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UNITED STATES NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

Standard Review Plan
SRP-15.0.1, Rev. 0

RADIOLOGICAL CONSEQUENCE ANALYSES USING ALTERNATIVE SOURCE TERMS

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USNRC STANDARD REVIEW PLAN

Standard review plans are prepared for the guidance of the Office of Nuclear Reactor Regulation staff responsible for the review of applications to construct and operate nuclear power plants. These documents are made available to the public as part of the Commission's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Standard review plans are not substitutes for regulatory guides or the Commission's regulations and compliance with them is not required. The standard review plan sections are keyed to the Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants. Not all sections of the Standard Format have a corresponding review plan.

Published standard review plans will be revised periodically, as appropriate, to accomodate comments and to reflect new information and experience.

Comments and suggestions for improvement will be considered and should be sent to the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Washington, D.C. 20555.

15.0.1 Radiological Consequence Analyses Using Alternative Source Terms

REVIEW RESPONSIBILITIES

Primary – various (see text)

Secondary – various (see text)

The NRC expects that most operating reactors will implement an alternative source term (AST) only as a means to justify desirable plant modifications. (In the text that follows the phrase, "implementation of an AST" includes any associated plant modifications.) These modifications may be to systems or procedures identified in the final safety analysis report (FSAR) or changes to the technical specifications. The review of the affected structures, systems, components, and accident analyses is covered in other sections of the Standard Review Plan (SRP). Those sections identify the branches responsible for the review of the modifications, as well as the acceptance criteria, areas of reviews, and evaluation documentation associated with those reviews. The review of the radiological consequences of the proposed modification as described in this SRP section is performed by the SPSB with the assistance of other technical review branches in the NRC's Office of Nuclear Reactor Regulation (NRR), as deemed necessary.

The nature of the licensee's request will determine which technical branch will serve as the primary review branch for the overall proposed amendment request. This primary review branch has overall responsibility for leading the technical review, drafting the staff safety evaluation report (SER) or other appropriate regulatory document, and coordinating input from other technical review organizations.

- Probabilistic Safety Analysis Branch (SPSB) holds the responsibility for reviewing the impact of the proposed plant modification on the radiological consequences of design basis accidents (DBAs). It assists the primary review branch by reviewing probabilistic risk analysis (PRA) information submitted by the licensee. It reviews issues related to severe accidents for operating reactors

- Reactor Systems Branch (SRXB) holds the responsibility for issues related to functional performance, design, operation, and accident response of the reactor core and reactor thermal-hydraulic systems (reactor coolant systems, normal and emergency core cooling).

- Plant Systems Branch (SPLB) holds the responsibility for issues related to the functional performance, design, operation, and accident response of essential auxiliary, support, and balance-of-plant systems. It reviews issues related to design features provided to ensure protection of the public from releases of radioactive gases and protection of the operators from releases of toxic and radioactive gases. It reviews issues related to design and performance of containments and their associated systems, and fuel storage and fuel handling systems.

- Mechanical and Civil Engineering Branch (EMEB) holds the responsibility for issues related to static and dynamic analysis for mechanical systems and components.

- Materials & Chemical Engineering Branch (EMCB) holds the responsibility for issues related to materials engineering, inservice inspection, and materials integrity related aspects of design and performance of reactor components and systems. It reviews issues related to chemical engineering, including containment sump pH, and containment spray performance for radioiodine scavenging. It reviews the impact of toxic gases on control room habitability.

- Electrical & Instrumentation and Controls Branch (EELB) holds the responsibility for issues related to the functional performance, design, and operation of onsite power systems, reactor trip systems, engineered safeguards features actuation systems, and plant instrumentation systems. It reviews environmental qualification of electrical equipment important to safety.

- Technical Specifications Branch (RTSB) develops, maintains, and updates standard technical specifications. It provides NRR interpretation of specific technical specification requirements and provides assistance in screening incoming change requests.

- Operator Licensing, Human Performance, and Plant Support (IOLB) holds the responsibility for issues related to operator licensing, in-plant radiation protection, effluent release control, and emergency preparedness. It reviews issues related to emergency operating procedures, human factors engineering design, in-plant radiation protection, and effluent release control.

- Office of Nuclear Regulatory Research (RES) assists the primary and secondary review branch, as requested, by providing necessary technical support.

