U.S. NUCLEAR REGULATORY COMMISSION

DRAFT REGULATORY GUIDE DG-1350

Proposed new Regulatory Guide X.XXX

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Performance-Based Emergency Preparedness for Small Modular Reactors, Non-Light-Water Reactors, and Non-Power Production or Utilization Facilities

A. INTRODUCTION

Purpose

This regulatory guide (RG) identifies methods and procedures the staff of the U.S. Nuclear Regulatory Commission (NRC) considers acceptable for small modular reactor (SMR), non-light-water reactor (non-LWR), and non-power production or utilization facility (NPUF) applicants and licensees to demonstrate compliance with performance-based emergency preparedness (EP) requirements in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities" (Ref. 1), Section 50.160, "Emergency preparedness for small modular reactors, non-light-water reactors, and non-power production or utilization facilities."

Applicability

This RG applies to applicants for and holders of construction permits, early site permits (ESPs), operating licenses (OLs), and combined licenses (COLs) for SMRs, non-LWRs, and NPUFs under the provisions of 10 CFR Part 50 and 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Reactors" (Ref. 2), that choose to adopt the regulations for the performance-based EP framework under 10 CFR 50.160.

Applicable Regulations

- 10 CFR Part 50 provides regulations for licensing production and utilization facilities.
    - 10 CFR 50.2, "Definitions," provides definitions for non-LWR, NPUF, and SMR.
    - 10 CFR 50.33, "Contents of applications; general information," provides requirements for applications for an OL or construction permit under 10 CFR Part 50 or a COL or an ESP under 10 CFR Part 52, including requirements for establishing emergency planning zone (EPZ) size for applicants complying with 10 CFR 50.160.

This RG is being issued in draft form to involve the public in the development of regulatory guidance in this area. It has not received final staff review or approval and does not represent an NRC final staff position. Public comments are being solicited on this DG and its associated regulatory analysis. Comments should be accompanied by appropriate supporting data. Comments may be submitted through the Federal-rulemaking Web site, http://www.regulations.gov, by searching for draft regulatory guide DG-1350 or Docket ID NRC-2015-0225. Alternatively, comments may be submitted to the Office of Secretary, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, ATTN: Rulemakings and Adjudications Staff. Comments must be submitted by the date indicated in the *Federal Register* notice.

Electronic copies of this DG, previous versions of DGs, and other recently issued guides are available through the NRC's public Web site under the Regulatory Guides document collection of the NRC Library at https://nrcweb.nrc.gov/reading-rm/doc-collections/reg-guides/. The DG is also available through the NRC's Agencywide Documents Access and Management System (ADAMS) at http://www.nrc.gov/reading-rm/adams.html, under Accession No. ML18082A044. The regulatory analysis may be found in ADAMS under Accession No. ML18134A077.

- 10 CFR 50.47, “Emergency plans,” provides EP requirements for nuclear power reactors.

- Appendix E to 10 CFR Part 50, “Emergency Planning and Preparedness for Production and Utilization Facilities,” provides EP requirements for nuclear power reactors and NPUFs.

- 10 CFR 50.54, “Conditions of licenses,” provides requirements for emergency plan changes.

- 10 CFR 50.160 provides alternative performance-based EP requirements for an SMR, non-LWR, or NPUF applicant’s or licensee’s EP program.

- 10 CFR Part 52 governs the issuance of ESPs, standard design certifications, COLs, standard design approvals, and manufacturing licenses for nuclear power facilities.

  - 10 CFR 52.1, “Definitions,” provides definitions applicable to EP programs.

  - 10 CFR 52.17, “Contents of applications; technical information,” describes the required contents of the site safety analysis report for an ESP.

  - 10 CFR 52.18, “Standards for review of applications,” describes the standards that will be used to review applications for an ESP.

  - 10 CFR 52.79, “Contents of applications; technical information in final safety analysis report,” describes the technical information that must be included in the final safety analysis report for a COL application.

