Section 6
Relay Functionality Review

6.0 INTRODUCTION

As part of the resolution of USI A-46, it is necessary to perform a relay seismic functionality review. The purpose of this review is to determine if the plant safe shutdown systems could be adversely affected by relay malfunction[1] in the event of an SSE and to evaluate the seismic adequacy of those relays for which malfunction is unacceptable.

The purpose of this section of the GIP is to provide an overview of the relay evaluation procedure and describe the interfaces between other GIP activities and the relay evaluation. The overview in this section is based upon the "Procedure for Evaluating Nuclear Power Plant Relay Seismic Functionality," Reference 8. This reference should be used when performing the relay functionality review since it contains the necessary data, forms, and additional details to implement this procedure.

The material contained in this section of the GIP is as follows:

- Section 6.1, SQUG Commitments, lists the requirements to which SQUG utilities commit when adopting the Relay Functionality Review procedure in Reference 8 for resolution of USI A-46.
- Section 6.2, Relay Evaluation Methodology, provides an overview of the methods for performing the relay seismic functionality review.
- Section 6.3, Identification of Essential Relays, describes the methods to be used to: (1) identify the safe shutdown equipment for which a relay review is necessary, and (2) identify the essential relays in the circuits of this equipment for which relay malfunction is unacceptable.

[1] The term "relay malfunction" is used throughout this section as shorthand notation to designate chatter or inadvertent change of state of the electrical contacts in a relay, contactor, motor starter or switch.

- Section 6.4, Comparison of Relay Seismic Capacity to Seismic Demand, describes the methods used to evaluate the seismic adequacy of the essential relays.
- Section 6.5, Relay Walkdown, describes the plant walkdown which should be performed as a part of the relay evaluation. This walkdown may be combined in part with the main seismic walkdown described in Section 4.
- Section 6.6, Outliers, summarizes the additional evaluations and alternative methods which could be used to resolve outliers which do not pass the screening evaluations described in this section of the GIP.
- Section 6.7, Documentation of Results, describes the method whereby a traceable record of the results of the review is developed for all relays reviewed.

The personnel qualifications and training for the individuals performing this relay review are described in Section 2.

6.1 SQUG COMMITMENTS

Members of SQUG adopting the Generic Implementation Procedure for USI A-46 resolution commit to the following in regard to identification and evaluation of relays. [1]As specified in GIP, Part I, Section 1.3, any substantial deviations from the SQUG Commitments must be justified to the NRC in writing prior to implementation. Likewise the NRC should be notified of significant or programmatic deviations from the GIP guidance (Sections 6.2 through 6.7) but implementation may begin without first obtaining NRC concurrence (at the licensee's own risk).

6.1.1 Identification of Relays To Be Evaluated

The licensee will identify the relays to be evaluated using a two-step process. First, the systems to be examined will be those identified pursuant to Section 3. Using this approach, the licensee will develop a Safe Shutdown Equipment List (SSEL) for relays which will include:
(1) electrically controlled or powered safe shutdown equipment whose function could be affected by relay malfunction, and (2) inactive safe shutdown equipment for which relay malfunction could cause spurious operation. Second, plant electrical drawings of the circuits associated with

the above safe shutdown equipment will be used to identify relays to be evaluated. Certain additional assumptions will be used to establish the scope of the relay review:

- Relays will not be damaged by the earthquake, with the exception of certain particularly fragile types.
- Unqualified relays are assumed to malfunction during the short period of strong motion during an earthquake.
- Relay types to be reviewed include auxiliary relays, protective relays, contactors, control switches, and other similar contact devices occurring in circuits controlling the systems identified.
- Solid state relays and mechanically actuated switches are considered to be seismically rugged and need not be evaluated for contact chatter.

6.1.2 Evaluation of Consequences of Relay Malfunction

The licensee will evaluate the relays as set forth in Section 6.1.1 for the consequences of relay malfunction on safe shutdown functions. The relays whose malfunction will not prevent achievement of any safe shutdown function and will not otherwise cause unacceptable spurious actuation of equipment will not be further evaluated. The seismic adequacy of the remaining essential relays will be verified to assure that safe shutdown can be achieved and maintained in the event of a Safe Shutdown Earthquake (SSE).

6.1.3 Assessment of Relay Seismic Adequacy

The licensee will verify the seismic adequacy of the essential relays identified pursuant to Sections 6.1.1 and 6.1.2, above, by comparing the relay seismic capacity to the seismic demand imposed upon the relay. Three types of data can be used to establish the seismic capacity of essential relays:

- Generic Equipment Ruggedness Spectra (GERS)
- Earthquake Experience Data
- Plant-specific or relay-specific seismic test data

6.1.4 Relay Walkdown

The licensee will conduct one or more walkdowns, as needed, to accomplish four objectives:

- Obtain information as required to determine in-cabinet amplification, including identification of cabinets, panels, and/or racks which house or support essential relays.
- Verify the seismic adequacy of the cabinets or enclosures which support essential relays.
- Spot check relay mountings.
- Spot check relay types and locations.

The relay walkdowns can be accomplished together with, or separate from, the main USI A-46 walkdown conducted pursuant to Section 4.