I. AREAS OF REVIEW

Section 50.67, *Accident source term,* of 10 CFR Part 50 allows a holder of an operating license issued prior to January 10, 1997, and holders of renewed licenses under Part 54 of this chapter whose initial operating license was issued prior to January 10, 1997, to voluntarily revise the accident source term used in design basis radiological consequence analyses. Paragraph 50.67(b) requires that applications under this section contain an evaluation of the consequences of applicable DBAs previously analyzed in the plant's FSAR. Potential changes in consequences could be due to the impact of the characteristics of the AST itself or from the proposed plant modifications. Regulatory Guide 1.183, *Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors* (Ref. 1)*,* provides guidance to licensees on performing evaluations and reanalyses in support of the implementation of an AST. Although, this SRP section is written primarily for the review of the application for the initial implementation of an AST at operating power reactors, it is expected to be of use in reviewing applications for subsequent license amendment requests from these plants.

A complete recalculation of all design basis radiological consequence analyses may not be required for an application to be acceptable. However, applications should be supported by evaluations of all significant radiological and nonradiological impacts of the proposed plant modifications in the context of the proposed AST. The scope and extent of the reanalysis effort, and the staff review, will depend on the specifics of the application. RG-1.183 provides guidance on required reviews.

An AST is characterized by radionuclide composition and magnitude, chemical and physical form of the radionuclides, and the timing of the release of these radionuclides. An accident source term is a fundamental assumption upon which a large portion of the plant design is based. Ideally, the licensee would update all design basis analyses based on the previous source term to reflect all five characteristics of the proposed AST. However, evaluations performed by the staff have indicated that this level of reanalysis may not be necessary for some AST implementations. There are potential implementations of an AST for which only limited reanalyses may be necessary. Some implementations may involve only one AST characteristic. Two categories of implementations, *full* and *selective*, are defined.

$ A *full implementation* is a modification of the plant design basis that addresses all characteristics of an AST, that is, the composition and magnitude of the radioactive material, its chemical and physical form, and the timing of its release. A full implementation replaces the previous accident source term used in all design basis radiological analyses and incorporates the total effective dose equivalent (TEDE) dose criteria. Once a full implementation is approved, all subsequent new or updated analyses would be based on the approved AST and TEDE criteria.

- A *selective implementation* is a modification of the plant design basis that (1) is based on one or more of the characteristics of an AST and/or (2) reevaluates a limited subset of the design basis radiological analyses. An example of an application of selective implementation is one in which a licensee desires to use the release timing insights of an AST to increase the required closure time for a containment isolation valve by a small amount. The licensee would only need to evaluate the impacts of the delay in valve closure. Radiological consequence analyses might not be necessary. The staff's approval for an AST (and the TEDE criterion, if applicable) would be limited to the particular selective implementation proposed by the licensee. The licensee would be able to make subsequent modifications based on the selected characteristics incorporated into the design basis by the approved initial implementation under the provisions of 10 CFR 50.59. However, use of other characteristics of an AST or use of TEDE criteria which are not part of the approved design basis, and changes to previously approved AST characteristics, requires prior staff approval under 10 CFR 50.67. As an example, a licensee with a timing-only implementation involving relaxed closure time on isolation valves could not use 10 CFR 50.59 as a mechanism to implement a modification involving a reanalysis of the radiological consequences of a DBA LOCA. However, this licensee could extend use of the timing characteristic to adjust the closure time on isolation valves not included in the initial approved implementation in accordance with 10 CFR 50.59.

The review associated with an application for the use of an AST is largely dependent on the scope and nature of the associated plant modifications being proposed. Thus, the areas of review identified in other SRP sections may be applicable and should be considered in performing the review. This SRP section covers the review by SPSB of the radiological consequences of DBAs. The review includes the following:

1. Reviews of the AST implementation to ensure that all significant radiological and nonradiological impacts have been considered. Radiological consequences that should be considered include the following:

    a. Exclusion area boundary (EAB), low population zone (LPZ), and control room habitability (10 CFR 50.67)

b. Emergency response center habitability (paragraph IV.E.8 of Appendix E to 10 CFR Part 50)

c. Equipment environmental qualification (10 CFR 50.49)

d. Environmental assessments (10 CFR Part 51)

e. Post-accident access shielding (NUREG-0737, II.B.2)[1]

f. Post-accident sampling capability (NUREG-0737, II.B.3)

g. Post-accident monitoring (NUREG-0737, II.F.1)

h. Leakage control (NUREG-0737, III.D.1.1)

i. Emergency response facilities (NUREG-0737, III.A.1.2)

j. Control room habitability (NUREG-0737, III.D.3.4)

2. A review of the sequence of accident events as described by the licensee to ensure that the case that maximizes the radioactivity release has been considered.

3. A review of the core inventory determined by the licensee to ensure that it is consistent with the current licensing basis rated thermal power, enrichment, and burnup.