Related Guidance

The list of related guidance is provided to designers, applicants, and NRC staff to assist in the development and preparation of applications and their review. Although some guidance documents are written mainly for light-water nuclear power reactors, the designers and applicants may find the approaches described as useful information to aid in developing accident consequence assessments and source terms for their given designs and applications. The staff may use the guidance as applicable in the review of the applicants’ approaches for the given subject areas. Further information concerning consequence assessments and source terms is given in Appendix A and Appendix B, respectively.

- RG 1.174, “An Approach for Using Probabilistic Risk Assessment In Risk-Informed Decisions on Plant Specific Changes to the Licensing Basis” (Ref. 3), describes an integrated decision making approach that the NRC has found acceptable.

- RG. 1.183, “Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Plants” (Ref. 4), provides guidance on design basis accident (DBA) radiological consequence analyses for light-water nuclear power reactors, including the development of design basis accident radiological source terms used in siting and safety analyses.

- RG 1.200, “An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities” (Ref. 5), provides guidance on determining whether the technical adequacy of the PRA, in total or the parts that are used to support an application, is sufficient to provide confidence in the results, such that the PRA can be used in regulatory decision-making for light-water reactors.

- RG 1.206, “Combined License Applications for Nuclear Power Plants” (Ref. 6), provides guidance on the format of and content to be submitted in a COL application for a nuclear power plant (NPP).

- RG 1.219, “Guidance on Making Changes to Emergency Plans for Nuclear Power Reactors” (Ref. 7), provides guidance for nuclear power reactor licensees implementing requirements in 10 CFR 50.54(q), for following and maintaining the effectiveness of and evaluating and implementing changes to emergency plans.

- RG 2.6, “Emergency Planning for Research and Test Reactors and Other Non-Power Production and Utilization Facilities” (Ref. 8), provides applicants and licensees guidance on an acceptable method for use in complying with the regulations on the content of emergency plans for NPUFs.

- NUREG-0396 (EPA 520/1-78-016), “Planning Basis for the Development of State and Local Government Radiological Emergency Response Plans in Support of Light-Water Nuclear Power Plants” (Ref. 9), provides a planning basis for offsite EP efforts considered necessary and prudent for large power reactor facilities.

- NUREG-0654/Federal Emergency Management Agency (FEMA)-REP-1 “Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants” (Ref. 10), provides guidance and evaluation criteria for the development and evaluation of operating power reactor licensees’ radiological emergency response plans.

- NUREG-0800, Chapter 13.3, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition – Emergency Planning” (Ref. 11), provides guidance on the review and evaluation of a power rector license applicant’s EP program as described in the safety analysis report.

- NUREG-0800, Chapter 15, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition – Transient and Accident Analysis” (Ref. 12), provides guidance on the review and evaluation of safety analyses, including the evaluation of event categorization and DBA radiological consequence analyses.

  NUREG-0800, Chapter 19, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition – Severe Accidents” (Ref. 13), provides guidance on the review and evaluation of severe accident assessment, including severe accident releases and PRA.

- NUREG-1855, “Guidance on the Treatment of Uncertainties Associated with PRAs in Risk-Informed Decision Making” (Ref. 14), provides further guidance on addressing uncertainties.

Purpose of Regulatory Guides

The NRC issues RGs to describe to the public methods that the staff considers acceptable for use in implementing specific parts of the agency's regulations, to explain techniques that the staff uses in evaluating specific issues or postulated events, and to provide guidance to applicants. Regulatory guides are not substitutes for regulations and compliance with them is not required. Methods and solutions that differ from those set forth in RGs will be deemed acceptable if they provide a basis for the findings required for the issuance or continuance of a permit or license by the Commission.

Paperwork Reduction Act

This RG provides voluntary guidance for implementing the mandatory information collections in 10 CFR Parts 50 and 52 that are subject to the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 et. seq.). These information collections were approved by the Office of Management and Budget (OMB), approval numbers 3150-0011 and 3150-0151. Send comments regarding this information collection to the Information Services Branch (T-6A10M), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by e-mail to Infocollects.Resource@nrc.gov, and to the OMB reviewer at: OMB Office of Information and Regulatory Affairs (3150-0011 and 3150-0151), Attn: Desk Officer for the Nuclear Regulatory Commission, 725 17th Street, NW Washington, DC 20503; e- mail: oira_submission@omb.eop.gov.