6.2 RELAY EVALUATION METHODOLOGY

The methodology for evaluation of the seismic functionality of relays is based on a two-part screening process. The first part: (1) identifies a minimum set of plant systems and items of equipment which should function properly to maintain the plant in a safe condition during and immediately after an earthquake; and (2) evaluates the consequences of malfunction of the associated electrical relays on system performance to determine if proper function of the relays is essential to safe shutdown. Relays whose malfunction is acceptable need not be seismically rugged. This screening process is intended to significantly reduce the number of systems, equipment electrical circuits, and, in turn, relays which are considered essential to plant safety in an earthquake, and, therefore, to reduce the number of relay types whose seismic functionality must be demonstrated.

The second part of the relay evaluation process uses relay GERS and test data to assess the seismic adequacy of the essential relay types. Taken together, these two screening approaches are expected to make the relay functionality verification under USI A-46 manageable and significantly more cost-effective than would be the case using current licensing criteria, while at the same time providing good assurance that the affected plants can be safely shut down during an earthquake. The two parts of the screening processes are (1) identifying those relays whose function is essential to safe shutdown and (2) assessing their seismic ruggedness. These parts are described below.

6.3 IDENTIFICATION OF ESSENTIAL RELAYS

The starting point for the relay evaluation is the identification of safe shutdown equipment to be examined during the USI A-46 resolution. Section 3 provides directions for generating two Safe Shutdown Equipment Lists (SSELs), one for use in conducting the plant walkdown of equipment to verify its seismic adequacy as described in Section 4, and the other for performing the relay functionality review as described in this section. These SSELs can be prepared in a computerized form to facilitate ease of use. The relay screening procedures provide guidance for reviewing each item of equipment on the relay review SSEL to identify essential relays and to assess the seismic adequacy of the essential relays.

The principal elements in the identification of the minimum set of essential relays are described below:

6.3.1 USI A-46 Safe Shutdown Criteria and Assumptions

For resolution of USI A-46, it is not necessary to verify the seismic adequacy of all plant equipment defined as Seismic Category I, e.g., in NRC Regulatory Guide 1.29. Instead, only those systems, subsystems, and equipment needed to bring the plant from a normal operating condition to a safe shutdown condition need be identified to ensure safety during and following a Safe Shutdown Earthquake (SSE). As a result, the scope of the seismic verification is limited to equipment and supporting systems which provide functions necessary to achieve and maintain safe shutdown.

The criteria and assumptions needed to define the systems and equipment which are needed to bring the plant to a safe shutdown condition are described in detail in Section 3 and summarized as follows:

- The plant should be brought to a hot shutdown condition (as defined by the plant's Technical Specifications) and maintained there during the 72 hours following the SSE.
- The earthquake does not cause a loss of coolant accident (LOCA) or other such events.
- A LOCA is not postulated to occur simultaneously with or during the SSE.
- Offsite AC power may be lost during or after the SSE.
- There should be sufficient redundancy such that the failure of the active function of a single item of safe shutdown equipment may occur without losing the ability to achieve and maintain safe shutdown conditions.

In addition to these general criteria, the following specific assumptions provide the bases for the relay evaluation:

- Unqualified relays are assumed to malfunction during the short period of strong motion during an earthquake. Such a malfunction, typically chatter, may result in loss of system function or inadvertent actuation of systems during the strong shaking period. It is also possible that relay malfunction during strong shaking can result in unacceptable seal-in or lockout of specific circuits which are designed to have this feature. In such cases, operator actions to reset or restore such circuits to their original condition may be acceptable provided there are sufficient time, awareness, access, and procedures for the operators to take this action.
- Earthquake experience data and test data show that, in general, relays are not structurally damaged during an earthquake; therefore, with the exception of certain particularly fragile relay types, which are identified in the screening procedure of Reference 8, it is assumed that relays are not damaged as a result of the earthquake and will be functional after the period of strong shaking.
- Relay types to be evaluated under this program include those devices which are provided to cause contact operation in electric control circuits. In general, they fall into three categories as shown in Figure 6-l. The largest category is designated auxiliary relays. This category typically includes electromechanical, pneumatic timing, and solid state relays used for general purpose control, blocking, closing, lockout, seal-in, and other logic or control functions.

  A second category includes protective electromechanical and solid state relays whose function is to protect equipment from system faults and other abnormal or dangerous conditions by automatically initiating appropriate control circuit action. Protective relays include over-current and under-voltage relays.

  The third general category of relays is contactors. A contactor is a heavy-duty relay which may carry significant amounts of current. It is distinguished from a circuit breaker such as is used in switchgear in that its contacts are moved by a small solenoid-type mechanism rather than by compressed springs or other actuating mechanisms.

Other devices which have contacts, such as control switches which are used in relay logic control circuits, are also addressed in the relay evaluation, even though they are not considered relays.

The foregoing criteria and assumptions focus the relay evaluation by defining the objectives of the reviews, the relay types to be considered, the failure modes to be assumed, and other important criteria.

