Advisory Memorandum

To: Current and Former SQUG Member Representatives and Alternates

From: John Richards, Chairman
SQUG/SEQUAL Steering Group

Date: September 7, 2004

Subject: SQUG Advisory 2004-02: Relay GERS Corrections

Dear SQUG Member Representatives and Alternates,

The Seismic Qualification Utility Group (SQUG) is issuing an advisory to alert current and former SQUG member utilities of errors in relay GERS reports. This is a follow-up to the 2004-01 Advisory which identified a typographical error in the GERS level provided in EPRI NP-7147, Volume 2: Addendum 2, April 1995 for the General Electric (GE) IAC66K relay. While SQUG does not have 10 CFR Part 21 reporting obligations, the Steering Group believes that it is appropriate that we notify utilities of these errors so that they can perform the proper reviews. In addition, we provided a copy of Advisory 2004-01 to the NRC and we will also provide a copy of Advisory 2004-02 to the NRC.

SQUG Advisory 2004-01 in May 2004 identified a typographical error in the GERS published for the General Electric IAC66K relay. The GERS level for the "operate" and "non-operate" conditions for a relay subcomponent were interchanged. The discovery of this error initiated a review of all published relay GERS levels, which resulted in the identification of additional errors. Most of the identified errors are slight changes in GERS levels or clarifications of model number and nomenclature. Only one additional case was found where the "operate" and "non-operate" ruggedness levels were interchanged.

We believe that the most efficient process for determining if this Advisory impacts your USI A-46 resolution is outlined below. If at any point in the review you determine that the Advisory does not apply to your USI A-46 resolution, you do not need to proceed through the remaining steps.

1. Review your USI A-46 Summary report to determine the date of your reviews. Most of the reported errors are in the last two GERS reports in 1996 and 1999. If your reviews were completed prior to 1996, then most of these errors should not impact your evaluations.
2. Review your Essential Relay List to determine if you have the applicable relays. If you don't have the applicable relays then this Advisory should not impact your evaluations.

3. Review your evaluations of the applicable relays included on your Essential Relay List to determine if you screened them by seismic capacity using the incorrect GERS capacities. If you did not screen them by capacity using the incorrect GERS capacities, then this Advisory should not impact your evaluations.
4. Review the relay adequacy using any of the methods described in Section 6 of the GIP.
5. If you determine that a relay is an outlier, then you should treat it as you would other outliers identified during your USI A-46 evaluation.

This completes our comprehensive review of the Relay GERS and we do not anticipate any additional Advisories related to relay GERS. EPRI will issue errata sheets as necessary to correct the relay GERS reports and we will let you know when they are published. If you have any questions or comments, please contact me at jmricha@duke-energy.com or (704) 382-3916.

Enclosure: SQUG Advisory 2004-02: Relay GERS Corrections

September 7, 2004

SQUG ADVISORY 2004-02: Relay GERS Corrections

References

1. *Seismic Ruggedness of Relays*, EPRI NP-7147, August 1991 (Volume 1).
2. *Seismic Ruggedness of Relays*, EPRI NP-7147 Volume 2, Addendum 1, September 1993.
3. *Seismic Ruggedness of Relays*, EPRI NP-7147 Volume 2, Addendum 2, April 1995.
4. *GERS Formulated Using Data from the SQURTS Program*, EPRI TR-105988, April 1996 (Volume 1).
5. *GERS Formulated Using Data from the SQURTS Program*, EPRI TR-105988, Volume 2, April 1999

Purpose

The Seismic Qualification Utility Group (SQUG) is issuing this advisory to alert utilities that editorial corrections have been found which affect certain relay GERS levels and the relay model identification nomenclature provided in the above References. SQUG utilities, that have used relay GERS as a capacity screening method, should evaluate the consequences of these relay GERS editorial corrections. The dates of the A-46 submittal for the plant should be noted, since a submittal prior to the affected document issue date would preclude any possible use of that document as a source of relay capacity screening information.

Background

SQUG Advisory 2004-01, May 2004, identified a typographical error in the GERS published for the General Electric IAC66K relay. The GERS for the operate and non-operate condition for a relay subcomponent were interchanged. The discovery of this error initiated a review of all published relay GERS levels represented by the above referenced reports. Some additional editorial corrections for this set of reports were identified during the review. Most of the identified corrections are slight changes in GERS level. Many of the corrections noted are clarifications of model number and nomenclature. Only one additional case was found that was the result of an interchange of operate and non-operate ruggedness level.

The following is a summary of the editorial corrections identified during the review of the relay GERS documents. In general, there are three general types of corrections: 1) changes in established GERS levels, 2) clarification of relay model nomenclature, and 3) additional clarification of reported test results.

Changes in Established GERS Levels

The primary results of interest are any changes in GERS level that were identified during the review. The following identifies the relay models with changed GERS levels.

GERS Reference 3, EPRI NP-7147 Volume 2, Addendum 2, April 1995

Table 2-1 of GERS Reference 3 requires the following editorial corrections, which were previously reported in SQUG Advisory 2004-01. They are repeated here for completeness.

Test Group 16
GE 12IAC66K HDI should have GERS levels as follows:

Non-Operate		Operate	
NO	NC	NO	NC
2 ~~10~~ g's	NA	***10*** ~~2~~ g's	NA

GERS Reference 4, EPRI TR-105988, April 1996 (Volume 1)

Table 3-1 of GERS Reference 4 requires the following editorial corrections of reported relay GERS levels. It should be noted that the publication date of GERS Reference 4 is 1996, which is after many of the plant A-46 submittals were filed.