4. A review of the models, assumptions, and parameter inputs used by the licensee for the calculation of the radiological consequences. For plants applying for, or having received, approval for the use of a full implementation of an AST, this SRP section supersedes the radiological analyses assumptions, acceptance criteria, and methodologies identified in the SRP sections listed below. Provisions related to the nonradiological analyses aspects of these SRP sections remain applicable.

   a. Section 15.1.5, *Steam System Piping Failures Inside and Outside of Containment* (PWR)

   b. Sections 15.3.3-15.3.4, *Reactor Coolant Pump Rotor Seizure and Reactor Coolant Pump Shaft Break*

   c. Section 15.4.8, *Spectrum of Rod Ejection Accidents (PWR)*

   d. Section 15.4.9, *Spectrum of Rod Drop Accidents (BWR)*

   e. Section 15.6.2, *Radiological Consequences of the Failure of Small Lines Carrying Primary Coolant Outside Containment*

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[1] Facility-specific licensing commitments may affect applicability of NUREG-0737 (Ref. 2) items.

f. Section 15.6.3, *Radiological Consequences of Steam Generator Tube Failure (PWR)*

g. 15.6.4, *Radiological Consequences of Main Steam Line Failure Outside Containment (BWR)*

h. 15.6.5, *Loss-of-Coolant Accidents Resulting From Spectrum of Postulated Piping Breaks Within the Reactor Coolant System Pressure Boundary*

i. 15.7.4, *Radiological Consequences of Fuel Handling Accidents.*

This SRP section and the referenced RG-1.183 may contain information that contradicts that provided in other SRP sections. In these cases, the most recent applicable information should be used.

5. Independent calculations by the staff, as necessary, to conclude, with reasonable assurance, that the licensee's analyses are acceptable.

6. Comparison of the doses calculated by the licensee and the staff against the appropriate exposure criteria, as stated in Section II below.

II. ACCEPTANCE CRITERIA

An application to replace the current DBA source term with an AST is acceptable if the plant, as modified, will continue to provide sufficient margin of safety with adequate defense in depth to address unanticipated events and to compensate for uncertainties in accident progression and analysis assumptions and parameter inputs. The staff should allow licensees to pursue technically justifiable uses of an AST in the most flexible manner compatible with maintaining a clear, logical, and consistent design basis.

A complete recalculation of all design basis radiological consequence analyses may not be required for an application to be acceptable. However, applications should be supported by evaluations of all significant radiological and non-radiological impacts of the proposed plant modifications in the context of the proposed AST. The scope and extent of the reanalysis effort, and the staff review, will depend on the specifics of the application. The acceptance criteria below address the implementation of an AST and the supporting radiological consequence analyses. Additional acceptance criteria may be found in other applicable SRP sections. If the application is justified, in part, on risk insights, the acceptance criteria of SRP Section 19.0 (Ref. 3) apply.

In addition to the nonradiological acceptance criteria provided in other SRP sections, an acceptable implementation of an AST is required to demonstrate compliance with the following regulations:

- Section 50.49, *Environmental qualification of electric equipment important to safety for nuclear power plants*, of 10 CFR Part 50, as it relates to qualification of safety-related equipment with regard to integrated radiation dose during normal and accident conditions.

- Section 50.67, *Accident source term,* of 10 CFR Part 50, as it relates to the implementation of an AST in current operating nuclear power plants. For plants applying for, or having received, approval for the use of an AST, the radiological criteria in § 50.67 supersede the radiological criteria of Section 100.11, *Determination of exclusion area, low population zone, and population center distance,* of 10 CFR Part 100.

- General Design Criterion (GDC) 19, *Control Room*, of Appendix A to 10 CFR Part 50, as it relates to maintaining the control room in a safe, habitable condition under accident conditions by providing adequate protection against radiation and toxic gases.

- Title 10, CFR Part 51, *Environmental protection regulations for domestic licensing and related regulatory functions,* as it relates to environmental assessments of radioactive material releases during normal and accident conditions.

- Paragraph IV.E.8 of Appendix E, to 10 CFR Part 50, *Emergency Planning and Preparedness for Production and Utilization Facilities*, as it relates to maintaining emergency facilities in a safe, habitable condition under accident conditions by providing adequate protection against radiation and toxic gases.

An acceptable implementation of an AST should demonstrate compliance with plant-specific licensing commitments made in response to the NUREG-0737 (Ref. 2). Specific provisions[2] of interest to this SRP section include the following:

- NUREG-0737 II.B.2, *Post-accident Access Shielding*, as it relates to post-accident radiation exposure incurred while performing necessary plant operations outside of the control room.

- NUREG-0737 II.B.3, *Post-accident Sampling Capability*, as it relates to post-accident radiation exposure during sampling operations.