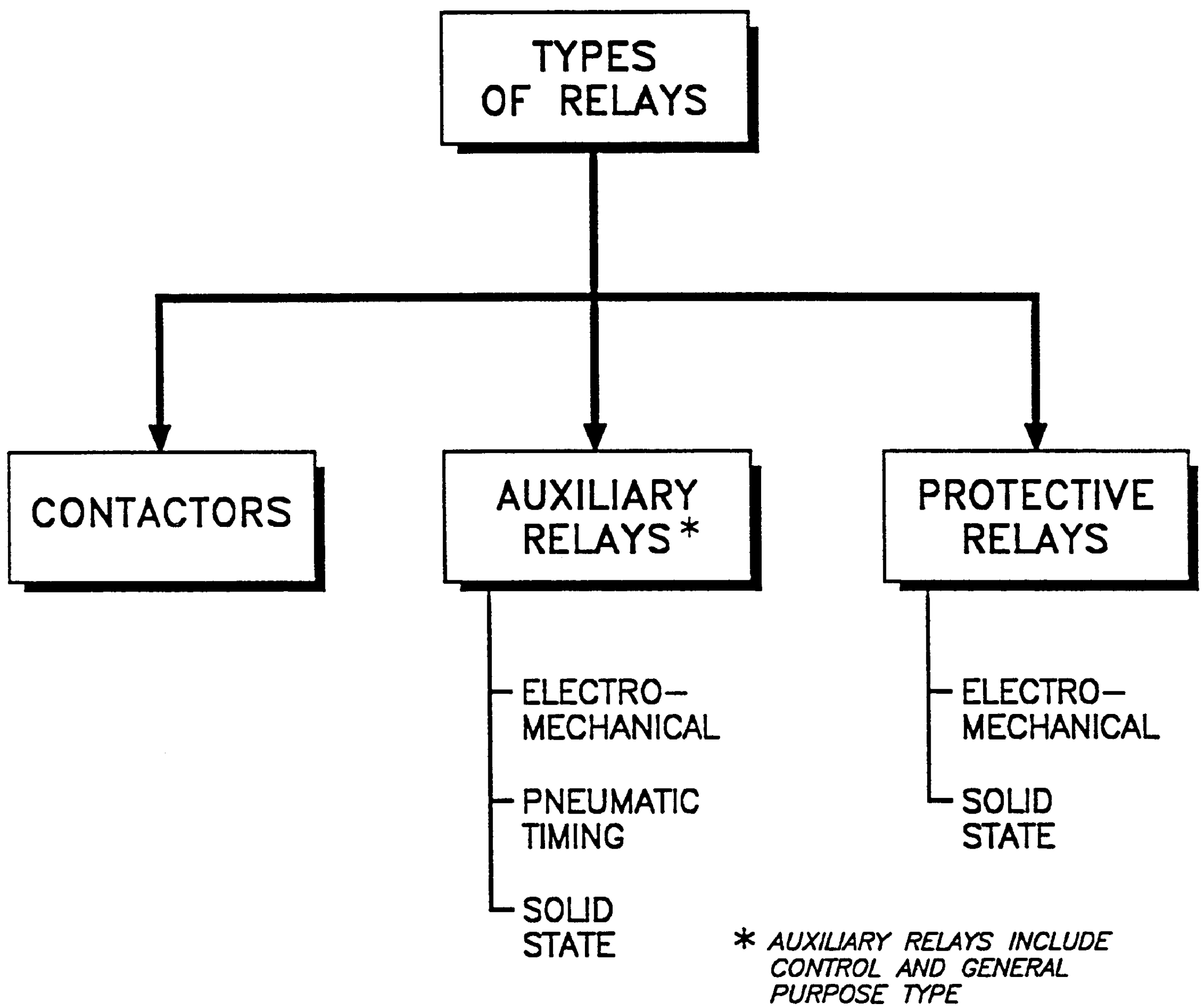


Figure 6-1. Relay Classification

6.3.2 Identification of Safe Shutdown Equipment

As described in detail in Section 3, a nuclear plant should accomplish each of the following safe shutdown functions to achieve and maintain safe shutdown conditions during and following an SSE.

- Reactor reactivity control
- Reactor coolant pressure control
- Reactor coolant inventory control
- Decay heat removal

In addition, certain instrumentation is needed to provide the capability to monitor safe shutdown conditions and to verify that these safe shutdown functions are being accomplished.

Several alternative methods for accomplishing each of the safe shutdown functions listed above are typically available in nuclear power plants. A preferred alternative should be selected and the individual items of active mechanical and electrical equipment in this alternative should then be identified. The guidelines for redundancy per Section 3.2.6 should be satisfied. Two safe shutdown equipment lists (SSELs) should be developed; one for the seismic walkdown and one for the relay evaluation.

The SSEL for relay evaluation includes electrically controlled or powered safe shutdown equipment whose function could be affected by relay malfunction. This list also includes inactive safe shutdown equipment which could inadvertently change state or become active due to relay malfunction and result in unacceptable consequences (e.g., loss of coolant inventory).

6.3.3 Identification of Circuits, Relays, Consequences of Relay Malfunction

Using the SSEL developed for the relay evaluation, drawings of the electrical control circuit(s) for each SSEL item of equipment should be identified. The electrical circuits used to operate and control the equipment should then be reviewed. The relays identified in this review should then be evaluated.

Once the list of system equipment, circuits, and relays needed for safe shutdown is narrowed to only those required to function (i.e., change state or maintain a state) during and immediately after the earthquake, an evaluation should be made of the consequences of relay malfunction in those systems and circuits. Relay malfunction includes chatter of the contacts in the relay itself and any other spurious signals from other devices which control the operation of the relay. The other devices could include other relays which chatter or instruments which send spurious signals due to the earthquake vibration (e.g., water sloshing in a tank could trigger a low water level signal from the level instrument).