1. Cutler-Hammer D26MR should have GERS levels corrected due to interchanged ruggedness levels as follows:

SA*	SA*
NON-OPERATE	OPERATE
NO/NC	NO/NC
6.4 ~~14~~ g's	***14*** ~~6.4~~ g's

2. Eagle Signal HP5 should have GERS levels corrected so that the level is the minimum spectral input level rather than the average as follows:

SA*	SA*
NON-OPERATE	OPERATE
NO/NC	NO/NC
2.4 ~~3.1~~ g's	***2.4*** ~~3.1~~ g's

3. Agastat 7012 –L, -T should have GERS levels corrected due to an error in reading a test report copy value as a "3" in lieu of an "8" as follows:

SA*	SA*
NON-OPERATE	OPERATE
NO/NC	NO/NC
11 g's (-L)	***8.5*** ~~3.5~~ g's (-L)
2.5 g's (-T)	2.5 (-T)

4. Agastat SSC1 should have GERS levels revised to reflect additional test results presented in GERS Reference 5 as follows:

SA*	SA*
NON-OPERATE	OPERATE
NO/NC	NO/NC
7.0 ~~11.8~~ g's	11.8 g's

GERS Reference 5, EPRI TR-105988, Volume 2, April 1999

Table 3-1 of GERS Reference 5 requires the following editorial corrections of reported relay GERS levels. It should also be noted that the publication date of GERS Reference 5 is 1999, which is after most of the plant A-46 submittals were filed

1. Agastat SSC1 should have GERS levels revised to reflect test results presented in GERS Reference 4 as follows:

SA*	SA*
NON-OPERATE	OPERATE
NO/NC	NO/NC
7.0 g's	**11.8** ~~14~~ g's

2. Allen-Bradley 700P, NO only, should be *"Allen-Bradley 700P"* with GERS levels revised to incorporate data that was omitted in the report preparation as follows:

SA*	SA*
NON-OPERATE	OPERATE
NO/NC	NO/NC
6.9 ~~7.8~~ g's	14 g's

3. General Electric IAC55A should have GERS levels corrected so that the level is the minimum spectral input level rather than the average level as follows:

SA*	SA*
NON-OPERATE	OPERATE
NO/NC	NO/NC
2.1 ~~3~~ g's	***2.1*** ~~3~~ g's

4. General Electric STV11A should have GERS levels corrected so that the level is the minimum spectral input level rather than the average level as follows:

SA*	SA*
NON-OPERATE	OPERATE
NO/NC	NO/NC
3.4 ~~3.5~~ g's	***3.4*** ~~3.5~~ g's

5. Joslyn Clark 4U and PM 5U should be *"Joslyn Clark **PM** 4U and PM 5U"* with GERS levels corrected so that the level is the minimum spectral input level rather than the average level as follows:

SA*	SA*
NON-OPERATE	OPERATE
NO/NC	NO/NC
4.1 ~~5~~ g's	14 g's

6. Potter & Brumfield KHAU-17 should have GERS levels corrected so that the level is the minimum spectral input level rather than the average level as follows:

SA*	SA*
NON-OPERATE	OPERATE
NO/NC	NO/NC
13.9 ~~14.5~~ g's	***13.9*** ~~14.5~~ g's

7. Westinghouse BF/BFMLF should have GERS levels corrected so that the level is the minimum spectral input level rather than the average level as follows:

SA*	SA*
NON-OPERATE	OPERATE
NO/NC	NO/NC
1.7 ~~2~~ g's	***1.7*** ~~2~~ g's

Clarification of Relay Model Nomenclature

In order to correctly utilize the GERS level for a given relay model, the manufacturer's model designation should match the minimum set of identifying characters given in the Reference GERS reports. The following identifies the relay models with incomplete relay model nomenclature that were identified during the review.

GERS Reference 1, EPRI NP-7147, August 1991 (Volume 1)

Appendix B of GERS Reference 1 requires the following editorial corrections of relay model identification nomenclature:

GERS-RLY-AIL.4 Table 1, p. B-37. Square D 8501-X0 should be *"Square D 8501-X**O**(8501-X**O**60 tested)"*

GERS-RLY-PPM.4 Table 1, p. B-92. PVD21A,D should be *"PVD21A,D **(1E only)**"* A footnote should be added to the table indicating that the PVD21 is on the low ruggedness list, however, the GERS level provided in the table is for a 1E device. In addition, Westinghouse KF Style 290B346A09 should be *"Westinghouse KF Style **617B287A09**"*

GERS Reference 2, EPRI NP-7147 Volume 2, Addendum 1, September 1993

Table 2-1 of GERS Reference 2 requires the following editorial corrections for relay model identification nomenclature:

Test Group 11
GE IAC53 (3) should be *"GE IAC53**A** (3)"*
GE IAC54 (3) should be *"GE IAC54**A** (3)"*
GE IAV54 (3) should be *"GE IAC54**E** (3)"*
GE IAC66 (4) should be *"GE IAC66**A** (4)"*

GERS Reference 3, EPRI NP-7147 Volume 2, Addendum 2, April 1995

Table 2-1 of GERS Reference 3 requires the following additional editorial corrections for relay model identification nomenclature:

Test Group 14
PB PRD11 should be *"PB PRD11 **(AC)**"*
W BFD should be **"***W BFD**/BFMLS***" (two sizes tested)
The second entry for BFD should be deleted.

Test Group 16
GE 12IJCV51 should be *"GE 12IJCV51**A**"*

Test Group 18
AB 849 should be *"AB 849**A**"*

Test Group 19
W CO should be *"W CO**-6**"*
GE 12HFA51A should be *"GE 12HFA51A **(AC)**"*

GERS Reference 4, EPRI TR-105988, April 1996 (Volume 1)

Table 3-1 of GERS Reference 4 requires following additional editorial corrections for relay model identification nomenclature:

General Electric IAV512D should be *"General Electric IAV51**2**D"*

General Electric NGA should be *"General Electric NGA**15**"*

General Electric STV should be *"General Electric STV11**A**"*

Additional Clarification of Reported Test Results

Reference 1 is the original report documenting SQUG relay test procedures and results. The results reported in Reference 1 were extensively peer reviewed and certain guidelines were used in the establishment of the GERS levels. One guideline was that the manufacturer's fragility level, if available, would not be exceeded, since the manufacturer's test results represent the typical statistics of fragility obtained from a

large sample. In Reference 1 such GERS levels are distinguished by the prefix symbol †. Appendix B of Reference 1 provides the peer reviewed GERS established for each relay class. Any additional test results presented within other reports for the same relay model are not to be considered as GERS.

Another guideline originally used in the development of GERS Reference 1 was that relays on the low ruggedness list (see EPRI NP-7148, Appendix E) should not be included as GERS. One exception was the HGA relay, which had only the NC contacts in the non-operate mode identified as low ruggedness. Thus, Reference 1 indicates an "NR" (not recommended) as the NC ruggedness level for all models of GE HGA relays.

