SQUG

June 30, 2004

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

Subject: SQUG Advisory 2004-01: GERS Correction for General Electric IAC66K Relay

Dear Sir:

The Seismic Qualification Utility Group (SQUG) is issuing an advisory to alert current and former SQUG member utilities that a typographical error has been found in the GERS level provided in EPRI NP-7147, Seismic Ruggedness of Relays, Volume 2: Addendum 2, April 1995 for the General Electric (GE) IAC66K relay. While SQUG does not have 10 CFR Part 21 reporting obligations[1], we believe that it is appropriate that we notify utilities of this error so that they can perform the proper reviews. We are also providing a copy of this Advisory to the NRC for information of a notice to licensees of a potential concern.

The enclosed SQUG Advisory provides a complete description of the error, how the error was identified, background on the relay operations, and recommendations for evaluating the impact on plant's USI A-46 resolutions.

Sincerely,

John M. Richards

John M. Richards, Chairman
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Enclosure

cc w/ encl: K. A. Manoly, NRC
R. P. Kassawara, EPRI

[1] See N. Smith (SQUG) to J. Partlow (NRC), "Revision 1 to 'Procedure for Revising the GIP'" (Mar. 26, 1993); W. Butler (NRC) to N. Smith (SQUG), "NRC Response to the Seismic Qualification Utility Group Revision 1 to 'Procedure for Revising the GIP,' Dated March 26, 1993" (June 23, 1993); and N. Smith (SQUG) to J. Stolz (NRC), "Generic Implementation Procedure (GIP) for Seismic Verification of Nuclear Power Plant Equipment, Revision 3, Updated 05/16/97, and Procedure for Revising the GIP, Revision 3" (May 16, 1997), Enc. 4, at 4, reviewed and approved by the NRC, J. Stolz (NRC) to N. Smith, "Supplemental Safety Evaluation Report No. 3 (SSER No. 3) on the Review of Revision 3 to the Generic Implementation Procedure for Seismic verification of Nuclear Power Plant Equipment, Updated May 16, 1997 (GIP-3)" (Dec. 4, 1997).

A025

June 8, 2004

SQUG ADVISORY 2004-01: GERS Correction for General Electric IAC66K Relay

Reference

Seismic Ruggedness of Relays, Electric Power Research Institute, EPRI NP-7147, Volume 2: Addendum 2, April 1995.

Purpose

The Seismic Qualification Utility Group (SQUG) is issuing this advisory to alert utilities that a typographical error has been found in the GERS level provided in the Reference report for the General Electric (GE) IAC66K relay. SQUG utilities, that have GE IAC66K relays in their plant control circuits and which used relay GERS as a capacity screening method, should evaluate the consequences of this GERS typographical error which interchanged the GERS level for the non-operate and operate mode for a subcomponent of the GE IAC66K relay.

Description of Circumstances

The test fragility level for a GE IAC66K relay was established in the Reference report (based on SQUG testing of a model 12IAC66K8A) and was inferred to be the GERS for the IAC66K protective relay model. Subsequent testing of a GE protective relay, model 12IAC66K58A, was conducted by the SQURTS program with anomalous results. SQUG was contacted to review the SQURTS test results to ascertain if a conflict with the GERS existed. After review of the SQURTS data, SQUG recommended retest of the relay with an alternate test monitoring setup. Review of the overall test effort indicated that the observed results were not inconsistent with previous SQUG testing, but rather the behavior that should be expected for an intermediate (alarm) operate state. However, the review of the SQURTS testing results and the expected operation characteristics of this relay did indicate that the test fragility values reported in the Reference report for the IAC66K subcomponent IOC-HD contact (designated as HDI in the EPRI report) have been interchanged for the non-operate and operate mode. The GERS level for the GE IAC66K relay should be corrected as follows:

IAC66K Sub-Component	Non-operate NO contact	Operate NO contact
	GERS	GERS
TOC/SI [SI/TOC]*	5	10
IOC-HD [HDI]*	~~10~~ 2	~~2~~ 10
IOC-N [STDI]*	7	7