The evaluation of the consequences of relay malfunction is comparable to a failure modes and effects analysis and is intended to identify those specific relays whose malfunction is important and those whose malfunction is inconsequential--that is, those relays whose malfunction will not prevent the essential function from occurring, either because of the specific circuit design or the failure logic employed. For example, many control and power circuits for systems in nuclear power plants are designed such that component malfunction (including relay malfunction) results in the system failing in a safe manner. An example of this fail-safe design approach is the circuitry for initiating reactor shutdown, or "SCRAM". In this case, failure of normally energized relays or their power supplies results in reactor SCRAM which, in the case of an earthquake, is an acceptable safe action. Relays in these shutdown systems would not be included on the list of essential relays because their malfunction is inconsequential from an earthquake resistance standpoint.

The relay screening and evaluation procedure (Reference 8) includes other screening methods to eliminate relays from the final group of essential relays. In one such method, relay malfunction may lead to inadvertent equipment or system operation which is acceptable. For example, spurious operation of some pumps and valves may not prevent safe shutdown functions and can be considered acceptable. Also, some relay-controlled devices respond slowly enough that relay chatter may cause either no operation or only a temporary but acceptable spurious operation of the controlled device (e.g., relay chatter leading to partial valve opening and then reclosing, or momentary energization of pumps which do not affect the safe shutdown of the plant). Also, operator actions can be relied upon in certain situations to correct the effects of relay malfunction by resetting the affected relays. These screening methods and others are described in detail in the step-by-step relay evaluation procedure in Reference 8.

The functional screening process described above will result in the minimum set of essential electrical relays whose seismic capacity, (that is, operability under design seismic loading) should be verified to ensure that the plant can be brought to a safe shutdown condition under the criteria established in USI A-46. It will also identify those cabinets, panels, racks, and other enclosures which support or house essential relays. These cabinets and panels will require evaluation as part of the equipment walkdown described in Section 4 to ensure they are properly anchored and not subject to unacceptable seismic interaction effects.

6.4 COMPARISON OF RELAY SEISMIC CAPACITY TO SEISMIC DEMAND

This section summarizes the screening method for evaluating the seismic capacity of essential relays (those relays identified using the method described in Section 6.3) compared to the seismic load (demand) imposed upon them by a seismic event. The details for performing this screening evaluation are described in Reference 8.

Under current design and licensing criteria for nuclear power plants, relays in safety-related systems are qualified by shake table tests, most often in the specific cabinet or panel arrangement in which they are mounted. This is generally not practical for older operating plants nor is it necessary since actual experience with power plants which have undergone strong earthquakes has not shown significant or widespread problems with standard power plant equipment, including most relays. Therefore, this alternative to formal qualification testing has been developed which uses available seismic test data and actual earthquake experience data to establish the seismic capacity of a wide variety of relay types. A method for determining the seismic demand on an essential relay in a cabinet is also included in this screening method.

The following two subsections describe the method for: (1) establishing the seismic capacity of relays, and (2) comparing this capacity to the seismic demand.

6.4.1 Seismic Capacity of Relays

Three methods can be used to establish the seismic capacity of essential relays:

- Generic seismic test data,
- Earthquake experience data, and
- Relay-specific test data.

These methods are described below.

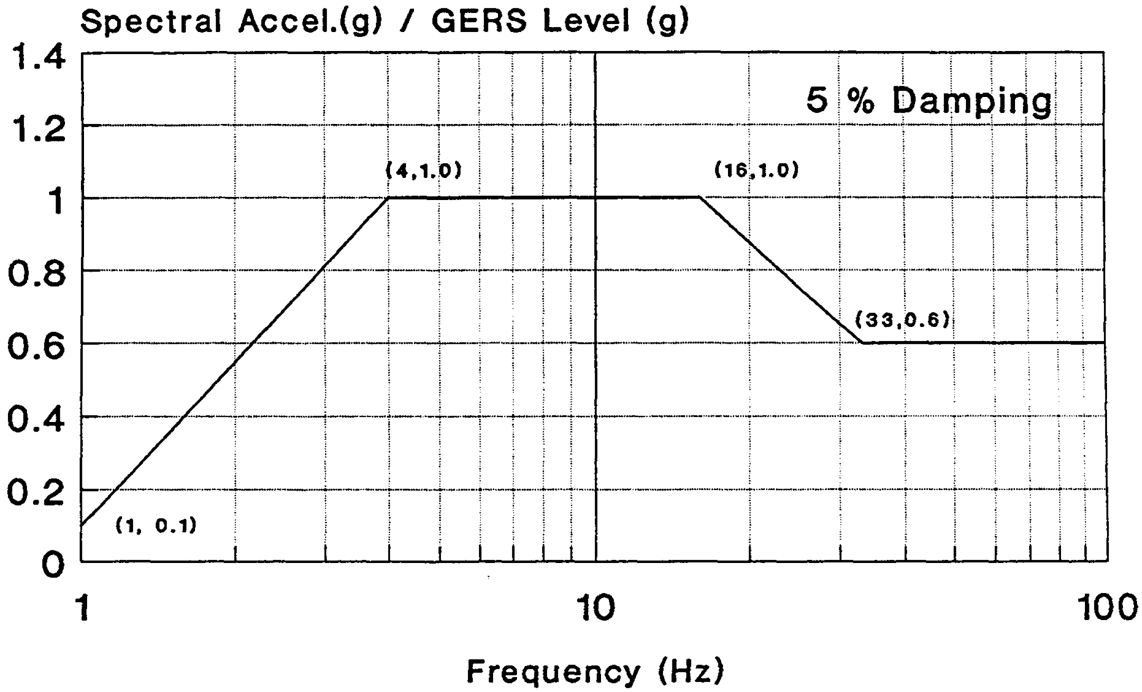
Generic Seismic Test Data. Available seismic test data on a variety of types of relays have been either gathered or generated, evaluated, and consolidated. These data have been reduced to Generic Equipment Ruggedness Spectra (GERS) in Reference 32 for relays which define seismic acceleration levels below which relays can be expected to function without chatter or other damage. The GERS are seismic response spectra within which a class or subclass of relays has functioned properly during shake-table tests. In some cases the GERS are based on "success" data (that is, seismic test spectra for which no relay malfunction occurred). In this case, the test spectra for one or more relays in a given class represent a lower bound of the seismic ruggedness of the class. In other cases, the GERS may be based on "fragility" data (that is, seismic response spectra in which failures or malfunctions occurred). In this case, the GERS represent an upper bound of the seismic ruggedness of the relay class. Where both success and fragility data are available for a given relay class, the GERS fall between the two spectra. Engineering judgment was used in developing the GERS level to smooth out sharp peaks and valleys in the test response spectra.

