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APR 16 1996

Docket No. 50-423
B15648

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

Millstone Nuclear Power Station, Unit No. 3
Revised Source Term Time-of-Release Proposal

Millstone Unit No. 3 is one of five pilot plants in the NEI/NRC initiative to develop industry guidelines for the implementation of the Revised Source Term (RST) for design basis radiological calculations. The Millstone Unit No. 3 license amendment request which will implement the time-of-release aspects of the RST is currently being finalized. However, Northeast Utilities believes it is beneficial to submit the initial dose calculation at this time for NRC review. This calculation is being submitted as part of the pilot plant application phase of the RST implementation project. We believe this approach is beneficial for the following reasons:

- The TACT III calculation of the public dose provides the source term and release assumptions that will be used in the habitability calculations for the control rooms and Technical Support Center. If the NRC has comments or recommended changes on the manner in which the RST timing assumptions were implemented in this calculation, it will affect the source term assumptions used in the habitability calculations. Hence, timely NRC feedback is desired on this initial calculation before the other calculations are finalized and submitted with the future licensing amendment request.

- It will be one to two more months before all assessments and internal reviews of the Millstone Unit No. 3 license amendment request are complete. If our calculation was not submitted until that time, it would delay any assessment of the timing-only application of the new source term. Since there are other plants interested in applying a timing-only option, any delay on our part would also delay all other interested utilities. The calculation provides all the necessary information for understanding how the RST is being applied on a timing-only basis. Hence, the NRC review will provide most of the assessment necessary to allow other applications of the RST timing-only option to begin.

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Attachment 1 presents a method of RST timing implementation that falls within the methods and philosophy proposed in NEI's Draft Framework Document for RST application. It is Northeast Utilities' perspective that the timing application method provided in Attachment 1 is the optimum method for timing applications in that it is simplistic, technically justifiable, and generically applicable. Simplistic and generic applicability are important in the minimization of NRC and utility resources for the review of subsequent submittals using a time only approach.

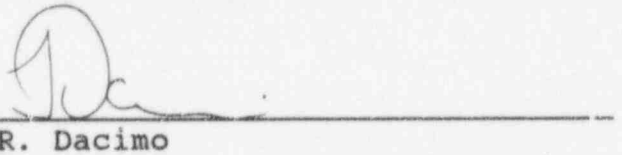
The calculations of the public dose at the Exclusion Area Boundary and the Low Population Zone for the proposed application are complete and are included in Attachment 2. These calculations incorporate the revised source term timing assumptions and the proposed secondary containment drawdown times. The calculations were performed using the TACT III code.

Attachment 3 provides the preliminary results of supplemental analyses for comparative purposes. These analyses are variations of the Attachment 2 analysis, presented to illustrate the effects of the RST versus the current source term, separating out the effects of the change in drawdown time. The NRC requested this type of comparison at the January 23, 1996, meeting with NEI.

Based on the above, we are requesting NRC review of Attachments 1 and 2. NRC approval will not be requested until the Millstone Unit No. 3 license application is submitted. However, we would appreciate feedback on the attached in a timely manner to help support justification of the other evaluations which must be performed and internally approved. We look forward to the opportunity to discuss this with you. If you have any questions please contact Mr. W. J. Temple at (860) 437-5904. If you desire, we would be pleased to meet with your Staff to discuss this matter.

Very truly yours,

NORTHEAST NUCLEAR ENERGY COMPANY



F. R. Dacimo
Vice President - Nuclear Operations

Attachments

cc: See Page 3

cc: T. T. Martin, Region I Administrator
V. L. Rooney, NRC Project Manager, Millstone Unit No. 3
A. C. Cerne, Senior Resident Inspector, Millstone Unit No. 3

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Attachment 1

Millstone Nuclear Power Station, Unit No. 3

Basic Assumptions of the Millstone 3 Pilot Plant Application

April 1996

Basic Assumptions of the Millstone 3 Pilot Plant Application: Proposed Timing Extension of the TID-14844 Source Term

The NEI/EPRI Source Term Task Force has prepared a Generic Framework for Application of Revised Source Term To Operating Plants [Ref. 2] which outlines methods in which the new source term can be applied to existing light water reactor designs. Northeast Utilities (NU) is a supporter and active participant in this effort, and the Millstone 3 plant has been selected for pilot application.