- NUREG-0737 II.F.1, *Additional Accident-Monitoring Equipment*, as it relates to the ability of the monitors to operate during and following an accident and perform the intended function in the accident environment.

- NUREG-0737 III.D.1.1, *Leakage Control*, as it relates to post-accident radiation exposure.

- NUREG-0737 III.A.1.2, *Emergency Response Facilities,* as it relates to maintaining emergency facilities in a safe, habitable condition under accident conditions by providing adequate protection against radiation and toxic gases.

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[2] The radiological criteria in these provisions reference GDC-19 or specify criteria derived from GDC-19. These criteria are generally specified in terms of whole body dose, or its equivalent, to any body organ. For facilities applying for, or having received, approval for the use of an AST, the applicable criterion should be updated for consistency with the TEDE criterion in 10 CFR 50.67.b.2.iii.

- NUREG-0737 III.D.3.4, *Control Room Habitability,* as it relates to maintaining the control room in a safe, habitable condition under accident conditions by providing adequate protection against radiation and toxic gases.

An implementation of an AST is acceptable with regard to the radiological consequences of analyzed DBA if the calculated TEDE at the EAB and the LPZ outer boundaries do not exceed the exposure criteria listed in Table 1. The methodology and assumptions for calculating the radiological consequences should reflect the regulatory positions of RG-1.183.

Table 1
Accident Dose Criteria[3]

Accident or Case	EAB and LPZ Dose Criteria	Analysis Release Duration
LOCA	25 rem TEDE	30 days for CNMT, ECCS, and MSIV (BWR) leakage
BWR Main Steam Line Break		Instantaneous puff
Fuel Damage or Pre-incident Spike	25 rem TEDE	
Equilibrium Iodine Activity	2.5 rem TEDE	
BWR Rod Drop Accident	6.3 rem TEDE	24 hours
PWR Steam Generator Tube Rupture		Affected SG: time to isolate; Unaffected SG(s) until cold shutdown is established
Fuel Damage or Pre-incident Spike	25 rem TEDE	
Coincident Iodine Spike	2.5 rem TEDE	
PWR Main Steam Line Break		Until cold shutdown is established
Fuel Damage or Pre-incident Spike	25 rem TEDE	
Coincident Iodine Spike	2.5 rem TEDE	
PWR Locked Rotor Accident	2.5 rem TEDE	Until cold shutdown is established
PWR Rod Ejection Accident	6.3 rem TEDE	30 days for CNMT pathway; Until cold shutdown is established for secondary pathway
Fuel Handling Accident	6.3 rem TEDE	2 hours

III. REVIEW PROCEDURES

The reviewer selects and emphasizes specific aspects of this SRP section that are appropriate for the particular application. The review areas to be given attention and emphasis are based on (1) the material presented and its similarity to recently reviewed applications for other plants, (2) the scope of the proposed AST implementation, that is., full or selective, (3) the

[3] For PWRs with steam generator alternate repair criteria, different dose criteria may apply to SGTR and MSLB analyses.

nature and extent of associated plant modifications, and (4) whether the application is for an initial AST implementation or is based on a previously accepted implementation.

1. An initial screening of the proposed application should be performed to establish the scope and extent of the needed review. An initial screening consists of the following steps:

   a. As discussed in Section I of this SRP section, a licensee can propose either a full or a selective implementation of an AST. The scope and extent of the review and the language of the staff SER will depend on this classification. The reviewer should ensure that the submittal clearly specifies the scope desired by the licensee.

   b. A preliminary review of the application for completeness and potential acceptability is performed to ensure that the application includes sufficient information to enable the reviewer to make an independent assessment regarding the acceptability of the proposal in terms of regulatory requirements and the protection of public health and safety. If the reviewer determines that the application is incomplete, or if the proposed changes cannot be accepted, the project manager should be consulted before continuing with the review.

   c. The reviewer should determine whether a precedent for the proposed change has been previously considered by the staff. These precedents may be identified by the licensee it its submittal or may be identified by the staff. Applicable precedents should be considered by the reviewer in structuring the review in the interest of maximizing staff efficiency and ensuring consistency of licensing actions.

   d. The reviewer should identify whether the application should be considered as being risk informed. A *risk-informed licensing action* is defined as any licensing action that uses quantitative or qualitative risk assessment insights or techniques to provide a key component of the basis for the acceptability or the unacceptability of the proposed action. If the application is risk informed, a review by risk analysts in SPSB should be performed using the SRP Section 19.0.

   e. The differences between the previous source term and an AST cannot, in and of themselves, affect the previously analyzed core damage frequency (CDF) and large early release frequency (LERF). However, the reviewer should ensure that any associated plant modification that may have an impact on CDF or on LERF is reviewed by risk analysts in SPSB.