The GERS reports, issued after EPRI NP-7147 (References 2-5 above), included additional test results that were meant to verify prior test results that established the GERS level for a particular relay model. These reports were written to document the technical effort during that phase of study, thus the report summary tables included the test results obtained for certain relays with established GERS levels or low ruggedness. The following identifies the relay models with additional test data that should not be considered as GERS.

GERS Reference 1, EPRI NP-7147, August 1991 (Volume 1)

Appendix B of GERS Reference 1 requires the following additional editorial corrections to clarify the reported test results:

GERS-RLY-ARH.5 Table 1, p. B-18. GE HFA151A GERS should have the 120V restriction removed. See editorial corrections to GERS Reference 3 Test Group 16.

GERS-RLY-ARH.5 Figure 5, p. B-24. A note should be added to this figure to indicate the DE, NC contacts of the HGA relay are not recommended due to low ruggedness. The test data presented for the DE, NC contacts of the HGA relay are for information only and should not be used as an indication of ruggedness level

GERS Reference 2, EPRI NP-7147 Volume 2, Addendum 1, September 1993

Table 2-1 of GERS Reference 2 requires the following additional editorial corrections to clarify the reported test results:

Test Group 7
W ITH should be *"W ITH* ***– special test only; relay is on low ruggedness list given in EPRI NP-7148****"*
(This relay model is on the low ruggedness list – the test level achieved was not a GERS. The testing was conducted to ascertain if gap adjustments had any affect on ruggedness level)

Test Group 8
SD 8501-XO should be *"SQD 8501 Type XO* ***– additional test level only; GERS level given in EPRI NP-7147 Volume 1****"*
(This relay was tested to ascertain the effect of contact loading on chatter monitoring – the test level achieved was not a GERS due to the reviewed GERS levels given in GERS Reference 1)

Test Group 10
A HC2 should be *"A HC2* ***(Circuit board mounted)****"*
PB R10 should be *"PB R10* ***(Circuit board mounted)****"*

GERS Reference 3, EPRI NP-7147 Volume 2, Addendum 2, April 1995

Table 2-1 of GERS Reference 3 requires the following additional editorial corrections to clarify the reported test results:

Test Group 13
Agastat ETR should be *"Agastat* ***TR – additional test level only, GERS level given in EPRI NP-7147 Volume 1****"*
Agastat EGP should be *"Agastat* ***GP - additional test level only, GERS level given in EPRI NP-7147 Volume 1****"*
(These relays were tested with and without restraining clips - the test levels achieved are not GERS)

Test Group 15
GE 12HMA111 should be "GE 12HMA111 (AC) ***– additional test level only, GERS level given in EPRI NP-7147 Volume 1***"
(Even though this relay achieved high levels of test ruggedness, the results are not GERS due to the reviewed GERS levels given in GERS Reference 1)

Test Group 16
GE 12HFA151A (250 VDC) should be *"GE 12HFA151A (250VDC)* ***– additional test for unique configuration, GERS level given in EPRI NP-7147 Volume 1****"*
(This 250VDC relay was tested with all 6 contacts in the NO configuration as check on the 120V restriction indicated in GERS Reference 1. Since no other contact configuration was tested, the single result is not a GERS and the reviewed GERS levels given in GERS Reference 1, p. B-18, should be used with the 120V restriction removed. See editorial corrections to GERS Reference 1.)

Test Group 18
GE 12IAV53L should be *"GE 12IAV53L* ***– additional test level only, GERS level given in EPRI NP-7147 Volume 1****"*
(The test results for this relay are not GERS due to the reviewed GERS levels given in GERS Reference 1)

Test Group 19
GE 12HFA151A should be *"GE 12HFA151A (DC)* ***– additional test for unique configuration, GERS level given in EPRI NP-7147 Volume 1****"*
(This 125VDC relay was tested with all 6 contacts in the NC configuration which exceeds the 3 NC contact limitation given in GERS Reference 1. An HFA relay with more than 3 NC Contacts cannot be adjusted in accordance with GE SIL 44. While the test results are in agreement with the results given in GERS Reference 1, the test cannot be considered as a GERS since the contact configuration is not in accordance with the reviewed configuration limitations for HFA relays given in GERS Reference 1)

Appendix A

GERS Reference 3 correctly reports test levels for two models of HGA14 relays with "NR" as the non-operate NC ruggedness level. However, Appendix A of GERS Reference 3 contains a listing of the test results for all 20 groups of relays tested by SQUG. It is noted that this list has been used as summary list of GERS levels on the SQUG BBS. Several of the listed test levels are not GERS. For example, the HGA relay models have values indicated for the non-operate NC contact of the HGA model relays. This Appendix A table of GERS Reference 3 should contain a footnote warning that some of the listed results are not GERS and that the set of GERS Reference Reports 1-3 should be consulted prior to use.

GERS Reference 4, EPRI TR-105988, April 1996 (Volume 1)

GERS Reference 4 summarizes the results of a review of the SQURTS program testing of relays and the establishment of GERS as appropriate. Table 3-1 of GERS Reference 4 did not print properly in the final report. The title of the table should be "TABLE 3-1. RELAY GERS SUMMARY". The header of the fourth table column should be "SA*, NON-OPERATE, NO/NC" and the header of the fifth table column should be "SA*, NON-OPERATE, NO/NC". A table footnote needs to be added as "*SA = Spectral Acceleration." The header of the sixth column should be "Comments, (SI = Structural Integrity)" which refers to the SQURTS practice of shaking an item at maximum table capacity to insure that the device is not physically damaged at that level of shaking.

Table 3-1 of GERS Reference 4 should be revised to have the editorial corrections as shown in Attachment 1. A new section has been added to the table to identify the results of relays conducted with Site Specific SSE input motion or special system configurations. These tests were not fragility level tests and thus cannot be considered as GERS. Key corrections are:

General Electric HEA61 should be moved from New GERS category to Existing GERS –Increased Capacity category.

General Electric IAV54E should be moved from New GERS category to Existing GERS –Confirming Data category.

GERS Reference 5, EPRI TR-105988, Volume 2, April 1999

GERS Reference 5 summarizes additional results of a review of the SQURTS program testing of relays and the establishment of GERS as appropriate. Table 3-1 of GERS Reference 5 should be revised to have the editorial corrections as shown in Attachment 2. Key corrections are:

ABB (Westinghouse) AR – the test level was determined to be the results of a site-specific operability test and thus should not be designated as a GERS.