Public Protection Notification

The NRC may not conduct or sponsor, and a person is not required to respond to, a collection of information unless the document requesting or requiring the collection displays a currently valid OMB control number.

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B. DISCUSSION

Reason for Issuance

This RG provides guidance on implementing a performance-based EP program for SMRs, non-LWRs, and NPUFs. It was developed to provide implementing guidance associated with the rulemaking that established 10 CFR 50.160. This rule established, for certain technologies, a performance-based, technology-inclusive, risk-informed, and consequence-oriented approach to EP that provides an alternative to the EP requirements under 10 CFR 50.47.

Background

Prior to the issuance of the EP requirements in 10 CFR 50.160, the NRC relied on EP regulations initially developed for large light-water reactors (LWRs) and non-power reactors, also referred to as research and test reactors (RTRs). Historically, small LWR and non-LWR applicants requested exemptions from some of the emergency planning requirements in 10 CFR 50.47 and Appendix E to 10 CFR Part 50 (e.g., La Crosse, Big Rock Point, Fort St. Vrain). Alternatively, certain license applicants could request to be evaluated on a case-by-case basis, as described in 10 CFR 50.47(c)(2). The EP requirements in 10 CFR 50.160 acknowledge technological advancements and other differences from large LWRs that are inherent in SMRs and other new technologies (ONTs).[1]

With the addition of 10 CFR 50.160, the NRC has addressed the differences in emergency planning and response between large LWRs and SMRs, non-LWRs, and NPUFs. Section 50.160 establishes an approach to EP that focuses on performance and results, rather than control of emergency plans and procedures. This RG applies to applicants and licensees choosing the performance-based approach to EP. Small modular reactor, non-LWR, and NPUF applicants and licensees may choose to adopt either the requirements of 10 CFR 50.160 or those in Appendix E to 10 CFR Part 50 and, for nuclear power reactor licensees, the planning standards in 10 CFR 50.47. Existing guidance in NUREG-0654/FEMA-REP-1 addresses implementation of EP programs under 10 CFR 50.47 and Appendix E to 10 CFR Part 50. Existing guidance in RG 2.6 addresses implementation of NPUF EP programs under Appendix E to 10 CFR Part 50.

The requirements of 10 CFR 50.33(g) specify that nuclear power reactor applicants must describe in their emergency plans actions as are appropriate to protect the food ingestion pathway. For SMRs, non-LWRs, and NPUFs that choose the performance-based approach to EP, 10 CFR 50.160(b)(4) requires applicants and licensees to describe ingestion response planning in the emergency plan. Regulatory Guidance C.3 of this RG provide additional guidance on ingestion response planning for SMRs, non-LWRs, and NPUFs choosing to comply with 10 CFR 50.160, including the need to describe in emergency plans the State, local, and Tribal resources available for protection of the food ingestion pathway in the event of a radiological emergency.

The concept of an ingestion pathway emergency planning zone (IPZ) was created in the 1970s when there may not have been sufficient infrastructure to support the identification and removal of radiologically contaminated goods from food chains. Of primary concern in the 1970s were the livestock and food products that could be contaminated from a radiological release at a large LWR. Since the 1970s, there have been significant improvements in the nation's Federal and State capabilities to identify and remove from the food chain biologically and radiologically contaminated goods or produce. Current Federal resources developed since then that are available for radiological emergency response include the

[1] The NRC uses the term "other new technologies," or "ONTs," to refer to technologies, such as non-LWRs and proposed medical radioisotope facilities that would be licensed under 10 CFR Part 50.

Federal Radiological Monitoring and Assessment Center (FRMAC) and the Advisory Team for Environment, Food and Health, as well as sampling and testing laboratories.

The mission of the FRMAC is to coordinate and manage all Federal radiological environmental monitoring and assessment activities during a nuclear or radiological incident, within the United States in support of State, local, Tribal governments, Department of Homeland Security (DHS), and the Federal response coordinating agency. The FRMAC is a Federal asset for response to a nuclear or radiological incident that is available upon request by DHS or State or Tribal agencies. The FRMAC is an interagency organization with representation from the National Nuclear Safety Administration (NNSA), Department of Defense (DOD), Environmental Protection Agency (EPA), Department of Health and Human Services (HHS), Federal Bureau of Investigations (FBI), and other Federal agencies. The NNSA has the responsibility to maintain the operational readiness and to deploy the FRMAC upon request.

The Advisory Team for Environment, Food and Health (Advisory Team) is a radiological emergency response group whose mission is to provide coordinated advice and recommendations for Federal, State, local, and Tribal governments in radiation emergencies. The permanent membership includes representatives from the EPA, Food and Drug Administration (FDA), Centers for Disease Control and Prevention (CDC), and U.S. Department of Agriculture (USDA). The permanent members may invite other agencies to participate in Advisory Team activities. The Advisory Team was incorporated into the FEMA "Nuclear/Radiological Incident Annex," October 2016 (Ref. 15), of the National Response Framework.

Ingestion response is not required in the early phase of an emergency because ingestion of contaminated foods and water is a longer term concern. The Federal, Tribal, and State resources that have been developed since the 1970s are available for the intermediate and late phases of the response, whether or not actions are pre-planned in a specific area. Therefore, SMRs, non-LWRs, and NPUFs that choose to comply with 10 CFR 50.160 do not need an IPZ because there are additional resources available and there is a better understanding of the process and timing for identifying and removing radiologically contaminated goods from food chains. Nonetheless, State, local, and Tribal response organizations can issue precautionary actions to the public, such as to wash all produce from gardens or to use stored feed for livestock for those areas in the downwind direction of a release. State, local, and Tribal response organizations do not need completed analyses to make a precautionary recommendation to interdict food or put livestock on stored feed. States and Federal agencies frequently issue such precautionary actions for non-radiological contamination of foods. None of these precautionary actions require an IPZ.

Background Discussion on EPA PAGs

The performance-based approach to EP utilizes protective action guides (PAGs) as a consequence-based factor in establishing EPZ size. A PAG, as defined in the 2017 EPA PAG Manual (Ref. 16), is the projected dose to an individual from a release of radioactive material at which a specific protective action to reduce or avoid that dose is recommended. The performance-based approach to EP requires that the plume exposure pathway EPZ should be established as the area in which public dose is projected to exceed 10 mSv (1 rem) total effective dose equivalent (TEDE) over the first 96 hours from the release of radioactive materials from a spectrum of credible accidents for the facility. This is consistent with the 2017 EPA PAG Manual guidance that the duration of early phase protective actions would begin at the actual or projected start of a release and generally last up until four days (i.e., 96 hours). Additional information regarding the timing for protective actions can be found in the 2017 EPA PAG Manual.

Harmonization with International Standards

The NRC staff reviewed General Safety Requirements Part 7 (GSR Part 7), "Preparedness and Response for a Nuclear or Radiological Emergency" (Ref. 17), from the International Atomic Energy Agency (IAEA). The guidance in this RG goes beyond the requirements found in GSR Part 7. The NRC is cooperating with the IAEA to further apply the general principles for EP and response to SMRs and non-LWRs.

C. STAFF REGULATORY GUIDANCE

This section provides the methods that the staff considers acceptable for meeting the requirements of the regulations cited in the Introduction.

General

1. Each SMR, non-LWR, or NPUF applicant or licensee that chooses to adopt the emergency planning standards located in Appendix E to Part 50 and in 10 CFR 50.47, as applicable, should use the existing guidance found in NUREG-0654/FEMA-REP-1 or RG 2.6, as appropriate to the design and use of the facility, to implement the EP program.