*[EPRI Designation]

Background

The IAC66K is actually three separate sub-component relays wired together to operate as a system. Each sub-component relay operates at different levels of input AC current to close its respective normally open contact. First, the time overcurrent (TOC) unit is a standard induction disk relay (designated as inverse, long time) that takes several seconds to operate. The TOC unit is set to begin timing operation at a low AC current setting. When this low current setting has been exceeded and the induction disk has finished its rotation, the TOC contact closes which energizes the coil of a target & seal-in (SI) relay, which closes an additional contact that is wired in parallel with the TOC contact. When the SI contact is closed, the SI relay coil is energized by its own contact, and the circuit is said to be sealed-in. The TOC contact can chatter or even open, but the SI contact remains closed. The output of the TOC/SI contact set is used as an alarm indication only. Next, a high dropout instantaneous overcurrent (IOC-HD) relay is set to operate at an intermediate current level. The IOC-HD output contact is wired **in series** with the TOC/SI contact set and connected with the plant DC control circuit for switchgear tripping. Thus, for the series contact pair to have an output, the contacts of ***both*** units must be closed. If the IOC-HD contact chatters and the TOC/SI contact set is open, then the DC circuit is still open and the chatter cannot affect the switchgear trip circuit. Likewise, chatter of the TOC/SI contact set can only affect the switchgear trip circuit if the IOC-HD contact has simultaneous chatter. If the TOC/SI contact set is sealed-in, then IOC-HD contact chatter can cause spurious switchgear operation. Finally, a separate instantaneous overcurrent (IOC-N) relay is set to operate at a high current. The IOC-N contact is directly connected to the switchgear trip circuit, thus IOC-N contact chatter can directly cause spurious switchgear operation.

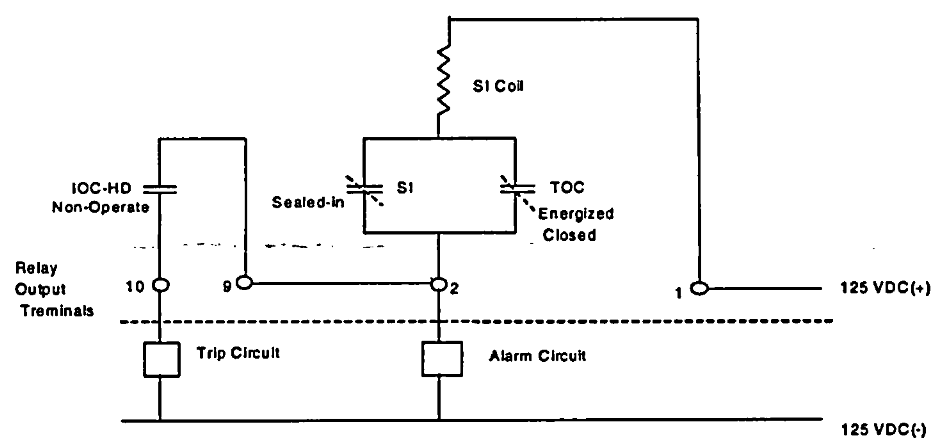

Figure 1 IAC66K Relay Internal Configuration

Discussion

The consequences of the GERS typographical error for the IOC-HD subcomponent of the IAC66K will depend upon how the results were utilized in A-46 relay reviews. If the minimum value of 5 g indicated in the GERS report for the TOC/SI unit was used as the non-operate fragility of the relay, then there is no issue concerning the actual lower fragility of the IOC-HD unit being less than 5 g, since the output contacts of the pair of units are connected in series and the non-operate fragility of the series pair is 5 g. However, if the relay evaluation recognized the series contact pair and concluded that the relay fragility in the non-operate mode was governed by the highest fragility level, then the use of the 10 g value erroneously indicated for the IOC-HD would result in an incorrect non-operate fragility for the relay. In this case, the non-operate fragility of 7 g for the separate IOC-N unit would govern. For the operate mode, the 2 g value erroneously indicated for the IOC-HD unit would govern the operate relay fragility in all cases.