ATC 305E was determined to have a GERS provided in EPRI TR-105988 Volume 1.

General Electric CHC11A - the test level was determined to be the results of a site-specific operability test and thus should not be designated as a GERS.

General Electric TAK - the test level was determined to be the results of a site-specific operability test and thus should not be designated as a GERS.

General Electric IAC66K was determined to have a GERS provided in EPRI TR-105988 Volume 1 (see also SQUG Advisory 2004-01).

Square D KPD-13 - the test level was determined to be the results of a site-specific operability test, however, an additional fragility test was also conducted which established the GERS level.

Discussion

The consequences of these above GERS editorial corrections for a given plant will depend upon (1) if the reports were used for the plant A-46 relay review, (2) if the relays were present in the plant control circuits, and (3) how the relay ruggedness data was utilized in A-46 relay reviews.

Attachments:

1. *Table 3-1, Relay GERS Summary, EPRI TR-105988-V1*
2. *Table 3-1, Relay GERS Summary, EPRI TR-105988-V2*

ATTACHMENT 1
Table 3-1 Relay GERS Summary
EPRI TR-105988-V1, April 1996

	RELAY TYPE	MANUFACTURER	MODEL	SA* NON-OPERATE NO/NC	SA* OPERATE NO/NC	COMMENTS (SI=Structural Integrity)
Site Specific SSE/Special Configuration Testing Only** – Not GERS						
#	*Auxiliary Relay - Miscellaneous*	*General Electric*	*NGA**15** (12NGA15AG3 tested in system)*	*~~5.7~~ **3.2** g's*	*~~5.7~~ **3.2** g's*	***Site Specific SSE**, System Test*
#	*Protective Relay - Induction Disk (Group 1) (Overvoltage)*	*General Electric*	*IAV51~~2~~D (12IAV51D1A tested to site specific SSE)*	*~~1.9~~ **1.5** g's*	*~~1.9~~ **1.5** g's*	*Site Specific SSE, 14.0 g's SI*
#	*Protective Relay - Induction Disk (Group 2) (Overcurrent)*	*ASEA Brown Boveri (W)*	*CO-6 SN 264C898A05 (tested to site specific SSE)*	*1.8 g's*	*1.8 g's*	*Site Specific SSE, 14.0 g's SI*
#	*Protective Relay - Miscellaneous (Machine Field Ground Detector)*	*General Electric*	*PJG12 (12PJG12B1A tested in system)*	*~~5.7~~ **3.2** g's*	*~~5.7~~ **3.2** g's*	***Site Specific SSE**, System Test*
#	*Protective Relay - Miscellaneous (Overexcitation)*	*General Electric*	*STV**11A** (12STV11A4A tested in system)*	*~~5.7~~ **3.2** g's*	*~~5.7~~ **3.2** g's*	***Site Specific SSE**, System Test*
#	*Protective Relay - Miscellaneous (Polyphase Power Directional)*	*General Electric*	*GGP53C (12GGP53C1A tested)*	***~~5.0~~ 2.7** g's*	***~~5.0~~ 2.7** g's*	***Site Specific SSE***
#	*Protective Relay - Induction Disk (Group 1) (Low Voltage Pick-up)*	*General Electric*	*IAV51K (12IAV51K1A tested)*	*3.4 g's*	*3.4 g's*	***Site Specific SSE** ~~Fragility Level,~~ 14.0 g's SI*
Existing GERS - Confirming Data						
	Auxiliary Relay - Hinged Arm	General Electric	HFA151 (DC) (12HFA151A2H tested)	Confirmation		
	Auxiliary Relay - Industrial Type 2	Westinghouse	BFD (BFD62S tested)	Confirmation		
	Auxiliary Relay - Pneumatic Timing	General Electric	CR2820B (CR2820B413AA41 tested to site specific SSE)	Confirmation		
	Auxiliary Relay - Socket Type	Struthers-Dunn	219 {219ABAP (120 VAC), 219ABAP (120 VDC), 219BBXP (48 VDC) tested}	Confirmation		
	Contactor	Square D	EB440PA-5	Confirmation		
	Protective Relay - Miscellaneous (Undervoltage)	ASEA Brown Boveri (ITE)	ITE-27 (ITE-275239U6-345 tested)	Confirmation		
#	*Protective Relay - Induction Disk (Group 1) (Undervoltage)*	*General Electric*	*IAV54E (12IAV54E1A tested)*	*3.4 g's*	*3.4 g's*	*Fragility level, 14.0 g's SI*
Existing GERS - Increased capacity						
	Auxiliary Relay - Industrial Type 2	Allen-Bradley	700N (700N400A1, 700N600A1 Tested)	14.0 g's	14.0 g's	
	Auxiliary Relay - Pneumatic Timing	Agastat	E7012 (E7012AD, E7012AE tested)	14.0 g's	14.0 g's	14.0 g's Transition
	Auxiliary Relay - Socket Type (in NP-7147,Vol.2)	Potter & Brumfield	KUP11 (KUP11A15-120 VAC, KUP11D15-12 VDC, KUP11D15-24 VDC tested)	14.0 g's	14.0 g's	
#	*Auxiliary Relay - Lockout Type*	*General Electric*	*HEA61 (12HEA61A225-X2 tested)*	*14.0 g's*	*14.0 g's*	
Low Ruggedness - Resolution/ Confirmation						
	Auxiliary Relay - Hinged Arm	ASEA Brown Boveri (W)	SG (DC) (1161540-C tested)	Confirmation		14.0 g's SI