The Millstone 3 pilot application will be a "timing only" type application. It is the intent here to apprise the NRC staff of some of the basic assumptions that NU believes appropriate to use for this application. For convenience, and to distinguish them from other possible timing only proposals, we call these assumptions the "timing extension of the TID-14844 Source Term" (TEx Source). The rationale behind the selection of these assumptions is also provided. In conjunction with the draft of the framework document and task force discussions with the staff, we believe that this letter will provide adequate information for the staff to reach some preliminary conclusions as to the reasonableness of the assumptions. It is intended that the assumptions be generic enough that other NU nuclear units, and possibly other industry units, can use them for additional timing only applications.

NU recognizes that the staff needs a complete submittal to make a full determination as to the acceptability of the timing extension proposal. With this letter we seek only to receive a preliminary indication of reasonablness, prior to expending the significant resources required for a full licensing submittal.

Background

Prior to the initiation of the NEI/EPRI effort, Northeast Utilities made a presentation to the ACRS which resulted in the following ACRS recommendation to the Commission:

> *Information provided to the Committee suggests that the use of realistic timing assumptions for radionuclide releases to the containment during accidents can lead to safety improvements in existing plants. We urge that the risk implications be evaluated and consideration be given to allowing current licensees the option of using the timing assumptions in the proposed source terms without performing a complete source term reanalysis.* [Ref. 1]

The information presented here is the basis of the Millstone 3 pilot application for implementing the ACRS recommendation. The assumptions here are an implementation of and consistent with the Generic Framework for Application of Revised Source Term To Operating Plants, and much background information is covered there. Some

information is repeated here to provide a complete picture to those readers unfamiliar with the draft document.

Current Source Term Timing Issues

The present DB source term, TID-14844 as refined by Regulatory Guides 1.3 and 1.4, calls for instantaneous release of the source. This non-mechanistic assumption presumably was made with conservative intent given a sparsity of knowledge of source term mechanics. In practice, this assumption often causes designs and practices that are less than ideal in terms of safety and cost-benefit when applied to mechanistic design requirements. Some examples will illustrate this point.

Example 1: The control room at Millstone Unit 3 has a one-hour supply of pressurized air to maintain positive pressure post-accident. To meet the GDC19 limits with the current DB instantaneous plume the pressurized air system auto-initiates one minute following a safety injection signal. Unless the operator takes manual action the air supply is exhausted in one hour. Source term knowledge reflected in NUREG-1465 clearly shows that it is preferable to have that system available for as much of the the major release period as possible, which would not start until at least t = 30 minutes. In addition, the 1 minute auto-initiation requirement increases the complexity of testing and maintaining the system.

Example 2: This example deals with the loading of emergency diesel generators. Some systems are loaded onto diesel generators very early on the presumption that the source term is released at t=0. Consequently, the diesels are challenged unnecessarily early in an accident sequence. This early loading also adds maintenance and testing complexity and expense without a resultant safety benefit.

There are many other examples that exist, including containment spray start time and MOV closure time requirements, in which unrealistic timing assumptions result in non-conservative operational practices. An additional realistic safety consequence of these difficulties is increased worker exposure resulting from extended maintenance outages.

Timing Extension as an Option

NUREG-1465 is generally recognized as the source term most reflective of current research and as providing a safe basis for licensing plants. It is also recognized that re-licensing all existing plants to NUREG-1465 is not cost-beneficial nor necessary for safety. The current TID-14844 source term remains a valid design basis; however, as noted above it suffers from deficiencies. The framework document [Ref. 2] notes that one of the ways to capture some of the benefits of the of improved source term knowledge is to implement a "timing only proposal."