An example GERS for several auxiliary relay types is shown in Figure 6-2. A normalized GERS shape is illustrated at the top of this figure; GERS levels (i.e., the peak acceleration) for example relays are tabulated at the bottom of this figure. Complete sets of all available GERS for relays are given in Reference 32.

Earthquake Experience Data. Data have been obtained on relay performance, specific failures, relay vulnerabilities, and other information from actual earthquake experience in power plants and other facilities which have undergone significant earthquakes. This information has been used to identify unacceptable relay types such as those which are known to be susceptible to damage or chatter due to moderate shaking. Unacceptable relays and related contact devices which must be avoided are listed and considered in the screening procedure given in Reference 8. Based on earthquake experience data and on test data, solid state relays, and mechanically actuated switches are considered seismically rugged and need not be evaluated for relay chatter. Details and restrictions regarding the screening of both the low-ruggedness and high-ruggedness classes of control circuit devices are described in Reference 8.

Relay-Specific Test Data. The GERS and earthquake experience data discussed above are expected to apply to the majority of installed relay types in essential circuits. Plant-specific and relay-specific seismic test data, where available, can also be used. This seismic test data is generally maintained by specific plants and/or relay suppliers and has not been included in the relay GERS. It may be used on a relay-specific or plant-specific basis.

Normalized Relay GERS
Auxiliary, Industrial Type 2 (300V)



Type and Submodel Identification	GERS Level[1] Non-Operate NO[2]	GERS Level[1] Non-Operate NC[2]	GERS Level[1] Operate NO/NC[2]
Make #1, Model A	10	9	10
Make #2, Model A	10	9	10
Make #2, Model B	10	-[3]	10
Make #3, Model A	10	9	10
Make #4, Model A	10	5	10
Make #5, Model A	10	10	10

1 "GERS Level" is the spectral acceleration (g) from 4 to 16 Hz for 5% damping.
2 "NO" = Normally Open; "NC" = Normally Closed; "NO/NC" = Change State.
3 "-" = Data not available.

Figure 6-2. GERS for Auxiliary Relays
(Source: Reference 32)

6.4.2 Seismic Capacity Compared to Seismic Demand

There are four methods for comparing the seismic capacity of an essential relay to the seismic demand imposed upon it. These are described below in a multi-level screening approach which starts with an approximate, generic capacity screening criterion based on earthquake experience, test experience, and analysis. The final screening level is a very detailed, relay-specific, and installation-specific analysis and/or test. Seismic adequacy of essential relays can be confirmed by successful application of any one of these screening methods.

In addition to this screening approach for use with relays in general, a special case is also described below for evaluating the seismic adequacy of relays which control the operation of a switchgear breaker.

Screening Level 1 - High Capacity Relays. This first screening level can be used if the following conditions are met:

- The plant is one of those for which USI A-46 applies and the largest horizontal component of the 5% damped, free-field, Safe Shutdown Earthquake (SSE) ground response spectrum, to which the nuclear plant is licensed, is enveloped by the Bounding Spectrum (shown in Figure 4-2 of Section 4).
- The equipment or cabinet containing the essential relay is mounted at an elevation in the plant which is no higher than about 40 feet above the effective grade of the plant. The "effective grade" is defined in Section 4.
- The essential relay is not one of the low-ruggedness types listed in Appendix E of Reference 8.

If the above conditions are met, then an essential relay is sufficiently rugged when the relay is mounted in one of the types of structures defined below and the relay has a seismic capacity at least as large as that given below for each of these structure types:

- When the essential relay is mounted in a cabinet similar to a conventional motor control center (MCC), the relay should have a defined spectral acceleration capacity of 5g or higher. Guidelines for classifying cabinets as MCCs are given in Appendix I of

Reference 8. GERS or relay-specific seismic data (e.g., IEEE-344 and/or IEEE-501 type tests) can be used to establish the spectral acceleration capacity of the essential relay.