This error has prompted a review of all published relay GERS levels. Subsequent Advisory Notices will be issued for any additional corrections found.

Attachment:
Impact of Additional Seismic Testing on GE IAC66K Protective Relay

Impact of Additional Seismic Testing on GE IAC66K Protective Relay GERS

K. L. Merz
May 2004

The test fragility level for a GE IAC66K relay was established in Reference 1 (based on SQUG testing of a model 12IAC66K8A) and was inferred to be the GERS for the IAC66K protective relay model. Subsequent testing of a GE protective relay, model 12IAC66K58A, was conducted by the SQURTS program with anomalous results. SQUG was contacted to review the SQURTS test results to ascertain if a conflict with the GERS existed. After review of the SQURTS data, SQUG recommended retest of the relay with an alternate test monitoring setup. Some of the results of this additional testing also had apparent conflicting results, but the test results allowed the identification of the source of the conflict. Review of the overall test effort indicated that the observed results were not inconsistent with previous SQUG testing, but rather the behavior that should be expected for an intermediate (alarm) operate state. However, the review of the SQURTS testing results and the expected operation characteristics of this relay did indicate that the test fragility values reported in the Reference1 for the IAC66K subcomponent IOC-HD contact (designated as HDI in the EPRI report) have been interchanged for the non-operate and operate mode.

GE IAC66K Operation

It must be understood that the IAC66K is actually three separate sub-component relays wired together to operate as a system. This relay is an overcurrent relay used for control of large motors that use switchgear for overcurrent protection. Thus, each sub-component relay operates at different levels of input current (AC motor current) to close its respective single contact (all contacts are normally open). The output contacts of the relay are wired into a DC control system that operates the switchgear trip coil. First, the time overcurrent (TOC) unit is a standard induction disk relay that takes several seconds to operate (the designation of the IAC66K TOC unit is an inverse, long time relay). The TOC unit is set to begin timing operation at a low AC current setting. When this low current setting has been exceeded and the induction disk has finished its rotation, the TOC contact closes (an internal relay circuit contact) which energizes the coil of a target & seal-in (SI) relay, which closes an additional contact that is wired in parallel with the TOC contact. When the SI contact is closed, the SI relay coil is energized by its own contact, and the circuit is said to be sealed-in. The TOC contact can chatter or even open, but the SI contact remains closed. The output of the TOC/SI is used as an alarm indication only. Next, a high dropout instantaneous overcurrent (IOC-HD) relay is set to operate at an intermediate current level. The IOC-HD output contact is wired **in series** with the TOC/SI contact set and connected with the switchgear trip circuit. Thus, for the switchgear to trip, the contacts of ***both*** units must be closed. If the IOC-HD contact chatters and the TOC/SI contact set is open, then the DC circuit is still open and the chatter cannot affect the switchgear trip circuit. Likewise, chatter of the TOC/SI contact set can only affect the switchgear trip circuit if the IOC-HD contact has simultaneous chatter. If the TOC/SI contact set is sealed-in, then IOC-HD contact chatter can cause spurious breaker operation. Finally, a normal instantaneous overcurrent (IOC-N) relay is set to operate at a high current. The IOC-N contact is directly connected to the switchgear trip circuit, thus IOC-N contact chatter can directly cause spurious switchgear operation.

Testing Results

The procedure that was used in the SQUG relay testing program (Reference 2), in the case of protective relays, was to test each relay sub-component as a separate device. For the DC output circuit, the contacts of each relay were separately monitored for chatter. The alternate output monitoring circuit, shown in Figure 1, was used in the SQURTS testing of the IAC66K. In this wiring setup, the TOC/SI (terminals 1-2) and IOC-HD (terminals 2-10) contacts are wired in series to reflect how the relay is actually used rather than monitoring each contact set individually (which requires a change of internal relay wiring).