ATTACHMENT 1
Table 3-1 Relay GERS Summary
EPRI TR-105988-V1, April 1996

	RELAY TYPE	MANUFACTURER	MODEL	SA* NON-OPERATE NO/NC	SA* OPERATE NO/NC	COMMENTS (SI=Structural Integrity)
	Auxiliary Relay - Hinged Arm	General Electric	HFA65D (AC) (12HFA65D84H tested w/98VAC pull-in adjustment)	14.0 g's	14..0 g's	Resolution for **Specific** Adjustment Only
	Protective Relay - Induction Cup (Loss Of Excitation)	General Electric	CEH (12CEH51A1A)	Confirmation		14.0 g's SI
New GERS						
#	*Auxiliary Relay - Industrial Type 1*	*Cutler-Hammer*	*D26MR (D26MR22A tested*	*~~14.0~~ **6.4** g's*	*~~6.4~~ **14.0** g's*	
	Auxiliary Relay - Industrial Type 2	Krause & Naimer	S1400B (S1400B5500044, S1400B1200044 tested)	13.9 g's	13.9 g's	
	Auxiliary Relay - Industrial Type 2	Allen Bradley	700DC-N (700DC-N-300Z1 tested)	14.0 g's	14.0 g's	
	Auxiliary Relay - Industrial Type 2	Furnas Electric	41DB (41DB30AF tested)	5.5 g's	14.0 g's	
#	~~Auxiliary Relay - Lockout Type~~	~~General Electric~~	~~HEA61 (12HEA61A225-X2 tested)~~	~~14.0 g's~~	~~14.0 g's~~	
#	*Auxiliary Relay - Miscellaneous*	*Eagle Signal*	*HP5 (HP58A6 tested)*	*~~3.1~~ **2.4** g's*	*~~3.1~~ **2.4** g's*	*Fragility Level, 14.0 g's SI*
#	~~Auxiliary Relay - Miscellaneous~~	~~General Electric~~	~~NGA**15** (12NGA15AG3 tested in system)~~	~~5.7 g's~~	~~5.7 g's~~	~~System Test~~
	Auxiliary Relay - Miscellaneous	Power Conversion Products	120 Hour Timer 913182 (timer only tested)	14.0 g's	14.0 g's	
	Auxiliary Relay - Miscellaneous	Precision Timer Co.	120 Hour Timer J1NM2V1/120 HD 6A (timer, knob & scale tested)	14.0 g's	14.0 g's	
	Auxiliary Relay - Miscellaneous	Automatic Timing & Controls	Reset Timer 305E (305E007A10PX tested)	7.5 g's	7.5 g's	
	Auxiliary Relay - Pneumatic Timing	Allen Bradley	700DC -NT (700DC-NT-300Z1 tested)	14.0 g's	14.0 g's	14.0 g's Transition
#	*Auxiliary Relay - Pneumatic Timing*	*Agastat*	*7012 -L, -T (auxiliary contacts - accessory items tested)*	*11(-L), 2.5(-T)*	*~~3.5~~ **8.5**(-L), 2.5(-T)*	*Add On Auxiliary Contacts L&T*
	Auxiliary Relay - Socket Type	IDEC	RH (RH2B-UDC110V, RH3B-UDC24V tested)	14.0 g's	14.0 g's	
	Auxiliary Relay - Socket Type	Agastat	GPIA (W & W/O Tie Wrap Security Cover)	14.0g's	14.0 g's	14.0 g's Transition
	Auxiliary Relay - Socket Type (off-delay timing)	Agastat	SSC2 (SSC22ACA tested)	7.2 g's	11.8 g's	
	Auxiliary Relay - Socket Type (on-delay timing)	Agastat	SSC1 (SSC12ALA tested)	***7.0*** g's	11.8 g's	Revision based on additional testing
	Auxiliary Relay - Socket Type (on-delay timing)	Agastat	SCCLA01 (SCCLA012XXAMXA tested)	11.8 g's	11.8 g's	Item Missiled at 14.0 g's
	Auxiliary Relay - Socket Type (interval timing)	Agastat	SCCLA03 (SCCLA032XXABXA tested)	11.8 g's	11.8 g's	
	Auxiliary Relay - Socket Type (time delay)	Potter & Brumfield	CNT-35-96	14.0 g's	14.0 g's	Item Missiled at 15.0 g's
#	~~Protective Relay - Induction Disk (Group 1) (Low Voltage Pick-up)~~	~~General Electric~~	~~IAV51K (12IAV51K1A tested)~~	~~3.4 g's~~	~~3.4 g's~~	~~Fragility Level, 14.0 g's SI~~
#	~~Protective Relay - Induction Disk (Group 1) (Overvoltage)~~	~~General Electric~~	~~IAV512D (12IAV51D1A tested to site specific SSE)~~	~~1.9 g's~~	~~1.9 g's~~	~~Site Specific SSE, 14.0 g's SI~~
#	~~Protective Relay - Induction Disk (Group 1) (Undervoltage)~~	~~General Electric~~	~~IAV54E (12IAV54E1A tested)~~	~~3.4 g's~~	~~3.4 g's~~	~~Fragility level, 14.0 g's SI~~
#	~~Protective Relay - Induction Disk (Group 1)~~	~~General Electric~~	~~ICW51B (12ICW51B4A tested to site specific SSE)~~	~~0.45 g's~~	~~0.45 g's~~	~~Site Specific SSE, 14.0 g's~~

ATTACHMENT 1
Table 3-1 Relay GERS Summary
EPRI TR-105988-V1, April 1996

	RELAY TYPE	MANUFACTURER	MODEL	SA* NON-OPERATE NO/NC	SA* OPERATE NO/NC	COMMENTS (SI=Structural Integrity)
	~~(Directional Power)~~					~~SI~~
#	~~Protective Relay - Induction Disk (Group 2) (Overcurrent)~~	~~ASEA Brown Boveri (W)~~	~~CO-6 SN 264C898A05 (tested to site specific SSE)~~	~~1.8 g's~~	~~1.8 g's~~	~~Site Specific SSE, 14.0 g's SI~~
#	~~Protective Relay - Miscellaneous (Polyphase Power Directional)~~	~~General Electric~~	~~GGP53C (12GGP53C1A tested)~~	~~5.0 g's~~	~~5.0 g's~~	
#	~~Protective Relay - Miscellaneous (Under Frequency)~~	~~ASEA Brown Boveri~~	~~MDF-2 SN 1357D42A27 (Aged & tested to site specific SSE)~~	~~2.5 g's~~	~~2.5 g's~~	~~Site Specific SSE, 14.0 g's SI~~
	Protective Relay - Miscellaneous (Under Frequency)	ASEA Brown Boveri	MDF SN 1357D42A247 (Aged)	14.0 g's	14.0 g's	
	Protective Relay - Miscellaneous (Generator Differential)	ASEA Brown Boveri (W)	SA1 SN 290B225A10	14.0 g's	14.0 g's	
	Protective Relay - Miscellaneous (High Drop-out Current Relay)	ASEA Brown Boveri	Type 50D SN 468S3275	14 g's	14.0 g's	
#	~~Protective Relay - Miscellaneous (Machine Field Ground Detector)~~	~~General Electric~~	~~PJG12 (12PJG12B1A tested in system)~~	~~5.7 g's~~	~~5.7 g's~~	~~System Test~~
#	~~Protective Relay - Miscellaneous (Overexcitation)~~	~~General Electric~~	~~STV**11A** (12STV11A4A tested in system)~~	~~5.7 g's~~	~~5.7 g's~~	~~System Test~~
	Protective Relay - Miscellaneous (Overvoltage)	Wilmar	300X (Cycle Aged)	14.0g's	14.0 g's	
	Protective Relay - Miscellaneous (Synchronizing)	General Electric	GES21A (12GES21A1D cycle aged and tested)	6.7 g's	6.7 g's	
	Protective Relay - Miscellaneous (Undervoltage)	Basler	BEI-27 (BEI-27-A3E-E1J-A1N6F tested)	14.0 g's	14.0 g's	