   f. A review of the proposed changes as they relate to the plant's licensing basis is performed. Areas of review include how the licensee satisfies certain basic regulatory requirements such as diversity, redundancy, defense-in-depth, safety margins, NUREG-0737 commitments and the General Design Criteria, as applicable. Review procedures related to structures, systems, and components, and nonradiological aspects of accidents in other SRP sections may be applicable. Previously approved implementations of an AST, if applicable, should be included in this review. If changes to technical specifications,

exemptions from regulations, or other forms of relief are needed to implement the licensee's proposed change, reviewers should ensure that the appropriate requests accompany the application.

2. An application may be a *full* or *selective* implementation of an AST. The reviewer should consider the following in performing the review of the application:

   a. A full implementation addresses all characteristics of an AST, replaces the previous accident source term used in all design basis radiological analyses, and incorporates the TEDE criteria of 10 CFR 50.67 and Section II of this SRP section. The reviewer should ensure that a complete analysis of the DBA LOCA has been performed, as a minimum. Other analyses may be necessary as described in RG-1.183.

   b. In a selective implementation, the licensee may opt to only implement one or more of the characteristics of an AST and may chose to use the AST only in analyses supporting limited plant modifications. The reviewer should ensure that the proposed selective implementation is technically justified and that a clear, logical, and consistent design basis is maintained. Since there are a large number of possible selective implementations, only generic review procedures can be provided. The reviewer will have to apply judgement. The following should be considered:

      (1) A selective implementation on the basis of only the timing characteristic of an AST may be acceptable without dose calculations, provided other impacts, if any, are adequately dispositioned. The acceptability of other combinations of AST characteristics is not as clear. The reviewer must ensure that the proposed combination is consistent. For example, it would be inconsistent to credit the chemical form as being cesium iodide (CsI) and ignore the increased cesium (Cs) release fraction.

      (2) As previously discussed, a selective implementation need not involve dose calculations. If dose analyses are performed, the TEDE criteria in 10 CFR 50.67 and Section II of this SRP section become the design basis criteria for those analyses. The previous whole body and thyroid criteria would continue to apply to the analyses that were not affected by the implementation. This dichotomy may cause confusion if there are plant modifications associated with an AST implementation. For example--

         (a) A licensee is proposing to modify the standby gas treatment system (SGTS) as part of the proposed AST implementation. The particular modification would affect the LOCA and fuel handling accident analyses. What are the dose acceptance criteria for these two accident analyses? For the remaining unaffected accident analyses? For the control room?

            Answer: The acceptability of the design change is based on the TEDE criteria for the reanalyzed LOCA and FHA. As the remaining offsite and control room accident analyses are

unaffected, the previous acceptance criteria continue to apply to those analyses.

(b) In the previous example, what would be the result be if the modification was to control room habitability systems instead of the SGTS?

Answer: Since the control room habitability criterion applies to all accident conditions, the licensee must demonstrate that control room doses will meet the TEDE criterion for all accidents. Once the application is approved, the design bases for these systems would incorporate the TEDE criterion.

In either case, the reviewer should ensure that the licensee's submittal and the staff's SER clearly identify the acceptance criteria for the accident, or the component, that will become part of the plant design basis.

c. Once an implementation of an AST is approved, the licensee may subsequently submit additional license amendment requests. The AST characteristics and the TEDE criteria incorporated into the design basis by previously approved AST applications are the bases for reviews of subsequent licensing actions. The reviewer should ensure that these subsequent requests are consistent with the design basis AST implementation.

3. The reviewer should ensure that the licensee has performed sufficient analyses to meet the staff's expectation that all significant potential impacts have been identified and evaluated. The reviewer should determine if the application adequately characterizes the radiological and nonradiological impacts of the proposed plant modifications in the context of the proposed AST. The reviewer should ensure that the analyses described by the licensee have the scope and depth to adequately evaluate the impacts of the change. All affected design basis analyses should be updated. An analysis is considered to be affected if the proposed modification changes one or more assumptions or inputs used in that analysis such that the results, or the conclusions drawn on those results, are no longer valid. Because of the wide scope of possible AST implementations, both full and selective, specific review guidance cannot be provided. However, the following aspects should be considered in performing these reviews:

a. A complete recalculation of all design basis radiological analyses may not be required. However, all significant radiological and nonradiological impacts of the proposed plant modifications are to be evaluated in the context of the proposed AST.

b. The NRC staff performed a rebaselining study (Ref. 4) of the implementation of an AST at operating reactors. This study may be referenced by a licensee to disposition the impacts of differences between source terms as they apply to radiation doses caused by fission product releases. The reviewer should ensure that all remaining radiological and nonradiological impacts of proposed plant modifications in the context of the proposed AST, including the impact on equipment environmental qualification, are evaluated. For example --

(1) A licensee has proposed removing analysis credit for the standby gas treatment system (SGTS) on the basis of a full implementation of an AST. The licensee has reanalyzed the offsite and control room doses for all accidents that credited the SGTS filtration. Does the licensee need to reanalyze the environmental qualification (EQ) doses for components exposed to the containment airborne activity?

