UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

Docket File

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Docket Nos.: 50-322/50-341/50-352/50-353/50-354/50-373/50-374/50-410
50-416/50-417/50-440/50-441/50-458/50-459/50-461/50-462

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Dear Mr. Carolyn:

Subject: Interim Staff Evaluation Findings Pertaining to Setpoint Methodology for General Electric Supplied Protection Systems Instrumentation

The purpose of this letter is to provide you with the NRC staff's interim evaluation of the General Electric Owners Licensing Review Group (LRG) information, transmitted by your letter dated September 24, 1984, in which the staff's review and analysis of that information was requested before proceeding further with the setpoint methodology program.

During the latter part of CY1982, the NRC staff requested several Operating License applicants with General Electric nuclear steam supply systems to document the methodology used to establish the protection system actuation instrumentation setpoints in plant Technical Specifications. On January 31, 1984, the staff met with the LRG and GE to hear a presentation on this issue.

A staff report was issued on May 15, 1984 which contained the findings that resulted from its review of the information presented by the LRG and GE during meetings held in Bethesda on July 14, 1983 and January 31, 1984, relative to the GE-supplied protection system instrumentation setpoint methodology. That report identified areas of the proposed setpoint methodology which needed to be further evaluated by GE to fully resolve the staff's concerns. Section 5 of that report summarized the areas of concern, and provided the staff's recommendations for resolution. The areas of concern stated therein were:

- Environmental effects
- Validation of design allowables
- Technical Specification trip setpoints and allowable values
- Extrapolation of manufacturer's performance specifications
- Calibration error validation
- Statistical methods
- Computer modeling conservatisms
- Safety limits
- Instrument setpoints outside the NSSS
- Documentation

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Several of these areas of concern were new, reflecting the results of the review of material presented for the first time at the January 31, 1984 meeting. They highlighted the staff's underlying concern that, although the use of the setpoint methodology developed up to that time had not resulted in transients exceeding safety limits, for limiting cases, the margins had been inadequately justified or supported.

Confirming agreements reached at a subsequent meeting between the staff and the LRG on April 12, 1984, during which time a draft of the May 15, 1984 staff report was screened for proprietary information, the LRG was to provide the staff a plan of action scoping the additional work to be contracted with GE to address the unresolved areas listed above and detailed in the staff's May 15, 1984 report. The LRG plan was submitted by your letter to T. M. Novak dated June 29, 1984, in which the staff's concurrence with the work scope was requested before commissioning GE to proceed. The staff's concurrence with the LRG work scope was communicated in my letter to you dated July 23, 1984.

Prior to issuance of the staff's report, the LRG presented information needed to resolve a number of concerns transmitted in your most recent letter dated September 24, 1984. That letter provided interim information regarding three of the ten areas of concern discussed in the staff's report which were: (1) NRC Concern 5.6, Statistical Methods; (2) NRC Concern 5.7, Computer Code Modeling Conservatisms; and (3) NRC Concern 5.8, Safety Limits.

The staff has reviewed the interim information provided relative to Sections 5.6, 5.7 and 5.8 of the May 15, 1984 report, and it has concluded that these concerns are satisfactorily resolved. The staff's detailed findings are enclosed. As previously noted, the staff would like to emphasize however, that each LRG member should perform a confirmatory review of their plant-specific Technical Specifications, predicated on the revised GE methodology, and the results documented in a report to the NRC. The report should be submitted within 6 months after being notified of the staff's acceptance of the revised GE methodology.

The staff has suggested that another meeting with the LRG would be helpful in resolving the remaining concerns addressed in Section 5 of the staff's report. It is therefore requested that you advise Mr. John J. Stefano of my staff when such a meeting can be scheduled.

Sincerely,

Paul W O'Connor for BJY

B. J. Youngblood, Chief
Licensing Branch No. 1
Division of Licensing

Enclosure: As stated

cc: See next page

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EVALUATION OF LRG INTERIM REPORT ON SETPOINT METHODOLOGY (SEPTEMBER 24, 1984)

NRC Concern 5.6, Statistical Methods

As discussed in Section 4.0 of the report, for certain instrument channels, statistical methods were used to combine instrument uncertainty allowances to show the margin provided between the trip setpoint and the analytic limit. It is the staff's concern that the statistical methods used may have included certain non-conservative aspects. One non-conservatism already discussed is the neglecting of environmental effects (See Section 5.1 of the report). Another is the treatment of certain variables as independent.