The "timing extension" is a timing only proposal which is an extension of the current TID-14844 source term using more realistic release timing. The timing extension option

is designed to be quickly applicable, that is, easily applied to existing plants and readily recognized as acceptable by regulators. It allows some of the benefits of new source term knowledge to be captured, but not as many of the possible benefits that would come with using some of the other, more complete approaches described in the framework document. It is recognized that the benefits captured using the timing extension may in many cases come at the cost of calculated off-site doses that are higher than those achievable with the full NUREG-1465 analysis.

The timing extension of the current source term has some significant benefits:

- Philosophically a direct extension of existing design basis, therefore easily understood.
- Modifies the current unrealistic timing assumption which is in some cases excessivley conservative, in others unconservative.
- Generic and universally applicable with one set of assumptions at all sites.
- Can be analyzed with existing codes and methods.
- Timing of the release is conservative with respect to NUREG-1465, i.e., all the activity for the major release period is completely released at the beginning of the period instead of gradually during the period.
- It is relatively inexpensive to apply to existing plants.

Timing Extension Defined

The timing extension of the TID-14844 source term changes the timing of the release. The net release fractions remain the same as the current design basis, e.g., 100% noble gases, 50% iodines to the containment atmosphere and 1% of the solids to the coolant. The timing changes from one puff release at t=0 to two puff releases, the first a release of the gap activity at t=30 seconds for PWR's (t=1 min for BWR's) post-accident, the second a puff release at t=30 minutes which releases the rest of the activity specified by the current source term. The first release is the gap phase release, using the timing identified in NUREG-1465. The proposed gap release fractions are 5% of the noble gases and iodines, consistent with NUREG-1465 as developed in the framework document (Ref. 2, Section 4 and Appendix B). The puff ("degraded fuel") release would consist of the current DB source term release less the already released 5% gap activity, i.e., 95% of the noble gases and 45% of the iodines.

Other aspects of the current design basis remain unchanged. The release form remains that specified in Reg. Guides 1.3 and 1.4. The dose calculation periods remain 0-2 hr for the EAB (the X/Q used for the degraded phase would the 0-2 hr X/Q) and 30 days for the LPZ. Credit for plateout of iodines and sprays would remain as specified in SRP 6.5.2, Rev. 2.

Table I
TID-14844 Timing Extension Source Term Releases

Time of Release
(Releases are instantaneous puffs)

	Long Term Cooling Maintained		Long Term Cooling Not Maintained	
	PWR	BWR	PWR	BWR
Coolant activity	t = 0	0	0	0
Gap release: 5% noble gas (airborne) + 5% iodine (airborne)	30 secs	1 min	0	0
Degraded core: 95% noble gas (airborne) + 45% iodine (airborne) + 1% solids (liquid)	30 mins	30 mins	NA	NA

Conclusions and Recommendations

Both existing source terms, NUREG-1465 and TID-14844, are of comparable magnitude to the proposed timing extension to TID-14844. Although details can be important, note that the differences between the source terms (e.g.,using the integrated release to containment as a measure, all are within a factor of 2) are greatly overshadowed by factor-of-10 conservatisms in other design basis analysis assumptions, such as meteorology. Especially note that the differences between the TID-14844 and the timing extended source term are very small. (For further discussion of this see the "Attachment: Questions Related To The Timing Extended Source Term.") Using the timing extended source term one can gain mechanistic safety and cost benefits that far outweigh any possible differences in the magnitude of the release. The same safety systems will be required but will be operated in a more mechanistic, safe, and cost-beneficial manner. For example, control room bottled air sources can be conserved by starting them when they are most likely to be needed, when there is significant fuel failure, rather than at t ~ 0.