Answer: In this case, the plant modification has no impact on the EQ doses. The licensee can reference the rebaselining study to disposition the airborne activity EQ doses.

(2) As part of a larger AST implementation, a licensee proposed removing analysis credit for in-containment fan cooler charcoal filter units. Offsite doses have been shown to be acceptable, but the in-containment source term and dose rates have increased. The new containment airborne source concentrations are greater than those previously assumed in several of the plant EQ calculations. What are the analysis requirements?

Answer: Those EQ calculations affected by the increased airborne source concentrations should be reanalyzed using the selected AST. This particular reanalysis requirement is driven not by the source term but by the plant modification. In addition, there are several potential non-radiological impacts, for example, the impact on the containment pressure-temperature transient, the impact on the fan of the reduced flow restriction, and so on, that may need to be considered.

(3) A licensee proposes to change the response time of a containment purge system isolation damper from 2.5 seconds to 5.0 seconds on the basis of timing characteristic of an AST. The licensee states that increases in offsite dose are insignificant since the containment will be isolated before to the onset of gap release. Are dose calculations necessary?

Answer: This is a selective implementation as only the timing characteristic is being proposed. The remaining characteristics of the AST are not being implemented. Thus, the previous analyses are not affected. Reanalyses would not normally be necessary. However, there may be other impacts that need to be considered, for example, can the damper close against the increased pressure that might exist at 5 seconds? Can the ductwork downstream of this damper withstand the increased pressure? If the damper could not close, dose calculations against the TEDE criteria would be warranted.

c. All affected analyses should be reevaluated and the applicable design bases updated.

d. If a particular analysis is to be recalculated, all affected assumptions and inputs should be updated and all selected characteristics of the AST and the TEDE criteria that will become part of the design basis should be addressed.

e. The licensee may use technically justifiable sensitivity or scoping evaluations to demonstrate that results from affected analyses calculated using the previous accident source term and previous dose criteria would bound the results obtained using the AST and the TEDE criteria. In this case, the affected analyses need not be updated. However, the reviewer should ensure that the licensee has made a commitment to update the design basis to indicate that the selected AST characteristics and TEDE criteria have superseded the prior source term and dose criteria. For example:

(1) As part of an AST implementation, the licensee has reanalyzed the dose for the most limiting component using the proposed AST and determined that the integrated dose would not increase by more that 20 percent. All of the licensee's existing EQ calculations include a designer's margin of a factor of two. Does the licensee need to re-calculate any additional EQ analyses? What is the design basis for the remaining analyses?

Answer: As long as the licensee has adequately identified the limiting case and the sensitivity analysis is sufficiently generic, the evaluation is appropriate and no further reanalysis is necessary. In this case, the licensee has been able to demonstrate that the existing analyses are bounding and would yield acceptable results if recalculated using the proposed AST. However, the design basis now incorporates the AST, and any future reanalysis or new analyses should be based on the AST, that is, the design basis source term.

(2) A licensee has proposed a full implementation of an AST but is not requesting any plant modifications. The licensee submitted an evaluation of the offsite and control room doses due to a DBA LOCA in support of this request. On the basis of its review of analyses performed in the staff's rebaselining study, the licensee has concluded that the existing LOCA analysis (based on the previous source term) remains bounding. In a sensitivity analysis, the licensee determined that multiplying the previous whole body result by a factor of 1.3 would yield a value that represents the TEDE dose. Is this an acceptable approach?

Answer: The implementation of an AST is a significant change to the design basis that should be viewed as a replacement rather than a adaptation of the earlier assumptions and methods. Although sensitivity and scoping analyses may have a minor role, the staff should expect that the offsite and control room dose analysis will largely be recalculated using the guidance of RG-1.183. This position is taken to ensure that a clear, logical, and consistent design basis will be in place to support evaluations of future modifications, including safety evaluations under 10 CFR 50.59.

f. For a full implementation, a complete DBA LOCA analysis as described in RG-1.183, should be performed as a minimum.