* SA = Spectral Acceleration
** Site Specific SSE and Special Configuration tests are not fragility tests but rather represent the highest level tested or the result of tests conducted with relays wired as a system
# Editorial Corrections

ATTACHMENT 2

Table 3-1
Relay GERS Summary
EPRI TR-105988-V2, April 1999

	Relay Description	Manufacturer	Model Number	Test Type	SA (Non-Operate) NO/NC	SA (Operate) NO/NC
Operability/Structural Integrity Only						
	Socket Relay	Potter & Brumfield	KRPA14 (KRPA14DY12 tested)	Circuit Operability	14g	14g
	Industrial Relay	Westinghouse	BF (BF40F tested)	Circuit Operability	14	14
	Hinged Armature Relay	General Electric	HFA151 (12HFA151A9F tested)	Operability	14.3	14.3
#	*Static Time Delay Unit*	*General Electric*	*TAK (TAKYUVT-3 tested)*	***Operability***	*14.5*	*14.5*
Site Specific SSE/Special Configuration Testing Only - Not GERS						
	Over/Under-Voltage Relay	ABB (Westinghouse)	CV-7 (1955332 tested)	Site Specific	3.6g	3.6g
	Over/Under-Voltage Relay	ABB (Westinghouse)	CV-7 (1875524)	Site Specific	4.4	4.4
	Under-Voltage Relay	ABB (Westinghouse)	CV-7 (1955332)	Site Specific	0.5	0.5
	Phase Distance Relay (Solid State)	ABB (Westinghouse)	SKD-T (1346D96A06 tested)	Site Specific	0.8	0.8
	Time Overcurrent Relay	General Electric	IFC51B (IFC51B1A tested)	Site Specific	4	4
	Industrial Relay	General Electric	CR122A (CR122A08322AA tested)	Site Specific	2	2
	Relay System	General Electric	Subcomponents: Auxiliary Relay NGA15AG3, Lockout Relay HEA61A225-X2/ST, & Loss-of-Excitation Relay CEH51A1A	Site Specific Circuit Test	3.2	3.2
	Overcurrent Relay	General Electric	IAC53~~A~~B (IAC53B811A tested)	Site Specific, Special Mount	2.4	2.4
	Overcurrent Relay	General Electric	IAC57A (IAC57B101A tested)	Site Specific, Special Mount	1.5	1.5
	Overcurrent Relay	General Electric	IAC57B (IAC57B104A tested)	Site Specific, Special Mount	2.4	2.4
	Overcurrent Relay	General Electric	IAC66C (IAC66C55A tested)	Site Specific, Special Mount	4	4
	Over-voltage Relay	General Electric	IAV51A (IAV51A1A tested)	Site Specific, Special Mount	2.4	2.4
	Over-voltage Relay	General Electric	IAV51D (IAV51D2A tested)	Site Specific, Special Mount	1.6	1.6
	Over-voltage Relay	General Electric	IAV53K (IAV53K1A tested)	Site Specific, Special Mount	1.5	1.5
	Time Over-Power Relay	General Electric	ICW51A (ICW51A2A tested)	Site Specific, Special Mount	2.5	2.5
	Time Over-Power Relay	General Electric	ICW51A4A	Site Specific, Special Mount	4	4
	3-Unit Voltage Relay	General Electric	NGV11B18A	Site Specific, Special Mount	4	4
	Socket Relay	Schrack	CAD11 (CAD11D10 tested)	Site Specific	4	4
#	~~Socket Relay~~	~~Square D~~	~~KPD-13 (tested with Subcomponent: Square D Class 8501 Type NR-61 Socket)~~	~~Site Specific~~	~~2~~	~~2~~
	Socket Relay (Time Delay)	Struthers-Dunn	236 (236ABX135NE, 236ABX140NE,236ABXP-020 tested with CX-3964NE & 27390 sockets)	Site Specific	3.4g	3.4g
	Socket Relay (Time Delay)	Struthers-Dunn	237 (237XBX120NE tested)	Site Specific	5	5
#	*Auxiliary Trip Relay*	*ABB (Westinghouse)*	*AR (606B017A09, 606B029A13 tested)*	~~*SRS*~~ ***Site Specific***	~~*3*~~ ***1.8***	*5.6*
#	*Instantaneous Overcurrent and Ground Protection Relay*	*General Electric*	*CHC11A (CHC11A29A tested)*	~~*SRS*~~ ***Site Specific, Special Mount***	~~*2.9*~~ ***0.91***	~~*2.9*~~ ***0.91***