- When the essential relay is mounted on an unsupported panel or in a typical conventional switchgear cabinet, or it is mounted on a control room panel or benchboard, the relay should have a defined spectral acceleration capacity of 8g or higher. Guidelines for classifying If these types of cabinets and panels are given in Appendix I of Reference 8 as amended by footnote (**) in Table 6-2. GERS or relay-specific seismic qualification data (e.g., IEEE-344 and/or IEEE-501 type tests) can be used to establish the spectral acceleration capacity of the essential relay.

If the relay is not mounted in one of the these types of structures, then the Screening Level 1 method cannot be used and one of the following screening methods should be used instead.

<u>Screening Level 2 - Use of In-Cabinet Amplification Factors</u>. The second screening level for comparing relay seismic capacity to demand is based on: (1) using an in-structure response spectrum (IRS) at the base of the 1 cabinet containing the relay, (2) multiplying this spectrum by both an appropriate factor of safety (FS) and by an in-cabinet amplification factor (AF), and (3) comparing this seismic demand to the relay seismic capacity (CAP) based on GERS or relay-specific seismic test data.

This comparison can be illustrated using the following equation:

$$CAP \geq IRS \cdot FS \cdot AF$$

Where:

CAP = seismic capacity of an essential relay based on either:

- Relay GERS (from Reference 32) or
- Relay-specific test data using test methods such as IEEE-344 and/or IEEE-501.

IRS = in-structure response spectrum at the base of the equipment. Using the guidelines given in Section 4.2, the in-structure response spectrum may be one of the following:

- 1.5 X SSE horizontal, ground response spectrum (for equipment which is mounted below about 40 feet above the effective grade and has a natural frequency greater than about 8 Hz),
- Realistic, median-centered, horizontal in-structure SSE response spectrum, or
- Conservative, design, in-structure SSE response spectrum.

FS = factor of safety to account for uncertainties in various types of in-structure response spectra as shown in Table 6-l.

AF = in-cabinet amplification factor, as given in Table 6-2, for various types of cabinets. The guidelines and criteria for identifying the various cabinet types are included in Appendix I of Reference 8, as amended by footnote (**) in Table 6-2.

To use this screening method, the essential relay should not be one of the low-ruggedness types listed in Appendix E of Reference 8.

A relay is considered seismically adequate if the seismic demand spectrum is bounded by the relay capacity spectrum in the frequency range from 4 - 16 Hz [2]and from 33 Hz and above, i.e., the zero period acceleration (ZPA). If the guidelines for this screening method cannot be applied, or the seismic demand is not bounded by the seismic capacity of the relay, then one of the following screening methods should be used instead.

Table 6-1.
Factors of Conservatism to be Applied to
Different Types of In-Structure Response Spectra

Type of In-Structure Response Spectrum	Factor of Safety (FS)
• 1.5 X SSE horizontal, ground response spectrum (For equipment which is mounted below about 40 feet above the effective grade and has a natural frequency greater than about 8 Hz)	1.5
• Realistic, median-centered, horizontal in-structure response spectrum for the SSE	1.5
• Conservative, design, horizontal in-structure response spectrum for the SSE	1.0

Table 6-2.
In-Cabinet Amplification Factors for
Use With Level 2 Relay Screening Method

Type of Cabinet	In-Cabinet Ampl. Factor (AF)
• MCC-type cabinet (Defined in Appendix I of Reference 8)	3
• Conventional control panel or benchboard (Defined in Appendix I of Reference 8)**	4.5**
• Switchgear-type cabinet or similar large unsupported panel (Defined in Appendix I of Reference 8)	7
• Other type of cabinet, panel, or enclosure for which cabinet-specific amplification data exist	*

* For the "Other" type of cabinets, an effective broad-based amplification factor can be developed from appropriate test data. Reference 33 can be used for this purpose as a guide in which an effective in-cabinet amplification factor can be obtained by multiplying the measured peak amplification factor, for the location in the cabinet where the relay is mounted, times an appropriate reduction factor. [3]Reference 33 found that a factor of 0.6 applies to the conventional control panels and benchboards covered by this reference. Use of the 0.6 reduction factor, or other appropriate reduction factors, for other types of cabinets, panels, or enclosures should be justified and documented using procedures described in Reference 2 of Section 4 of GIP Reference 33.

** To use an amplification factor of 4.5, the control panel or benchboard must meet the restrictions (or caveats) given in Reference 8, Appendix I, except that a 13 Hz lower bound fundamental frequency shall apply when assessing essential relays mounted on internal independent racks, cantilevered appendages such as cantilevered wing walls attached to a front face or side wall, and access doors which are part of a control panel or benchboard, instead of the 11 Hz fundamental frequency specified by the relevant caveat in Reference 8, Appendix I. Note that one intent of the control panel and benchboard caveats is to restrict use of this amplification factor to only those cabinets and panels which have significant natural modes (those related to seismic demand motion for essential relays) at 13 Hz and higher.

