment Spray breaker will not be tripped by a LOOP condition and therefore the MCC and Spray will come on simultaneously once the EDG breaker closes.

7.5.2.2 Simulation Timer Settings

Time(sec)	Breaker Closes
0.100	Diesel Generator and Containment Spray
0.350	SI 1B
5.850	SI 1C
10.850	RHR 1B
15.850	SW 1D
20.850	CF 1B
25.850	CF 1C
30.850	AFWP 1B

7.5.2.3 Simulation Results

The complete set of input data for this simulation is contained in Attachment J2 along with the initial (time = 0 -) load flow solution. The dynamics of the system as it goes from the initial load flow solution to the final load flow solution is summarized in Figures 1 - 3 of Attachment J2. The minimum voltage was 76.2% and the minimum frequency was 58.75 Hz. Both of these are above the 75% and 57 Hz criteria. Figure 2 is a plot of the generator power (internal losses included) as a function of time. The peak power capability (2.3 MW) of the engine is above the peak value (2.25 MW) obtained in this simulation. The final steady state load out of the EDG for this simulation is about 2.0 MW which is in close agreement with the steady state analysis (Reference 4.3.2). It is evident from each of the above figures that all motors successfully accelerate.

7.5.3 Case DGB_FU3

7.5.3.1 Simulation Description

This case is a repeat of DGB_FU1 with the Containment Spray pump coming on with SI1C. This was determined to be the worst possible time for this random load to come on since this is when the voltage is at a minimum (See Figure 1 of Attachment J1).

7.5.3.2 Simulation Timer Settings

Time(sec)	Breaker Closes
0.100	Diesel Generator (both Bus 16 and 17)
0.350	SI 1B
5.850	SI 1C and Containment Spray
10.850	RHR 1B
15.850	SW 1D
20.850	CF 1B
25.850	CF 1C
30.850	AFWP 1B

7.5.3.3 Simulation Results

The complete set of input data for this simulation is contained in Attachment J3 along with the initial (time = 0 -) load flow solution. The dynamics of the system as it goes from the initial load flow solution to the final load flow solution is summarized in Figures 1 - 3 of Attachment J3.

The minimum voltage was 72.52% and the minimum frequency was 58.61 Hz. The slight violation of the 75% voltage criteria is considered acceptable since the voltage recovers above 90% within 1.1 second. Figure 2 is a plot of the generator power (internal losses included) as a function of time. The peak power capability (2.3 MW) of the engine is above the peak value (2.25 MW) obtained in this simulation. The final steady state load out of the EDG for this simulation is about 2.0 MW which is in close agreement with the steady state analysis (Reference 4.3.2). It is evident from each of the above figures that all motors successfully accelerate.