It is for these reasons that we request that the timing extension to TID-14844 be given preliminary approval as a source term for the NEI/ NU-Millstone 3 pilot plant project. As discussed in the Oct 12, 1995 NEI/NRC Revised Source Term meeting, it is hoped that this piece of the pilot proposal can be reviewed in parallel with the Generic Framework for Application of Revised Source Term To Operating Plants, and that preliminary approval can be granted in a short time.

References

1. Letter dated Sept. 20, 1994, W. J. Lindblad, Vice-Chairman ACRS, to Ivan Selin, Chairman USNRC, "Proposed Final Version of NUREG-1465, 'Accident Source Terms for Light-Water Nuclear Power Plants'".

Attachment: Questions Related To The Timing Extended Source Term

During the development of the timing extended source term proposal some issues arose. These are presented below in a question and answer format.

Is this approach consistent with the Generic Framework for Application of Revised Source Term to Operating Plants (Draft)?

The framework document permits many approaches to applying the revised source term. This timing extension is one example, using methods from the framework document.

How do we know that the timing extension is conservative?

Conservatism is difficult to define, and can be excessive. Also, there are now two benchmarks to compare against: the TID-14844 and the NUREG-1465 source terms, both of which are recognized as safe and acceptable bases for plant design. As previously noted, the Reg. Guides 1.3 and 1.4 "conservative" assumption of instantaneous releases actually results in non-conservative plant designs. The timing extended source is very comparable to the other source terms.

A sometimes used measure of comparision is time integrated releases into containment. How does the timing extended option compare?

As one might intuitively presume, the timing extension is a balance between the TID-14844 and the NUREG-1465 source terms. Note that the time-integrated release into containment is not the only or even the best measure of safety. However, as one measure of reasonableness it is shown below that the timing extended time-integrated containment release is comparable to the NUREG-1465 and the TID-14844 sources.

Gap Activity

For purposes of comparison one can arbitrarily divide the TID-14844 source term into a gap release and a degraded core release, both occuring at t = 0. The gap fractions are taken to be 5% noble gas and 5% iodine. Doing so makes it easy to compare both the gap release and the more significant degraded core releases.

The timing extended source term uses the magnitude and start time of the NUREG-1465 gap release phase. The gap releases are seen to be similar for all three of the source terms. A relatively insignificant difference between the timing extended source and NUREG-1465 is that the gap release is a puff release instead of the gradual release as specified in NUREG-1465. Given the relative magnitude of the gap activity versus the degraded core releases, the differences can be considered negligible.

Degraded Core Activity

The significant differences between NUREG-1465, TID-14844, and the timing extended sources exist in the degraded fuel release.

The noble gas portion of the timing extended degraded fuel release is of the same magnitude (95% after gap activity) as the TID-14844 and corresponding NUREG-1465 early in-vessel release. The difference here is that the timing extended source is a puff release at t = 30 minutes. As shown in Table II, the timing extended term is "conservative" with repect to NUREG-1465 and slightly less "conservative" than the TID-14844 time integrated noble gas source in containment.

The iodines are also different in timing. The timing extended source is a puff at t=30 minutes of 45% of the core inventory.[1] The NUREG-1465 release is 35% (=40% - 5% gap) for PWR's and 25% (=30% - 5%) for BWR's at a constant release rate. Using the development of Appendix A [Ref. 2], and examining the more conservative case of the PWR, one can express the iodine release for the PWR NUREG-1465 as $35\%*M_C$, released at rate $35\%*M_C/T$. For the simple case of no mechanistic removal (i.e., no sprays) and credit for 50% iodine instantaneous plateout, Table III shows that the timing extended time integrated releases are between the TID-14844 and the NUREG-1465 values. Note that the timing extended releases would have an even greater margin over the case of NUREG-1465 BWR's.