Screening Level 3 - Use of In-Cabinet Response Spectra. In this screening level, the method of comparing relay seismic capacity to demand is the same as Screening Level 2 [2](i.e., the demand spectrum is bounded by the capacity spectrum in the frequency range from 4 - 16 Hz and from 33 Hz and above) except that instead of using an in-cabinet amplification factor to determine the seismic demand on the relay, an in-cabinet response spectrum is used. There are two methods for developing in-cabinet response spectra, depending upon the type of equipment:

- Control Room Benchboards and Panels. An amplified, in-cabinet response spectrum can be determined using the methodology and software described in Reference 33 for control room benchboards and panels. In this option, the cabinet or panel evaluated must meet the restrictions (or caveats) given in Reference 33 except that a 13 Hz lower bound fundamental frequency shall apply when assessing essential relays mounted on internal independent racks, cantilevered appendages such as cantilevered wing walls attached to a front face or side wall, and access doors which are part of a control panel or benchboard, instead of the 11 Hz fundamental frequency specified by the relevant caveat in Reference 33. Note that one intent of the control panel and benchboard caveats is to restrict use of this amplification factor to only those cabinets and panels which have significant natural modes (those related to seismic demand motion for essential relays) at 13 Hz and higher. [4]The GENRS software, described in Reference 33, should not be used for other classes of equipment without the review and approval of the NRC Staff.
- Other Types of Equipment. For other types of cabinets and panels which are not covered by Reference 33, in-cabinet response spectrum can be determined using analytical and/or test methods which are suitable for the specific case. These other methods should be justified in the documentation of the Relay Functionality Review as described in Section 9.3. This is equivalent to the case-specific analysis and/or test approach acceptable under current licensing criteria. Caution should be exercised when using this method to determine in-cabinet response spectra by considering the effects of local flexibilities and mounting details such as local plastic deformation, slotted holes, fitted connections, etc.

To use this screening method, the essential relay should not be one of the low-ruggedness types listed in Appendix E of Reference 8.

If the guidelines for this screening method cannot be applied, or the seismic demand is not bounded by the seismic capacity of the relay, then the following screening method should be used instead.

Screening Level 4 - Use of Current Qualification Methods. Use of seismic qualification methods currently specified in NRC-approved IEEE standards (e.g., IEEE 344-1975, -1987) and current licensing criteria (e.g., NRC Standard Review Plan and Regulatory Guides) are acceptable means for evaluating the seismic adequacy of relays.

If none of the above screening methods result in an acceptable comparison of seismic capacity to demand, then the relay should be classified as an outlier as discussed in Section 6.6, below. Note that it is permissible to declare a relay an outlier without applying all of the above screening methods.

Seismic Adequacy of Relays in Switchgear. A special case can be used for essential relays which directly control the operation of switchgear. To show that this type of essential relay is seismically adequate, it is not necessary to use the above screening methods. Instead the relay can be shown to be adequate if: (1) the cabinet containing the relay has been shown to be seismically adequate using the seismic evaluation method given in Section 4, and (2) the essential relay is not one of the low-ruggedness types listed in Appendix E of Reference 8. Note that these relays which control the operation of the circuit breaker may be mounted in the switchgear cabinet or in another cabinet. As a minimum, all relays screened using this method must be documented in the relay evaluation report. Further details on screening of essential relays in switchgear are provided in Reference 8.

Note that this special case for screening relays is applicable only to the relays which control the operation of the switchgear. Essential relays which control components or systems other than the breaker are not covered by this special case and should be evaluated using one of the four screening levels described above.

6.5 RELAY WALKDOWN

A walkdown should be performed as a part of the relay evaluation. The purposes of the relay walkdown are to:

- Obtain information needed to determine cabinet types which house essential relays and to determine the in-cabinet amplification, where needed, for the seismic capacity screening described above.
- Verify the seismic adequacy of the cabinets or enclosures which support the essential relays.
- Spot check the mountings of essential relays.
- Spot check the essential relays to verify their types and locations, including checks for vulnerable relays (as listed in Appendix E of Reference 8).

These purposes can be accomplished during one walkdown or separately during different walkdowns. To accomplish the first purpose of the relay walkdown, the cabinets or panels which house essential relays should be identified and the information needed to determine in-cabinet amplification should be reviewed. A Seismic Capability Engineer and a Relay Reviewer (as defined in Section 2) should accomplish this purpose.

The second purpose, evaluation of the seismic adequacy of the cabinet or enclosure supporting the relay, should be done as a part of the Screening Verification and Walkdown as described in Section 4. Note that the cabinets or enclosures supporting essential relays should be identified prior to this walkdown.

The third purpose of the relay walkdown is to spot check relay mountings to confirm that relays are mounted in accordance with manufacturer's recommendations. The objective of the spot checks is to identify any abnormal or atypical relay mounting techniques. The specific number of relays to be checked is not quantified because the bulk of the relays addressed in the relay evaluation procedure are typically located in a few specific plant areas and can be easily checked. Most of the relays encountered in the relay evaluation can be checked by opening relay cabinets in the following plant areas:

- Control room
- Relay room or auxiliary control room
- Switchgear rooms
- Diesel generator control panel area

Spot-checking relay mountings can be performed during a separate relay walkdown by personnel familiar with relay installation. Alternatively, relay mountings may be spot checked during the seismic walkdown when in-cabinet amplification information is gathered. Special preparation or training is not required for spot checking relay mountings. Indications such as proper relay label orientation, mounting bolts in place and tight, and whether the relay is snug in its mounting bracket are sufficient to judge the adequacy of the mounting; analytical checks are not intended except as a means to verify atypical mountings.

The fourth purpose of the relay walkdown is to confirm relay types and locations. This can be performed at the same time that the relay mountings are checked and by the same individuals. The approach for confirming relay types by the relay walkdown team includes noting relay types observed in the cabinets and then comparing this with the relays identified on electrical drawings. It is important to note that relay mountings are considered to be standard and the circuit drawings are assumed to be correct and up-to-date. Spot checks of the relay mountings and relay types are a mechanism to confirm these assumptions. Any significant spot check discrepancies will necessitate more thorough relay inspections.