ATTACHMENT 2

Table 3-1
Relay GERS Summary (continued)
EPRI TR-105988-V2, April 1999

	Relay Description	Manufacturer	Model Number	Test Type	SA (Non-Operate) NO/NC	SA (Operate) NO/NC
Site Specific SSE Testing only - GERS Comparative Values - Not GERS						
	Over-Current Relay	ABB (Westinghouse)	CO-8 (264C900A07 tested)	Site Specific	4.4g	4.4g
	Socket Relay (Time Delay)	Agastat	ETR14D3B002 (Subcomponent: Buchanan/Amerace 16-Pin Socket)	Site Specific	1.4	1.4
	Industrial Relay	General Electric	CR120A (CR120A04422AA tested)	Site Specific	9	9
	Industrial Relay	General Electric	CR120AD (CR120AD03041AA tested)	Site Specific	9	9
	Time Over Current Relay with Voltage Restraint	General Electric	IJCV51A (IJCV51A1A tested)	Site Specific	3.2	3.2
	Hinged Armature Relay	Potter & Brumfield	PRD-11 (PRD-11DYO-110 tested)	Site Specific	2	2
	Socket Relay	Struthers-Dunn	219 (219BBX221NE with CX-3966NE socket tested)	Site Specific	5	5
Low Ruggedness Resolution/Confirmation						
	Percentage Differential Relay	General Electric	IJD52A (IJD52A11A tested)	Site Specific	2.5g	2.5g
	High speed Differential Relay	General Electric	CFD (12CFD22B1A tested)	SRS	0.6	0.6
	Differential Voltage Relay	General Electric	PVD11C (PVD11C11A tested)	SRS	3.3	3.3
Contactors/Motor Starters - Confirming Data						
	Motor Starter	Cutler-Hammer	A10 (A10DN0AB with Auxiliary Contacts C320KA3 tested)	Site Specific	4.8g	5.7g
	Magnetic Contactor Type	General Electric	CR305 (CR305D102 tested)	SRS	5	5
	Motor Starter	General Electric	CR306 (CR306C002 tested)	SRS	5.8	5.8
	DC Contactor, Size 1	Siemens	3TC (3TC44-170AG4 tested)	SRS	7.7	7.7
	Contactor Block	Square D	9001 (9001TB tested)	SRS	15.5	15.5
	Combination Starter	Square D	Class 8538 (SEA11V86,X22,Y76,FF4T with Subcomponents - TE-1, SE02, K150D5, BC6032PO, FNO-R3-3/4, 9080PFI, FRN-R1 6/10 tested)	SRS	8.3	8.3
	Contactor	Westinghouse	OT2A [mounted to previous SQURTS test sample #50094-95-12-06-1 DLC (operator only) as first stage].	SRS	15.5	15.5
Existing GERS - Confirming Data						
	Hinged Armature Relay	ABB (Westinghouse)	MG-6 (288B977A15, 288B977A19, 289B360A19 tested)	SRS ~~& Site Specific~~	3g	14g
	Time Delay Relay	Agastat	7012 (7012AH tested)	SRS	14.9	14.9
	Time Delay Relay	Agastat	7024 (7024 AD tested)	SRS	10.8	10.8
	Socket Relay (Time Delay)	Agastat	ETR (ETR14I3I002 tested)	SRS	5.1	5.1
#	~~Overcurrent Relay~~	~~General Electric~~	~~IAC66K (IAC66K68A tested)~~	~~SRS~~	~~7.7~~	~~7.7~~
	Industrial Relay	Westinghouse	AR440 (AR440AR tested)	SRS	8.7	8.7
#	*Auxiliary Relay - Miscellaneous*	*ATC*	*305E (305E011L10PX, tested)*	*SRS*	*14.8*	*14.8*
Existing GERS - Increased Capacity						
	Industrial Relay	Cutler-Hammer	D40RR30A	SRS	14.1g	14.1g
	Industrial Relay	General Electric	CR120B04002	SRS	8.5	8.5
	Time-Delay Relay	General Electric	CR2820B (CR2820B119AA2, CR2820B119AA2MFP	SRS	14	14

ATTACHMENT 2

Table 3-1
Relay GERS Summary (continued)
EPRI TR-105988-V2, April 1999

	Relay Description	Manufacturer	Model Number	Test Type	SA (Non-Operate) NO/NC	SA (Operate) NO/NC
	Socket Relay	Potter & Brumfield	KHU17A11-120 with 27E166 socket	SRS	13.2	14.8
	Socket Relay	Potter & Brumfield	KRP11AG-120	SRS	14.9	14.9
	Rotary Relay	Potter & Brumfield	MDR Non-Latching (MDR 137-8, MDR 138-8, MDR 163-1, MDR 173-1, MDR-136-1, MDR 131-1, MDR-4103-1, MDR-5139, MDR-7032 SCE-0, MDR-7033 SCE-0,MDR-7034 SCE-0 tested)	SRS	14.3	14.3
New GERS						
	Socket Relay (Auxiliary Multi-Contact)	ABB	RXME1 (RK221-052-AN tested with Subcomponent: ABB Socket, P/N: RX4 RK924)	SRS	14.7g	14.7g
	Synchronism Check Relay	ABB (Westinghouse)	424K (424K1105 Type 25V tested)	SRS	15	15
#	~~Auxiliary Trip Relay~~	~~ABB (Westinghouse)~~	~~AR (606B017A09, 606B029A13 tested)~~	~~SRS~~	~~3~~	~~5.6~~
	Auxiliary Trip Relay	ABB (Westinghouse)	ARS (718B820A10 tested)	SRS	8	8
	Time Delay Start/Close Relay	ABB (Westinghouse)	TD-5 (293B301A25B tested)	SRS	4	4
	Time Delay Relay	Agastat	2845 (2845K81C tested)	SRS	14.7	14.7
#	*Socket Relay (Time Delay)*	*Agastat*	*SSC1 (SSC12AAA, SSC12AEA, SSC12AMA tested with Subcomponent: Agastat Socket #BCSA08SC)*	*SRS*	*7.0*	*~~14~~ **11.8***
#	*Industrial Relay*	*Allen-Bradley*	*700P (700P800B11, 700P1200A1 tested, NO only)*	*SRS*	*~~7.8 (NO)~~ **6.9***	*~~14(NO)~~*
#	~~Auxiliary Relay - Miscellaneous~~	~~ATC~~	~~305E (305E011L10PX, **305E007A10PX** tested)~~	~~SRS~~	~~14.8~~	~~14.8~~
	Auxiliary Relay - Miscellaneous	Communication Instruments	42 R06 (42 R06-1000S-SIL tested)	SRS	4.7	14
	Rotary Relay	Electroswitch	422D (422D949G14H, 422D949G45H, 422D949G56H tested)	SRS	14.9g	14.9g
	Transfer Relay	Emerson	Assembly System tested (03-779738-12 Rev. C. ; RH 2B-UDC24V; SH2B-62; SY4S-51F1; 2TK)	SRS	14.8	14.8
	Under Frequency Relay	General Electric	CFF12A (CFF12A63A tested)	SRS	2	2
#	~~Instantaneous Overcurrent and Ground Protection Relay~~	~~General Electric~~	~~CHC11A (CHC11A29A tested)~~	~~SRS~~	~~2.9~~	~~2.9~~
	Hinged Armature Relay	General Electric	HFA54 (12HFA54E187F, 12HFA54L187H tested)	SRS	3.4	8
	Overcurrent Relay	General Electric	IAC51A (IAC51A801A tested)	SRS	7.7	7.7
#	*Overcurrent Relay*	*General Electric*	*IAC55A (IAC55A3A tested)*	*SRS*	*~~3~~ **2.1***	*~~3~~ **2.1***
	Over Frequency Relay	General Electric	IJF51A (IJF51A7A tested)	SRS	14.3	14.3
	Under Frequency Relay	General Electric	IJF51B (IJF51B2A tested)	SRS	14.4	14.4
#	*Static Overexcitation Relay*	*General Electric*	*STV11A (STV11A5A tested)*	*SRS*	*~~3.5~~ **3.4***	*~~3.5~~ **3.4***
	Industrial Relay	General Electric	CR2811A (CR2811A217B641 tested)	SRS	4.7	4.7
#	~~Static Time Delay Unit~~	~~General Electric~~	~~TAK (TAKYUVT-3 tested)~~	~~SRS~~	~~14.5~~	~~14.5~~
	Socket Relay, Board mount	Gordos Corp.	7405(740510/F81-1423 tested)	SRS	14.5	14.5
	Auxiliary Relay - Miscellaneous	Gould Shawmut	J10A (J10A4012 tested)	SRS	9.4	9.4