For the non-operate mode, the contact fragility (terminals 1-10) is controlled by the contact with the highest fragility of the pair. The fragility of the contact pair should be higher than fragility of either of the individual contacts since both contacts must chatter simultaneously for a series contact pair to have circuit chatter. For the operate mode, the contact fragility is controlled by the contact with the lowest fragility of the pair.

For the operate mode tests, the SQURTS testing was conducted with the relay input at 200% pull-in current of the TOC/SI, but this input current level was only approximately 75% of the pull-in of the IOC-HD, thus the IOC-HD was actually in the non-operate mode. Thus, the operate mode testing was actually conducted in the alarm state with the TOC/SI operated (and sealed-in), and with the IOC-HD in a non-operate mode. This is the contact state indicated in Figure 1. As can be noted in Figure 1, the IOC-HD is free to chatter which led to the anomalous results observed during the testing. The contact monitor indicated chatter on both the TOC/SI and IOC-HD contacts for low test input levels. Since the TOC/SI unit had operated and sealed-in, this behavior indicates that IOC-HD was chattering at a very low motion level. The apparent chatter noted on the TOC/SI is not actually a chatter, but instead a current fluctuation due to the IOC-HD loop of the monitoring circuit going in and out of the circuit when the IOC-HD contact chatters (see Figure 1). Thus, the test results are actually for the IOC-HD contact in the non-operate mode.

Based on the data available, it is judged that the fragility levels of the IOC-HD sub-component of the IAC66K is slightly greater than 2 g (4-16 Hz range) in the non-operate mode. Based on SQUG testing experience, relays designated as "high dropout" units (i.e., drop out with only a small decrease in voltage or current) tend to have low ruggedness for the normally open contact. Therefore, a conservative value of 2 g is used. It is judged that the fragility levels of the TOC/SI units are greater than 5 g (4-16 Hz range) in the non-operate mode. Based on a review of the available test data, it is apparent that the non-operate and operate GERS levels for the IOC-HD [HDI] given in Reference 1 should be interchanged to indicate that non-operate fragility level is 2 g and that the operate level is 10 g.

Conclusions

1. The behavior of the series connected output contacts for the TOC/SI and IOC-HD units of the IAC66K is now understood. For the non-operate mode, the IOC-HD chatters at a low level but the TOC/SI chatters at a high level, thus the series pair has a high fragility. With the TOC/SI in a operate mode and the IOC-HD in a non-operate mode (alarm condition), then the IOC-HD is still chattering at the low

level, but now the series pair has a low fragility. The case with both the TOC/SI and IOC-HD in an operate mode was not tested by SQURTS but this should yield a high fragility for the series pair.

2. Usually protective relays are tested as though they were in a system under normal operating conditions. The relay functions only to trip the breaker. Thus, relays are tested in their non-operate state (normal current in this case) and their operate state (overcurrent in this case). The only relay function necessary is to trip a breaker in case of an overcurrent. As long as the relay correctly transitions there should not be a concern about contact chatter in an operate state, since the required breaker action has been accomplished.
3. Table 1 provides a comparison of the SQUG and SQURTS test results for the IAC66K relay. It is apparent that GERS levels indicated for the IOC-HD unit are inconsistent with the expectation that an energized relay should have a higher fragility than a non-energized relay. Evaluation of the test results of an alternate chatter monitoring circuit has identified a typographical error for the IAC66K in the report issued as relay GERS Addendum 2. If the non-operate and operate GERS levels for the IOC-HD [HDI] are interchanged, as discussed above, then the results of the SQUG and SQURTS testing are in general agreement.
4. The consequences of the GERS typographical error for a subcomponent of the IAC66K will depend upon how the results were utilized in A-46 relay reviews. If the minimum value of 5 g indicated in the GERS report for the TOC/SI unit was used as the non-operate fragility of the relay, then there is no issue concerning the actual lower fragility of the IOC-HD unit being less than 5 g, since the output contacts of the pair of units are connected in series and the non-operate fragility of the series pair is 5 g. However, if the relay evaluation recognized the series contact pair and concluded that the relay fragility in the non-operate mode was governed by the highest fragility level, then the use of the 10 g value erroneously indicated for the IOC-HD would result in an incorrect non-operate fragility for the relay. In this case, the non-operate fragility of 7 g for the separate IOC-N unit would govern. For the operate mode, the 2 g value erroneously indicated for the IOC-HD unit would govern the operate relay fragility in all cases. But, as noted above, the operate state fragility should not be a concern since the required breaker trip has already occurred.