Sprays complicate the analysis for iodines. Essentially when early releases take place there is more material available for a longer time for removal, which somewhat offsets the earlier release time. (This argument is more completely presented in Ref 2.) As sprays become more effective the NUREG-1465 source produces relatively larger values of integrated releases when compared to TID-14844. For the same conditions the timing extended source approximates the TID-14844 value.

Wouldn't the use of the full (including chemical form) NUREG-1465 source be more beneficial?

In most cases it is thought that one would calculate lower offsite doses. However, the benefit that we are seeking through the use of the timing extended source is quickly applicable realistic mechanistic design requirements, recognizing the cost of this may come in terms of dose. Also, implementing a full NUREG-1465 analysis may be cost prohibitive.

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[1] Note that the NRC has recently indicated to NU that, contrary to SRP 6.5.2, Rev. 2, it cannot be assumed that both instantaneous plateout and spray removal be credited, but only one or the other. An earlier revision of this proposal incorporated iodine instantaneous plateout in containment as part of the proposal. Here it is treated as one option.

Table II
Comparison of TEx Degraded Core Noble Gas Releases

M_c is the Mass Noble Gas Core Inventory

	TID-14844	TEx TID[2]	NUREG-1465 PWR Timing
Time of Release	0	0.5 hrs	0.5 - 2 hrs, constant
Mass Released Noble Gas[3] (less 5% gap)	95% * M_c	95% * M_c	95%*M_c
0-2hr Ctmt Integrated Release	95%M_c* 2 hrs	95%M_c* 1.5 hrs	95%M_c * 0.5 (1.5 hrs)
Relative Integrated Releases	1.35	1	0.5

[2] Timing Extended TID-14844 source term.

[3] The TID-14844 source term is arbitrarily divided into a gap phase release and a degraded core release, all at t=0. This provides a common baseline for comparision.

Table III
Comparison of TEx Degraded Core Iodine Releases

M_c is the Mass Iodine Core Inventory

	TID-14844	TEx TID[4]	NUREG-1465 PWR Timing
Time of Release	0, puff	0.5 hrs, puff	0.5 - 2 hrs, constant
Mass Released Iodine[5] (less 5% gap)	45% * M_c	45% * M_c	35%*M_c
Effective Total Mass Release	22.5%M_c	22.5%*M_c	35%*M_c
No Mechanistic Removal			
Instantaneous Plateout	50%	50%	0
0-2hr Integrated Release to Ctmt	22.5%M_c* 2 hrs	22.5%M_c* 1.5 hrs	35%M_c * 0.5 (1.5 hrs)
Relative Integrated Releases	1.3	1	.8
Spray Removal - Constant lambda's			
Mass in Containment, f(t) (τ = t - 0.5hrs for t >= 0.5)	45%M_c * $e^{-\lambda(t)}$	45%M_c * $e^{-\lambda\tau}$	(35%M_c/T/λ) * (1 - $e^{-\lambda\tau}$)
Integrated Release to Ctmt, f(t)	(45%M_c / λ)(1– $e^{-\lambda t}$)	(45%M_c / λ)(1– $e^{-\lambda\tau}$)	(35%M_c/T/λ) * (τ + ($e^{-\lambda\tau}$ -1)/λ)
0-2hr Relative Integrated Release			
Case λ = 1	1.1	1	0.5
Case λ = 3	1.0	1	0.5
Case λ = 5	1.0	1	0.6
Case λ = 10	1.0	1	0.7
Case λ = 20	1.0	1	0.8

[4] Timing Extended TID-14844 source term.

[5] The TID-14844 source term is arbitrarily divided into a gap phase release and a degraded core release, all at t=0. This provides a common baseline for comparision.

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Attachment 2

Millstone Nuclear Power Station, Unit No. 3

EAB and LPZ Doses from a Millstone Unit 3 LOCA

April 1996

2. Generic Framework for Application of Revised Source Term to Operating Plants (Draft), EPRI Report TR-105909, Project 4080-2, November 1995.