ATTACHMENT 2

Table 3-1
Relay GERS Summary (continued)
EPRI TR-105988-V2, April 1999

	Relay Description	Manufacturer	Model Number	Test Type	SA (Non-Operate) NO/NC	SA (Operate) NO/NC
	Relay w/ socket and clips	Guardian Electric	1335-2C-12D tested (Subcomponents: Guardian Socket #1330-1ST, Hold Down Clip #1330-HDC, Socket Retainer Clip #1330-SRC)	SRS	14.5	14.5
	Auxiliary Relay - Miscellaneous	ICM	MAR 115A (MAR 115A1X60 tested)	SRS	15.4	15.4
	Socket Mounted Electronic Timer	IDEC	GT3A (GT3A-3 AD24 tested)	SRS	14	14
#	*Industrial Relay*	*Joslyn Clark (Sylvania)*	***PM** 4U (4U4-2, 4U4-3, 4U6-1, 4U6-3, 4U8-1, 4U8-8, 4U9-1, 4U9-4 tested with TB137-12 Coil)*	*SRS*	~~*5*~~ ***4.1***	*14*
#	*Industrial Relay*	*Joslyn Clark (Smith)*	*PM 5U (5U10-10,5U10-9,5U10-3,5U12-11,5U12-5,5U12-9,5U14-13,5U14-5,5U4-2,5U6-0,5U6-3,5U8-0,5U8-4 tested with TB113-3, TB113-61, TB113-1, TB113-13 coils)*	*SRS*	~~*5*~~ ***4.1***	*14*
	DC Industrial Relay (Time Delay)	Joslyn Clark (Sylvania)	PMT 714UPA (714UPA,714UPD, 714UPDA tested	SRS	2	5
	Undervoltage Relay	Mole-Richardson	A500 (A500868-60B tested)	SRS	15.2	15.2
	Socket Relay	Omron	MY4Z (MY4ZNDC100/110 tested)	SRS	14.6	14.6
	Timer	Paragon Electric	537 (537-141-0 tested)	SRS	15.4	15.4
	Socket Time (Delay Relay)	Potter & Brumfield	CLB (CLB-51-70030 tested)	SRS	14.5	14.5
	Socket Time (Delay Relay)	Potter & Brumfield	CNS (CNS-35-92 tested with socket P/N: 27E122)	SRS	14.1g	14.1g
#	*Socket Relay*	*Potter & Brumfield*	*KHAU-17 (KHAU-17D18-12 , KHAU-17D18-24 tested with Subcomponent: P&B socket #27E006 and P&B Hold Down Spring #20C217*	*SRS*	~~*14.5*~~ ***13.9***	~~*14.5*~~ ***13.9***
	Socket Relay	Potter & Brumfield	KRPA-11 (KRPA-11AG-120 tested)	SRS	14.1	14.1
	Anti-Recycle Timer	Precision Timer Co.	Y-115 (Y-115-W2/17172-Y tested)	SRS	14.7	14.7
	Timer	Ranco	T34 (T34-136 tested)	SRS	14	9.1
	Dual-Trip Voltage Alarm	Rochester Instrument Systems	ET-1219 (ET-1219-T2-T10-FS tested)	SRS	8.9	8.9
	Socket Relay	Square D	KPD-13 (8501-KPD-13V63 tested)	SRS	14.2	14.2
	Control Latching Relay	Struthers-Dunn	255 (255ABX105 tested)	SRS	3.5	3.5
	Auxiliary Relay - Miscellaneous	Telemecanique	J13 (J13PA4011 tested)	SRS	14.2	14.2
	Industrial Relay with Latch	Westinghouse	AR440/ARLA (AR440AR with ARLA Latch tested)	SRS	5	5
#	*Industrial Relay with Latch*	*Westinghouse*	*BF/BFMLF(BFA22F with BFMLF Latch tested)*	*SRS*	~~*2*~~ ***1.7***	~~*2*~~ ***1.7***
	Auxiliary Relay - Miscellaneous	White-Rogers	RBM 91 (RBM 91-902 tested)	SRS	13.8	13.8
	Auxiliary Relay - Miscellaneous	White-Rogers	W-R/RBM tested	SRS	15.4	15.4
	Undervoltage Relay	Wilmar	WUV-1 (WUV-1-120-H tested)	SRS	4	11.6

* SA = Spectral Acceleration
\# Editorial Corrections