Recommendations

SQUG utilities, that have GE IAC66K relays in their plant control circuits and which used relay GERS as a capacity screening method, should evaluate the consequences of this GERS typographical error which interchanged the GERS level for the non-operate and operate mode for a subcomponent of the GE IAC66K relay.

References

1. "Seismic Ruggedness of Relays," Electric Power Research Institute, EPRI NP-7147, Volume 2: Addendum 2, April 1995.
2. "Seismic Ruggedness of Relays", Electric Power Research Institute, EPRI NP-7147, August 1991.

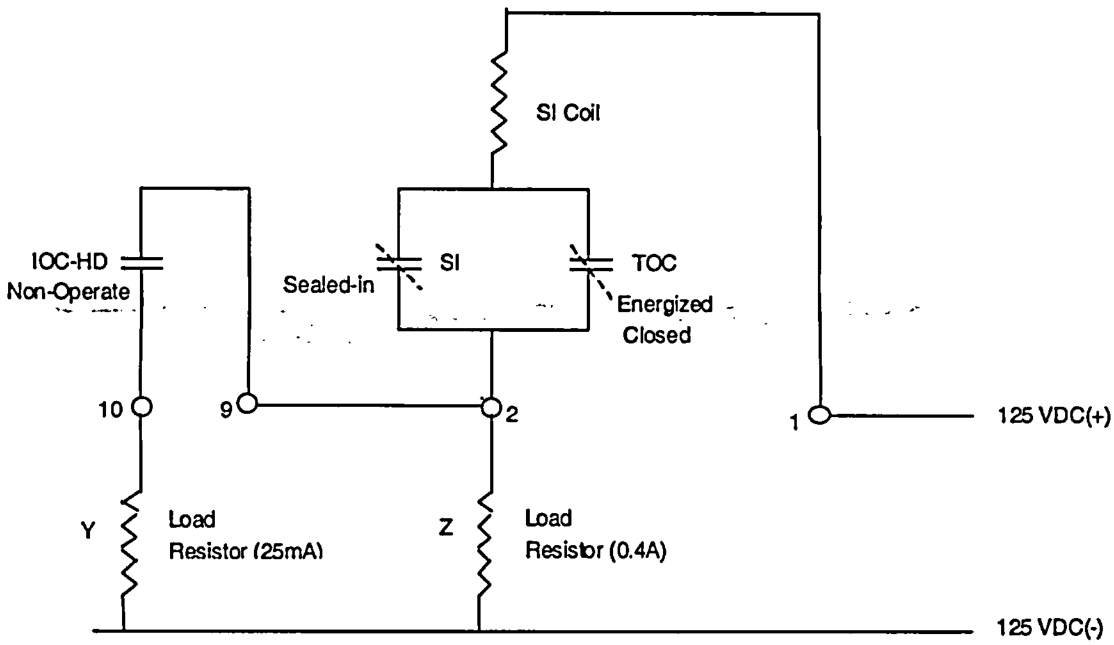

Figure 1. Alternate Output Monitoring Circuit

Table 1. Comparison of SQUG and SQURTS Test Results

Component	Non-operate/NO contact		Operate/NO contact	
	GERS	SQURTS	GERS	SQURTS
TOC/SI [SI/TOC]*	5	9	10	NT
IOC-HD [HDI]*	~~10~~ 2**	<3	~~2~~ 10**	NT
IOC-N [STDI]*	7	>7	7	>10
TOC/SI&IOC-HD	NT	>10	NT	NT

*[EPRI Designation]
**corrected typographical error in GERS report (Reference 1)
NT - Not tested