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JAN 11 1983

Docket Nos. 50-280
and 50-281

Mr. W. L. Stewart
Vice President - Nuclear Operations
Virginia Electric and Power Company
Post Office Box 26666
Richmond, Virginia 23261

Dear Mr. Stewart:

SUBJECT: NUREG-0737 II.F.1.4 Containment Pressure Monitor
II.F.1.5 Containment Water Level Monitor
II.F.1.6 Containment Hydrogen Monitor

Re: Surry Power Station, Unit Nos. 1 & 2

The staff is conducting a post implementation review of NUREG-0737 Items II.F.1.4, II.F.1.5, and II.F.1.6. We have reviewed your submittals and have identified in Enclosure 1, those areas which we need additional information to complete our review. Enclosure 2 contains guidance on answering some of the questions. You are requested to provide the additional information within 30 days of receipt of this letter.

This request for information was approved by the Office of Management and Budget under clearance number 3150-0065 which expires May 31, 1983.

Sincerely,

Original signed by:
S. A. Varga

Steven A. Varga, Chief
Operating Reactors Branch No. 1
Division of Licensing

Enclosures:
1. Request for Information
2. Clarifications

cc w/enclosures:
See next page

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REQUEST FOR ADDITIONAL INFORMATION ON NUREG-0737 ITEMS

II.F.1.4 CONTAINMENT PRESSURE MONITOR
II.F.1.5 CONTAINMENT WATER LEVEL MONITOR
II.F.1.6 CONTAINMENT HYDROGEN MONITOR

(1) EXCEPTIONS BEING TAKEN TO NUREG-0737 REQUIREMENTS

The submittals we have received to date do not indicate that you plan to take any exceptions to the NUREG-0737 requirements in our scope of review. Please indicate any exceptions you plan of which we are not aware. For each exception indicate (1) why you find it difficult to comply with this item, (2) how this exception will affect the monitor system accuracy, speed, dependability, availability, and utility, (3) if this exception in any way compromises the safety margin that the monitor is supposed to provide, and (4) any extenuating factors that make this exception less deleterious than it appears at face value.

(2) II.F.1.4 - PRESSURE MONITORING SYSTEM (PMS) - ACCURACY & TIME RESPONSE

(2a) Provide a block diagram of the configuration of modules that make up your PMS. Provide an explanation of any details in the block diagram that might be necessary for an understanding of your PMS accuracy and time response.

(2b) For each module provide a list of all parameters* which describe the overall uncertainty in the transfer function of that module.

(2c) Combine** parameters in 2b to get an overall system uncertainty. If you have both strip chart recorder and indicator output, give the overall system uncertainty for both systems. If you have systems spanning different ranges, give the overall system uncertainty for each system.

(2d) For each module indicate the time response***.
For modules with a linear transfer function, state either the time constant, τ, or the Ramp Asymptotic Delay Time, *RADT*.
For modules with an output that varies linearly in time, state the full scale response time. (Most likely the only module you have in this category is the strip chart recorder.)

(2e) We will compute the overall system time response for you****.

(3) II.F.1.5 ---- WATER LEVEL MONITORING SYSTEM (WLMS) ---- ACCURACY

(3a) Provide a block diagram of the configuration of modules that make up your WLMS. Provide an explanation of any details in the block diagram that might be necessary for an understanding of your WLMS accuracy.

(3b) For each module provide a list of all parameters* which describe the overall uncertainty in the transfer function of that module.

(3c) Combine** parameters in 3b to get an overall system uncertainty. If you have both strip chart recorder and indicator output, give the overall system uncertainty for both systems. If you have systems spanning different ranges, give the overall system uncertainty for each system.

(4) II.F.1.6 ---- HYDROGEN MONTIOR SYSTEM (HMS) ---- ACCURACY & PLACEMENT

(4a) Provide a block diagram of the configuration of modules that make up your HMS. Provide an explanation of any details in the block diagram that might be necessary for an understanding of your HMS accuracy. If you have different types of HMSs give this information for each type.

(4b) For each module provide a list of all parameters* which describe the overall uncertainty in the transfer function of that module.