4. The reviewer should evaluate the AST proposed by the licensee against the guidance in RG-1.183. Differences between the licensee's proposal and the guidance should be resolved with the licensee. Although the licensee is allowed to propose alternatives to the guidance, large amounts of staff resources were expended in developing the revised source term (Ref. 5) from which the RG-1.183 source term was derived. Section 2.0 of RG-1.183 provides generic guidance on what would be expected before the staff would approve an AST with deviations from the AST in Section 3.0 of the guide.

5. The analysis methods and assumptions used by the licensee in determining the core inventory should be reviewed to ensure that they are based on current licensing basis rated thermal power, enrichment, and burnup.

6. The following review should be performed for each radiological analysis described in the licensee's submittal:

   a. The sequence of accident events described by the licensee should be reviewed to ensure that the analyzed case that maximizes the radioactivity release has been considered. This portion of the review should be coordinated with SRXB and SPLB as necessary.

   b. The models, assumptions, and parameter inputs used by the licensee should be reviewed to ensure that the conservative design basis assumptions outlined in RG-1.183 have been incorporated. These assumptions provide an integrated approach to performing the individual analyses and licensees are generally expected to use these assumptions or to propose acceptable alternatives. Licensee-proposed alternatives to this guidance may be accepted if technically appropriate and of an appropriate level of conservatism. Significant departures from this guidance will warrant additional review. Previously approved licensing basis assumptions may be utilized unless the assumptions are technically inconsistent with the AST or TEDE, or if the use of that assumption in conjunction with the proposed modification creates a concern regarding adequate protection of the public.

   c. Independent calculations should be performed as necessary to conclude, with reasonable assurance, that the applicant's analyses are acceptable. The staff's approval of the application is to be based on the licensee's docketed information. If differences are discovered between the licensee's methods and assumptions and those deemed acceptable to the staff, the reviewer should resolve the differences with the licensee. If necessary, the licensee should update the disputed assumptions and resubmit the affected analyses.

   d. The radiation doses postulated for the EAB, the LPZ, and the control room are compared to the acceptance criteria in Section II of this SRP section.

7. The analyses of radiological doses associated with the applicable NUREG-0737 items identified in Section I are evaluated against the guidance provided in NUREG-0737 and

in any license commitments related to these items. The dose criterion for these items is generally derived from the GDC-19 criteria. As GDC-19 has been updated to 5 rem TEDE, the dose criterion for NUREG-0737 items should also be 5 rem TEDE.

8. Evaluations of integrated radiation doses associated with equipment qualification are performed by EELB using the guidance of Regulatory Guide 1.89 (Ref. 6), supplemented by Appendix I to RG-1.183. The NRC staff is assessing the effect of increased cesium releases on EQ doses to determine if licensee action is warranted. Until such time as this generic issue is resolved, licensees may use either the AST or the TID14844 assumptions for performing the required EQ analyses. However, no plant modifications are required to address the impact of the difference in source term characteristics (i.e., AST vs TID14844) on EQ doses pending the outcome of the evaluation of the generic issue.

9. Licensees may propose changes in the period over which EQ dose estimates are calculated. These proposals are reviewed by EELB with support from other branches as necessary. These proposals may credit planned corrective or preventative maintenance, or planned modifications performed after 30 days post-accident for those components having a longer design basis survivability period. The staff review needs to consider at a minimum, post-accident accessability of components, the ability to perform the planned activities within the occupational exposure limits of 10 CFR 20.1201, the availability of needed material, and the feasibility of performing the planned activities in a post-accident environment.

10~~9~~. Reviewers should determine that the proposed AST implementation and supporting analyses will be appropriately included in future updates to the licensee's FSAR. This task should be accomplished, if possible, through a review of revised FSAR pages submitted by the licensee. At a minimum, the submittal should summarize the projected changes to the FSAR. These updates should identify important assumptions that play an essential role in supporting the acceptability of the proposed implementation. Reviewers should verify that such assumptions are reflected by licensee commitments that are incorporated into the FSAR, technical specifications, or license conditions.

IV. EVALUATION FINDINGS

The reviewer prepares an SER or provides input to a larger SER prepared by the primary review branch. Findings of acceptability should have a consistent, scrutable basis that is derived from the information submitted by the licensee on the docket and the staff's evaluation of these data. The following information should be included as applicable to the particular AST implementation. These conclusions should be combined with the conclusions of other reviewers with regard to nonradiological aspects of the evaluation as applicable.

1. The AST implementation should be described in sufficient detail to reasonably document the approved design basis, as modified. This step is particularly important for selective implementation applications. Cross-references to information submitted on the docket should be used when available in the interest of minimizing unnecessary repetition.

2. The regulatory mechanism, for example, 10 CFR 50.67, under which the change is being considered, is identified. Any regulatory exemptions, related technical specification changes, or licensee commitments are identified.