As discussed in Section 5.5 of the report, calibration error can be attributed to a number of factors including those related to human factor considerations, calibration equipment, and procedural requirements. These error factors, in combination with component drift, tend to come together as a singular error component in their effects on the input/output relationship of a transmitter or trip unit. When summing these errors statistically they should be added into one unit; that total error may then be used in a statistical summation. If, for example, the square root of the sum of the squares method were used, the following would be an appropriate method to consider the dependent variables associated with drift [(sensor drift + human factor calibration considerations + calibration equipment inaccuracy + error band allowed by procedure)^2 + (trip unit drift + human factor calibration considerations + calibration equipment inaccuracy + error band allowed by procedure)^2 + $(x)^2$ + $(y)^2$ + $(z)^2]^{1/2}$. In this equation, x, y and z represent independent error contributors to the total channel error. It was the staff's recommendation that the methods described above or other appropriate methods be used to treat the dependent variables associated with drift and calibration inaccuracy.

To facilitate referring to these terms, the following definitions and expressions should be used:

For the measurement signal, v:

v1 = sensor drift

v2 = human factor calibration considerations (applicable to the sensor)

v3 = equipment calibration inaccuracy (applicable to sensor)

v4 = error band allowed by procedure (in calibration of sensor)

For the reference signal, w:

w1 = trip unit drift

w2 = human factor calibration considerations (applicable to the trip unit)

w3 = calibration equipment inaccuracy (applicable to the trip unit)

w4 = error band allowed by procedure (in calibration of trip unit)

For the (measurement - reference) signal difference:

x = an independent error contributor to total channel error

y = an independent error contributor to total channel error

z = an independent error contributor to total channel error

The expression in the first paragraph now can be written as:

$$((v1 + v2 + v3 + v4)^2 + (w1 + w2 + w3 + w4)^2 + x^2 + y^2 + z^2)^{1/2}.$$

Terms v1 and w1 involve drift; and v2-4 and w2-w4 involve the calibration procedures. To further facilitate discussion, this expression can be broken down into two major algebraic expressions which are:

$$v1 + v2 + v3 + v4 \text{ and } w1 + w2 + w3 + w4.$$

According to General Electric's definitions, these terms are defined as follows:

Drift, terms v1 and w1, is a selected number of standard deviations in the distribution of random values which characterize the difference between initial and final indicated signal values, as that value might change over a relatively long period of time between calibration and check due to some type of sensor deterioration, for example, exclusive of the parts of the initial and final indications which reflect random error due to all aspects of the calibration procedure and to instrument accuracy. Thus, drift is "pure" long term change in indication for the same true value. Its value exists conceptually; it could be found in practice by averaging many initial readings and many final readings before taking the difference. (Thus, GE infers that "drift" is different from the "drift allowance" or "reading-difference allowance" which appears in the GE setpoint methodology as the adjustment on Allowable Value to reach to Nominal Trip Setpoint (NTSP)).

Human factor calibration considerations, terms v2 and w2, is a selected number of standard deviations in the distribution of random errors introduced in the calibration process, both initial and check, by the human element. These errors have to do with the ability of the operator to interpret the procedure and accurately read the calibration instruments. GE has taken the position that these errors are totally unrelated to, and independent of, either drift or factors affecting the correctness of the calibration equipment.

Calibration equipment inaccuracy, terms v3 and w3, is a selected number of standard deviations in the distribution of random errors in the calibration process due to any physical instability or incorrectness of the equipment used in the calibration. GE believes that this term is totally equipment related, and independent of drift or human factors involved in use of the equipment.