(4c) Combine** the parameters in 4b to get an overall system uncertainty. If you have both strip chart recorder and indicator output, give the overall system uncertainty for both systems.

(4d) Indicate the placement and number of hydrogen monitor intake ports in containment. Indicate any special sampling techniques that are used either to examine one region of containment or to assure that a good cross section of containment is being monitored.

(4e) Are there any obstructions which would prevent hydrogen escaping from the core from reaching the hydrogen sample ports quickly?

CLARIFICATIONS

* UNCERTAINTY PARAMETERS

The measure of overall system uncertainty we wish to obtain is the standard deviation, S. In order to compute the overall standard deviation of a system we need the standard deviations of each type of measurement error associated with each module. Therefore all module uncertainty parameters should be expressed as one standard deviation. Also, to simplify the final computation, all uncertainty parameters should be expressed as a percentage of full range of the module.

We will assume that all error components have a normal density function unless some other density function is specifically indicated.

The vendor may quote the upper limit for a random variable which is either implicitly or explicitly assumed to have a normal density function. In this case, by convention, one third the upper limit can be taken as the standard deviation. The convention of using this as the standard deviation is based on the fact that if a random sample of *1000* values of the variable are drawn from the parent population of that variable, then we would expect about *997* of the values to be less than three standard deviations. Thus three standard deviations is a good practical upper limit for the variable. (By comparison we would expect about *683* of the values to be less than one standard deviation.)

Generally, the greatest part of the uncertainty of the transfer function of a module is the random bias, and when the vendor quotes only one number as a measure of module accuracy, this number is a measure of the random bias.

In addition to the random bias, other factors which may contribute to the overall uncertainty in the transfer function of a module are:

(1) Random error. (Sometimes called reproducability, repeatability, or precision.)

(2) Uncertainty due to temperature effects. (State environmental conditions.)

(3) Uncertainty in power supply voltage.

(4) Flow measurement uncertainty for the hydrogen monitor.

(5) If the transducer and transmitter are separate modules, be sure to consider the uncertainty in each.

(6) Hysteresis effect.

(7) Deadband effect.

** STANDARD DEVIATION OF TOTAL SYSTEM UNCERTAINTY

To obtain the standard deviation of the total system uncertainty, the standard deviations of the module random biases can be combined Root-Sum-Square (RSS). Also the standard deviations of the first 5 of the 7 items listed under (*) can be combined in the same RSS. Call the final result
$S(total\ system,\ bias\ etc.) = S(s,b)$

For systems exhibiting hysteresis and deadband effects, the standard deviation of the total error is a function of the pattern of time variation of the monitored variable. Hence it is not possible to derive an algorithm for the standard deviation that is applicable to all cases. The following algorithm, which is developed in reference 2, provides an upper bound for the standard deviation in virtually any realistic situation, and we recommend that all licensees use this algorithm for computing hysteresis and deadband errors.

(1) Determine the hysteresis loop half width, $H(j)$, and the deadband half width, $D(j)$, for each module (j). Note that for most modules $H(j)$ and $D(j)$ are zero.

(2) Combine the $H(j)$ and $D(j)$ to obtain the total system half widths, $H(s)$ and $D(s)$. If the system is composed of a string of components then the system half widths are simply the sum of the module half widths. If the system configuration is other than a string of modules we leave it to the licensee to devise a method for combining module half widths.

(3) The standard deviation of the total measurement error is bounded by the following formula:

$$S^2(total\ system) = S^2(s) = S^2(s,b) + H^2(s) + H(s) * D(s) + D^2(s)/2$$

*** MODULE TIME RESPONSE

Generally we deal with modules that have one of two types of time response:

(1) Modules with a response that is linear in time, such as a strip chart recorder. Here the measure of time response that is usually quoted is the time, T, required for the module output to traverse *100%* of its range. The time required for the module to traverse $x\%$ of its range is then $x\%$ of T.

(2) Modules with Linear Transfer Functions (LTFs).
By definition an LTF module produces an output function such that a specific linear combination of the input function plus its time derivatives is equal to a specific linear combination of the output function plus its time derivatives. For any realistic LTF module, the highest order output time derivative is greater than the highest order input time derivative.