3. The licensee's supporting analyses and conclusions are described in sufficient detail to adequately document the design bases. Key analysis assumptions and inputs, analysis methods, and postulated doses should be included.

4. The staff's evaluation of the licensee's submittal, including the proposal, supporting evaluations, and conclusions drawn, should be described. Independent analyses prepared by the staff, if any, should be described. Essential analysis assumptions and inputs, analysis methods, and postulated doses should be included.

5. A conclusion similar to the following is to be included in the SER:

> The staff has reviewed the alternative source term (AST) implementation proposed by the <licensee> for the <facility>. The staff also reviewed the plant modifications associated with this proposed implementation. In performing this review, the staff relied upon information placed on the docket by <licensee>, staff experience in performing similar reviews and, where deemed necessary, on staff confirmatory calculations.
>
> The staff reviewed the assumptions, inputs, and methods used by <licensee> to assess the radiological impacts of the proposed plant modifications in the context of the proposed AST. The staff finds that <licensee> used analysis methods and assumptions consistent with the conservative guidance of RG-1.183, with the exceptions discussed and accepted earlier in this SER. The staff finds the methods and assumptions used by <licensee> to be in compliance with applicable requirements. The staff compared the doses estimated by <licensee> to the applicable acceptance criteria and to the results estimated by the staff in its confirmatory calculations. The staff finds with reasonable assurance that the licensee's estimates of the total effective dose equivalent due to design basis accidents will comply with the requirements of 10 CFR 50.67 and the guidance of RG-1.183. [As necessary, discuss NUREG-0737 items, equipment EQ].
>
> The staff finds reasonable assurance that the <facility>, as modified by this proposal, will continue to provide sufficient safety margins with adequate defense in depth to address unanticipated events and to compensate for uncertainties in accident progression and analysis assumptions and parameters. The staff concludes that the proposed AST implementation and the associated plant modifications are acceptable.

6. For a full implementation of an AST, text similar to the following is to be included in the above conclusion:

> This licensing action is considered a full implementation of the AST. With this approval, the previous accident source term in the

<facility> design basis is superseded by the AST proposed by <licensee>. The previous offsite and control room accident dose criteria expressed in terms of whole body, thyroid, and skin doses are superseded by the TEDE criteria of 10 CFR 50.67 or small fractions thereof, as defined in RG-1.183. All future radiological analyses performed to demonstrate compliance with regulatory requirements shall address all characteristics of the AST and the TEDE criteria as described in the <facility> design basis.

7. For a selective implementation of an AST, text similar to the following is to be included in the conclusion:

> This licensing action is considered a selective implementation of the AST. With this approval, the selected characteristics of the AST and the TEDE criteria, if applicable, become the design basis for the <explain the boundaries of the approved implementation>[4]. This approval is limited to this specific implementation. Subsequent modifications based on the selected characteristics incorporated into the design basis by this action may be possible under the provisions of 10 CFR 50.59. However, use of other characteristics of an AST or use of TEDE criteria which are not part of the approved design basis, and changes to previously approved AST characteristics, requires prior staff approval under 10 CFR 50.67. The selected characteristics of the AST and the TEDE criteria may not be extended to other aspects of the plant design or operation without prior NRC review under 10 CFR 50.67. All future radiological analyses performed to demonstrate compliance with regulatory requirements shall address the selected characteristics of the AST and the TEDE criteria as described in the <facility> design basis.

V. IMPLEMENTATION

The preceding material in this SRP section is intended to provide guidance to operating power reactor licensees applying for approval of a proposed AST implementation regarding the staff's plans for performing reviews of these applications. Although primarily directed toward the review of the initial implementation, the staff will also use this SRP section in its review of license amendment requests following the initial implementation.

Except in those cases in which the licensee proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the methods described in RG-1.183, and herein, will be used by the staff in its evaluation of conformance with Commission regulations.

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[4] The description of the boundary should identify all structures, systems, and components, and accident analysis for which the design basis has been changed.

VI. REFERENCES

1. RG-1.183, *Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors.*

2. NUREG-0737, *Clarification of TMI Action Plan Requirements,* November 1980.

3. SRP 19.0, *Use of Probabilistic Risk Assessment In Plant-Specific, Risk-Informed Decisionmaking: General Guidance*, July 1998.

4. SECY-98-154, *Results of the Revised (NUREG-1465) Source Term Re-Baselining for Operating Reactors*, June 1998.

5. NUREG-1465, *Accident Source Terms for Light-Water Nuclear Power Plants,* February 1995.

6. Regulatory Guide 1.89, *Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants*