NORTHEAST UTILITIES

THE CONNECTICUT LIGHT AND POWER COMPANY
THE HARTFORD ELECTRIC LIGHT COMPANY
WESTERN MASSACHUSETTS ELECTRIC COMPANY
HOLYOKE WATER POWER COMPANY
NORTHEAST UTILITIES SERVICE COMPANY
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March 28, 1979

Docket No. 50-336

Director of Nuclear Reactor Regulation
Attn: Mr. R. Reid, Chief
Operating Reactors Branch #4
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

References: (1) D. C. Switzer letter to G. Lear dated October 24, 1977.
(2) D. C. Switzer letter to R. Reid dated March 21, 1978.
(3) R. Reid letter to W. G. Counsil dated December 28, 1978.
(4) J. F. Opeka letter to B. H. Grier dated March 8, 1979.

Gentlemen:

Millstone Nuclear Power Station, Unit No. 2
Resistance Temperature Detectors

In References (1) and (2), Northeast Nuclear Energy Company (NNECO) proposed a change to Technical Specifications to increase the allowable resistance temperature detector (RTD) time constant from five (5) to ten (10) seconds. This proposed revision was approved in Reference (3) at which time NNECO was requested to provide information concerning a new method of testing the response time of the RTD's developed by Analysis and Measurement Services.

The attached report, in response to this request, provides the NNECO evaluation of the Loop Current Step Response (LCSR) method of in-situ response time testing of RTD's. A description of the testing method with appropriate references is included as well as the LCSR test results and a comparison to test results given by plunge tests. Note that as a result of the attached evaluation, NNECO has identified LCSR as the preferred test method. In the future, LCSR response time testing will be used to verify Technical Specification surveillance requirements.

We trust the attached information is response to your request.

Very truly yours,

NORTHEAST NUCLEAR ENERGY COMPANY

W. G. Counsil

W. G. Counsil
Vice President

Attachment

7903300389

MILLSTONE UNIT NO. 2

REACTOR COOLANT RTD RESPONSE TESTS

Introduction

An evaluation of the Loop Current Step Response (LCSR) method of in-situ surveillance response time testing of precision RTD's as performed by Analysis and Measurement Services (AMS) is discussed.

Data is tabled showing comparative LCSR versus plunge test results. This data, in conjunction with EPRI reports referenced below establishes the suitability of LCSR for determining the time constants of the RTD's installed in the reactor coolant system used at Millstone Unit No. 2.

It is concluded that credit for LCSR to perform response time surveillance testing in accordance with Tech Spec Tables 3.3-2 and 4.3.1 is technically acceptable.

Basis of Evaluation

A form of "in-situ" testing for RTD's spring-mounted in thermal wells (permanently welded into reactor coolant piping) has been considered the only technically sound way of obtaining truly valid RTD response time, due to time conditioned effects of heat transfer between the well metal and the bulb sheath metal. Heat transfer effects are unpredictable under differing interface contact conditions, and any possible but immeasurable crud build-up on the outside of the well.

This situation was recognized by several University of Tennessee authors/investigators in making EPRI Report NP-459 "Response Testing of Resistance Thermometers", published January, 1977. A subsequent, superseding report, NP-834, published July, 1978, was more aptly entitled "In-Situ Response Testing of Platinum RTD's".

Of the three in-situ test methods referenced and currently available, we consider the LCSR to be the most practical and reliable. MP-2 test data is based on this method carried out on two occasions and compared with Rosemount factory Plunge tests performed in June, 1977.

Of the two remaining in-situ test methods, the self-heating method appears incapable of providing any absolute values of time constant, while the Noise Analysis Method has a basic requirement that the thermal fluctuations be in the form of "white noise" (i.e., of a purely random, unforced nature). In PWR coolant systems such noise form cannot be assured during the time it is desired to do a test. Furthermore, an excessively sophisticated computer mathematical time series analysis is required to obtain RTD time constant values.

Synopsis of LCSR Test Method (Ref. EPRI NP-834)

The temperature transient due to a step change in the I^2 R heating of the sensor filament is analyzed to determine the response that would have resulted from a fluid temperature change, hence providing data from which time constant may be obtained.

The LCSR test exploits the fact that heat transfer resistances and heat capacities are independent of the direction of heat flow. It follows that the same heat transfer characteristics which control the transient response following a change in ohmic heating in the sensor also control the transient response subsequent to a change in fluid temperature.

A mathematical transformation has been developed to provide conversion from LCSR response data to that which would have resulted from a step change in fluid temperature. This transformation/conversion is fully described in EPRI NP-459 and 834, which is shown to yield values that are 10% to 20% less than the results of plunge tests done under laboratory conditions.

AMS has developed correction factors, based on the ratio of the first two exponential coefficients (as measured by LCSR). The application of these factors conservatively corrects for any disparity between plunge and raw LCSR time constant data. This result has been confirmed by extensive laboratory tests.

MP-2 RTD Response Reports (Table Attached)

The original factory tests were done in December, 1972, in accordance with Rosemount QA procedures, using RTD's with machined tapered tips, spring loaded into matching internally tapered wells. Certified results were provided by the manufacturer, which results were accepted as the valid response times. Time constants were obtained for each RTD/Thermal well combination under the conditions in which they were tested, viz: initial 70°F step change to 170°F, at atmospheric pressure, with water flowing velocity 3 ft/sec.

Combustion Engineering then provided an equation/graph method to correlate the above plunge test time constants to those which should apply at reactor coolant operating conditions of approximately 540°F, 2250 psia, and a flowing velocity of 40 ft/sec. This correlation information was included in the NNECO letter to the NRC dated June 15, 1977. However, its use has been questionable in that it may provide results which are unduly optimistic.

The first surveillance test is fully described in the above NNECO letter, during which all reactor coolant RTD's were removed from their wells and subjected to a response time plunge re-test at Rosemount in June, 1977. A small number (2) appeared to have time constants longer than 5.0 sec. Tech Spec limit and were replaced by ones with an appropriate faster response time.

Subsequent to returning to full power after the extended 1977 springtime outage, Analysis and Measurement Services were engaged to carry out in-situ MP-2 LCSR testing on a trial basis. This was performed in August, 1977, with the results included in attached table. Note that LCSR time constants reported by AMS were all longer than those obtained two months earlier from plunge tests, by amounts ranging between 30 to 120%.

Although six of the sixteen LCSR time constants were indicated as being longer than 5 seconds, as the new LCSR method was unapproved and unaccepted, the results were considered to be experimental, conditional to further refinement and testing at some future time.

The NRC was requested, in Reference (1), to approve a Technical Specification change of RTD maximum response time from 5.0 to 10.0 seconds. This was eventually approved in Reference (3).

Subsequent to this approval, AMS were again engaged to repeat the LCSR tests. The procedure, although similar to their previous procedure, utilized a more sophisticated computer program to apply corrections to the raw data to arrive at the final results. A detailed AMS report was issued on January 20, 1979, documenting these tests.

Of the sixteen RTD's tested in December 1978, twelve had been left undisturbed in their thermal wells since June 1977, and four (protective channel "B") had been replaced by new elements in April 1978, as permitted by Technical Specification surveillance requirements.

Of the twelve (12) RTD's which had previously been LCSR tested in August 1977, the new results indicated that eight (8) had increased by $\leq$ 20%, two had increased by 59% and 70%, respectively; one RTD had shown no change; and one had improved by 5%.

Conclusions

Our evaluation of the data obtained in both the plunge test (correlated to operating temperature, pressure and flow rate) and the LCSR test has established the suitability of LCSR to identify both RTD time constant, and changes in that value to a degree consistent with surveillance requirements.

The time constant values obtained by LCSR appear to be most conservative when compared with plunge test results, however, this provides greater assurance of required function than using the plunge test method.

Operationally, LCSR in-situ testing is not only easier and safer to perform, but tests the RTD under its operating conditions and configuration, including the well and RTD/well interface. Laboratory evidence has indicated that these mating interfaces play a critical part in establishing the resulting RTD time constant.

In summary, this evaluation concludes that the LCSR method of performing surveillance response testing of precision, well-type RTD's is a superior, practical, and technically sound procedure at this present time, which can be used to establish or verify RTD time constants.

TABLE OF TEST RESULTS

TE Tag. No.	Serial Number	Plunge 6/77	C-E Correlation	LCSR 8/77	%	LCSR 12/78	% Degradation
122 HA	75313	4.4	2.9	5.6	+93	6.7	+20
112 HA	A7765	3.5	2.3	3.4	48	3.6	6
112 CA	A7770	4.5	3.0	3.9	30	6.2	59
122 CA	A7774	4.3	2.9	4.6	59	5.2	13
112 CB	A7759	4.2	2.8	4.1	46		
"	B2456					6.4	
112 HB	A7760	4.3	2.9	4.2	45		
"	B2454					5.2	
122 HB	75291	5.6	3.8	6.6	74		Replacements
"	B2455					5.4	
122 CB	75292	4.5	3.0	5.1	70		
"	B2453					5.4	
112 HC	75299	5.7	3.9	6.6	69	11.2*	70
122 HC	75310	3.8	2.5	5.5	120	5.5	-
122 CC	75300	4.8	3.2	5.5	72	5.6	2
112 CC	75294	4.4	2.9	4.4	52	5.3	20
112 CD	75297	3.7	2.5	4.3	72	4.1	-5
112 HD	80364	4.3	2.9	4.8	66	5.0	+4
122 HD	75309	5.1	3.4	4.8	41	5.6	17
122 CD	A7769	3.8	2.5	3.7	48	4.3	16

*Although in excess of 10 sec. unrestricted plant operation was continued as described in Reference (4).