Error band allowed by the procedure, terms v4 and w4, involves a practice in which there is a range, upon a check calibration, within which no adjustment of the calibration would be made. It is anticipated that such a range would be a reflection of the random errors affecting the indicated value due to the calibration process and to instrument accuracy at the times of both the initial and check calibrations. GE has accounted for these errors in the other terms discussed above, and believes there is no need to account for them a second time. Therefore, GE has chosen to omit this term.

In a given application, the number of standard deviations selected must be consistent for each term. GE ordinarily uses two standard deviations. Typically, the NRC staff has accepted 95% as a probability limit for errors. That is, of the observed distribution of values for a particular error component in the empirical data base, 95% of the data points will be bounded by the value selected if the data base follows a "normal" distribution. This corresponds to an error distribution approximately equal to a "two sigma" value.

In general, the error values discussed above are consequences of one or more physical causes. GE has taken the approach that different physical causes account for the values of each of the error terms in the above expressions, and that those causes operate independently to assign a random error value to each term, at a point in time. Based on our review of this information, the staff has concluded that the probability of occurrence of two or more events (errors) is not influenced by the occurrence of any of them on the other and, therefore, the staff agrees with the LRG that these errors are independent. The error values for the above discussed terms cannot reasonably be expected to move in concert. Thus, different error values apply to each term and these can be chosen from their distributions independently.

The selection of the method to be used for analyzing and combining uncertainties in determining the allowable value for the safety limit may be based on the "square root of the sum of the squares" method since the above terms are independent and no common error source exists. Therefore, the expression can be written as the sum of squared standard deviations rather than as an absolute sum. The expression now becomes $(v1^2 + v2^2 + v3^2 + w1^2 + w2^2 + x^2 + y^2 + z^2)^{1/2}$.

The staff has concluded that this portion of the setpoint methodology meets the relevant Commissions regulations. (General Design Criterion 20, 10 CFR Part 50.36 and Part 50.46). Further, the LRG has followed the guidance contained in Regulatory Guide 1.105, "Instrumentation Setpoints," including the additional information provided in ISA Standard S67.04, "Setpoints for Nuclear Safety-Related Instrumentation Used in Nuclear Power Plants."

NRC Concern 5.7, Computer Code Modeling Conservatisms

As discussed in Section 4.0 of the report for the APRM scram functions evaluated, the statiscally determined sum of the instrument channel bias and uncertainty exceeded the analytic limit. To justify the proposed setpoints credit was taken for conservatisms in the core transient models. NEDO-24154, "Qualification Of The One-Dimensional Core Transient Model For Boiling Water Reactors" (ODYN) October 1978 and NEDO-24011 PA Rev. 6 "GESTAR - Reload Licensing Topical Report" contained the codes used.

By letter dated February 4, 1981 from R. Tedesco (NRC) to G. Sherwood (GE), the NRC documented its findings on ODYN in an SER. As discussed in the staff's SER, the code represents a best estimate calculation. From the review of the test program undertaken by General Electric to verify ODYN's analytical methods, the staff found that the code either over or under predicted peak pressures at various reactor coolant system locations. A review of the test results indicated that all model conservatisms claimed by General Electric such as those associated with the calculation of the steam dome pressures and neutron flux, the colapsing of 3-D core neutronics and thermal hydraulics, the gap conductance input parameters and any other conservatism claimed in the computer model are either so small that it did not make any difference in the calculated delta Critical Power Ration (CPR) for these tests or all of these claimed conservatisms are offset by an unidentified nonconservatism somewhere else, perhaps in calculation of vessel flow. Based on a review of the evaluation of the codes contained in the SER, the staff finds that the credit taken in the instrument setpoint evaluation for code modeling conservatisms has not been justified. Therefore, it was the staff's recommendation that the instrument setpoints be revised or that an equivalent margin from some other source be shown to account for the instrument bias and uncertainty.

By letter dated April 13, 1983 from C. Thomas (NRC) to J. Charnley (GE), the NRC documented its findings on GESTAR in an SER. As discussed in the staff's SER, the review focused on the barrier fuel design. It was not apparent that the 3-D transient modeling code was thoroughly addressed in GESTAR. As such, the staff recommended that the LRG provide a discussion of the code and any test programs undertaken to verify its analytical methods, or the instrument setpoints be revised, or an equivalent margin from some other source be shown to account for the instrument bias and uncertainty.

By letter dated September 24, 1984 from John F. Carolan to B. J. Youngblood, the LRG provided a response to this concern which consisted mostly of General Electric Company Proprietary Information. In this response GE presented a discussion and an analysis that illustrated the model conservatisms claimed were less than the actual model conservatism. While we disagree somewhat with the setpoint methodology that GE has used, the staff concludes that the calculated model conservatisms as shown are acceptable. However, the staff is very much interested (as part of GE's final response to this concern) in reviewing the computer model conservatisms calculated for the reactor trip caused by an increasing reactor power event. Therefore, we request that the computer code modeling conservatisms for this event be calculated by GE and included as part of its final response. The staff is currently verifying the GE analysis, the values assumed for the various parameters, and the resulting consequences.

NRC Concern 5.8, Safety Limits

As discussed in Section 4.0 of the report, the reactor high pressure trip setpoint was evaluated to show that with the combined design allowances for uncertainties, the trip function would be accomplished prior to exceeding a 1500 psig safety limit. At the January 31, 1984 meeting, the staff questioned the LRG's basis for choosing 1500 psig as a safety limit. The LRG stated that this value represented 125 percent of the reactor vessel design pressure.

As discussed in Sections 3 and 4 of the report, each facility's technical specifications define plant specific safety limits. For reactor vessel pressure, 110 percent of vessel design pressure is the safety limit which is 1375 psig for the BWRs currently undergoing licensing review. Therefore, it was the staff's requirement that safety limits as defined in the technical specifications must be used in the setpoint methodology calculations.

GE stated that for most transient events presented in the FSAR are in the moderate category (Service Level B* or Upset), the criteria stated in the FSAR

*The ASME Boiler and Pressure Vessel Code, Section III, Nuclear Power Plant Components, recognizes the difference between more and less frequent situations. This is the reason for the categories of events called Service Level A, B, C and D in ASME code paragraph NCA-242.2. Earlier usage called the categories Normal, Upset, Emergency, and Faulted.

clearly applies to that type of event. The criteria states (among other details) that the peak pressure must be limited to less than 110% of the design pressure of the vessel. For GE BWRs, vessel design is usually at 1250 psig, so this Upset limit is 1375 psig. The plant is designed and evaluated to show that the combination of scram and safety-relief valves maintains peak pressure within this limit. Chapter 5 of each FSAR shows that this limit is met for the worst upset category events.

For all current plants, the worst event is the MSIV closure with failure of the position switch scram. High flux scram and the safety-relief valves must provide protection below the Upset limit. However, this event plus the failures is a very remote situation. It is expected to be in the low-frequency range which is considered by the ASME to be Emergency: however, it is conservatively evaluated in the current FSARs as an Upset event. The case discussed in the setpoint methodology review (noted above) assumed even further failures, i.e., an APRM high flux scram failure. GE believes the likelihood of this event along with the additional failures is beyond the upset (service level B) range and based on the ASME code this scenario would be classified service level D or faulted. GE has conservatively applied the service level C or energency overpressure criteria.

The ASME code, Paragraph NB-3224.1 allows the equivalent of 120% overpressure in this category, which is 1500 psig for all current GE BWRs. GE has stated that ASME vessel design practice has always recognized these categories and vessel design stress analyses include several Emergency and Faulted situations.

No relaxation of limits for the more frequent events is proposed, in fact the setpoint methodology presentation explicitly includes the Upset limit for the APRM high neutron flux setpoint evaluation. The 1500 psig limit application of the ASME Emergency limit is only being used by GE for an event that is clearly in that remote range of occurrence. GE has provided calculations that show the failure of two reactor protection system functions clearly fit this category. The staff has reviewed the LRG response to this concern and concludes that the information is valid and that the safety limit of 1500 psig chosen for the event analyzed (service level C) is acceptable. However, the staff is currently verifying the accuracy of the risk analysis used to reach the LRG's conclusion.