For LTF modules, a step function impressed on the input produces an output that is a linear combination of a step function plus a series of exponentials. Frequently for practical purposes a Higher Order Transfer Function (HOTF) can be adequately approximated by a First Order Transfer Function (FOTF). A step function impressed on the input of a FOTF module produces an output with only one exponential term, which makes the analysis of a FOTF module particularly simple.

For LTF modules the measure of time response most frequently quoted is the time constant, τ, which is defined as the time required for the output to reach *63.2%* of its final response after having a step function impressed on the input. For FOTF modules the single exponential term is $exp(-t/\tau)$, so that τ is a physically significant quantity for FOTF modules. For HOTF modules, τ is simply a figure used to compare the relative merit of different modules, and has no underlying physical significance as it did for FOTF modules.

By convention the time required for a LTF module to reach *100%* of its response after a step function is impressed on the input is taken to be 4τ. (Some people prefer to use 5τ, but both the numbers *4* and *5*, or anything else one might want to use, is an arbitrary convention.)

Sometimes the time response to a step function change in the input is measured in some other way, for example the vendor may quote the time required for the module output to go from *0%* to *90%* of its final response. In this case if the FOTF approximation is made, the single exponential term, $exp(-t/\tau)$, can be fit to the two data points, and the value of τ determined.

Another useful measure of a LTF module time response is the Ramp Asymptotic Delay Time (*RADT*), which is defined as the time by which an input ramp function leads the output ramp function after the initial transient has died out. For FOTF modules τ and *RADT* are identical. For HOTF modules τ and *RADT* are different. They have different definitions, and different numerical values. However in practice it is found that τ is always equal to or slightly greater than *RADT*, the largest difference being about *2%*. This difference is much less than the experimental error incurred in measuring τ or *RADT*. Thus for practical purposes the numerical values of τ and *RADT* can be considered to be identical.

The following discussion may be useful to some licensees. For LTF modules the time response is sometimes measured by inputting sinusoidal signals at two different frequencies, ω_1 and ω_2, and observing the (output signal amplitude)/(input signal amplitude), $A(\omega_1)$ and $A(\omega_2)$. If the time response is quoted in terms of these parameters, then for a FOTF module *RADT* is given by the following formula, which is developed in reference 2.

$$A^2(\omega_1) * [1 + \omega_1^2\tau^2] = A^2(\omega_2) * [1 + \omega_2^2\tau^2]$$

The above formula is exact for FOTF components and for HOTF components the formula provides a conservative estimate of *RADT* if ω_1 and ω_2 are chosen in the proper range. However, if ω_1 and ω_2 are not in the proper range the value of *RADT* computed from the formula will, at worst, be only slightly nonconservative. (The maximum achievable nonconservatism for pressure transducers is about *10%*. For other types of modules the nonconservatism may be significantly higher.) We do not require the licensees to show that ω_1 and ω_2 are in the proper range because our acceptance criteria for the value of τ (or *RADT*) is sufficiently flexible to permit this small nonconservatism in the computed value of *RADT*.

**** SYSTEM TIME RESPONSE

The overall time constant for a string of LTF modules is a complicated function of the time constants of the individual modules. This overall time constant must be computed iteratively, and the computation is most easily done with the help of a computer. We have a computer programmed to do this computation, and are planning to do the computation with the data from all licensees. This program and its mathematical basis are described in reference 1.

REFERENCES

Some analytical methods described in the clarifications are developed in the following internal NRC memoranda. These memoranda will be provided to any licensee upon request.

(1) Memorandum from Peter S. Kapo to Walter R. Butler, dated 12 April 82, Subject: NUREG-0737, Item II.F.1.4, Containment Pressure Monitor System, Method for Estimating the Combined Time Constant of a String of Components each of which has a Known Time Constant.

(2) Memorandum from Peter S. Kapo to Walter R. Butler, dated 23 August 82, Subject: NUREG-0737, Analytical Solution to Two Problems Pertinent to Items II.F.1.4,5,6: (1) Statistical Treatment of Hysteresis and Deadband Errors, and (2) Determination of the Time Constant of a First Order Transfer Component from Variation with Frequency of Sinusoidal Output.