6.6 OUTLIERS

An outlier is defined as an essential relay which does not meet the screening guidelines for:

- Comparison of relay seismic capacity to seismic demand as given in Section 6.4 or,
- Relay mounting as given in Section 6.5.

When an outlier is identified, proceed to Section 5, Outlier Identification and Resolution, and document the cause(s) for not meeting the screening guidelines. The Outlier Seismic Verification Sheet (OSVS), found in Exhibit 5-1, should be used.

The screening criteria given in this section are intended for use as a generic basis to evaluate the seismic adequacy of essential relays. Therefore, if an essential relay fails this generic screen, it may not necessarily be deficient for seismic loading; however, additional evaluations are needed to show that it is adequate. Some of the additional evaluations and alternative methods for demonstrating seismic adequacy are summarized below. Generic methods for resolving outliers are also provided in Section 5.

- Refine the seismic screening requirements and/or analyses.
- Test the relay and/or the cabinet in question.
- Re-design and modify the circuit to make the relay function nonessential.
- Relocate the relay to reduce the seismic demand imposed upon it.
- Replace the relay with a seismically qualified one.
- Stiffen the relay mounting.
- Use other justifiable approaches.

6.7 DOCUMENTATION OF RESULTS

The required documentation for the relay evaluation is described in Section 9. In addition, the relay functionality screening and evaluation procedure in Reference 8 defines the recommended documentation for plant-specific relay evaluations. This Reference 8 documentation consists of tabulation forms which provide a record of the evaluation and includes:

- Identification and listing of all safe shutdown equipment for relay evaluation.
- Identification and listing of all relays or groups of relays which affect the operation of the safe shutdown equipment. The documentation should be sufficiently detailed such that a reviewer can trace the conclusions reached regarding the effect of relay malfunction on operation of any safe shutdown item of equipment. The relays (including all contact

devices) which are screened out because chatter is acceptable or by use of the other screening approaches which do not require relay-specific evaluation do not need to be identified individually. Only the essential relays which require relay-specific seismic capacity evaluation need to be individually identified.

- Identification of essential relays in switchgear.
- Functional screening results.
- Comparison of relay seismic capacity to seismic demand results.
- Identification of cabinets, panels, and other enclosures which house essential relays.
- Results of walkdown spot checks.
- Outliers, if any.
- Recommended corrective actions.

By using the tabulation forms provided with the relay evaluation procedure, every relay and contact (or group of relays and contacts when appropriate) in the control circuits for a safe shutdown item of equipment should be identified and referenced to a plant drawing providing traceability. These forms also provide for documentation of the conclusion of the evaluation made for each relay and contact or each group of relays and contacts. If any of the essential relays are classified as outliers, the Outlier Seismic Verification Sheet (OSVS), found in Exhibit 5-1, should be completed to document the cause(s) for not meeting the screening guidelines described in this section.

A full list of all the information which should be documented is described in Section 9 of the GIP, including information to be retained for later reference and information to be submitted to the NRC.

REASONS FOR CHANGES TO GIP, PART II, SECTION 6

Listed below are the specific reasons for making the changes marked with a vertical line in the margin of this section to create GIP-3A from GIP-3, Updated 5/16/97. The endnote numbers listed below correspond to the bracketed numbers (e.g., [1]) located in the text of this section where the changes are made.

---

[1] SSER No. 2, Sec. II.4.1 – The Staff position is that the licensee must commit to both the SQUG commitments and the use of the entire implementation guidance provided in GIP-2, unless otherwise justified to the staff as described in GIP-2 and SSER No. 2.

The GIP has been amended in the "SQUG Commitments" sections of Part II to reiterate the requirement contained in the GIP, Part I, Section 1.3 to (1) provide written justification to the NRC for prior approval of any substantial deviations from the SQUG commitments and (2) notify the NRC of significant or programmatic deviations from the GIP guidance no later than the summary report.

[2] SSER No. 2, Sec. II.6.1 – The Staff position is that relays must be shown to have adequate seismic capacity not only in the frequency range from 4 – 16 Hz, but also at the ZPA

The GIP has been amended in Part II, Section 6.4.2, Screening Levels 2 and 3 to address the Staff position. Addendum 1 of the EPRI Report NP-7148 (Reference 8) also requires this ZPA check to be performed for GERS screening of switchgear (SWGR) and motor control centers (MCCs).

[3] SSER No. 2, Sec. II.6.2 – The Staff position is that the 0.6 reduction factor developed in GIP Reference 33 is only applicable for the electrical benchboards and panels covered by that reference. For other types of cabinets, panels, or enclosures, the user must justify and document the basis for the reduction factor using procedures described in Reference 2 of Section 4 of GIP Reference 33.

The GIP has been amended in Part II, Section 6.4.2, Screening Level 2, Table 6-2 to address the Staff position.

[4] SSER No. 2, Sec. II.6.3 – The Staff position is that the GENRS software may be used only for determining in-cabinet amplified response spectra of electrical benchboards and panels as defined in Reference 33. GENRS should not be used for other types of cabinets, panels, or enclosures, without the review and approval of the NRC Staff.

The GIP has been amended in Part II, Section 6.4.2, Screening Level 3 for "Control Room Benchboards and Panels" to address the Staff position.