2. Each SMR, non-LWR, or NPUF applicant or licensee that chooses to adopt the EP regulations in 10 CFR 50.160 should use the guidance found in Regulatory Guidance C.5 through C.8 of this RG, as applicable, to establish an EP program. Appendix A, "General Methodology for Establishing Plume Exposure Pathway EPZ Size," provides a sample format acceptable to the NRC for the analysis for establishing EPZ size, as required under 10 CFR 50.33(g)(2).

    a. All SMR, non-LWR, or NPUF applicants and licensees should address the requirements in 10 CFR 50.160(b)(1)(i)-(iii), 10 CFR 50.160(b)(1)(iv)(A), and 10 CFR 50.160(b)(2)-(4) as described in Regulatory Guidance C.5, C.6, and C.8 of this RG.

    b. All SMR, non-LWR, or NPUF applicants and licensees proposing a plume exposure pathway EPZ that extends beyond the site boundary should address the requirements in 10 CFR 50.160(b)(1)(i)-(iii), 10 CFR 50.160(b)(1)(iv)(A) and (B), and 10 CFR 50.160(b)(2)-(4) as described in Regulatory Guidance C.5 through C.8 of this RG.

3. Each SMR, non-LWR, or NPUF applicant or licensee that chooses to adopt the EP regulations in 10 CFR 50.160 must describe in the emergency plan the Federal, State, local, and Tribal resources for protection of the ingestion pathway in the event of a radiological emergency. Even in cases where the facility's plume exposure pathway EPZ is bounded by the site boundary, the applicant and licensee should reference capabilities of local, State, Tribal, and Federal authorities that provide actions to protect contaminated food and water from entering the ingestion pathway. The capabilities described in the emergency plan would need to address major exposure pathways associated with the ingestion of contaminated food and water.

    a. For ingestion response planning, the licensee or applicant should demonstrate that Federal, State, local, Tribal, or licensee capabilities exist to support intermediate and long term monitoring, analysis, and interdiction or embargo when warranted, for the products identified as a part of the local site's food and water ingestion pathway.

    b. In order to interdict food pathways effectively, the contamination would need to be located, sampled, and identified. State, Tribal, and local officials would need to notify food producers to stop harvesting, using, and distributing from those identified locations to limit contaminated foods and water from entering the ingestion pathway. Therefore, the applicant's and licensee's emergency plan should describe the Federal, State, local, or Tribal capabilities to assess, sample, and notify to interdict foods and waters in a timely manner sufficient to avoid exceeding ingestion PAG doses.

4. Each SMR, non-LWR, or NPUF applicant or licensee that chooses to adopt the EP regulations in 10 CFR 50.160 must include in the emergency plan an analysis of any credible hazard from a contiguous or nearby facility that would adversely impact the implementation of emergency plans. Regulatory Guidance C.8 of this RG provides additional guidance on the required hazard analysis.

Performance-Based Framework

5. Section 50.160 requires applicants and licensees to demonstrate effective response in drills and exercises for emergency and accident conditions.

   Because of the performance-based nature of 10 CFR 50.160, this section of the RG provides general guidance on the content of emergency plans but does not provide specific methods for compliance. The methods needed to demonstrate preparedness will vary based on design- and site-specific considerations. If design-specific guidance is developed by the NRC or industry at a future date, applicants may reference those documents within their applications. Applicants should begin interacting with the NRC early in the application development process to ensure that significant issues and content to support the application are identified and resolved early.

   The NRC will review each application to determine that the applicant describes how the performance-based framework in 10 CFR 50.160 will be met. The staff will evaluate applications using a graded approach based on site-specific consequence analyses. Program elements that may be implemented and evaluated according to a graded approach include periodicity between inspections, drills, exercises, number of performance objectives, and staffing.

   a. Maintenance of Performance (10 CFR 50.160(b)(1)(i))

      (1) The emergency plan should include a general description of the facility, any site-specific definitions, and any relevant appendices, drawings, diagrams, and other information needed to demonstrate compliance with this section.

      (2) The emergency plan should describe the process for maintaining and making changes to the emergency plan and associated procedures, including methods to account for facility changes and the methods used to conduct independent review of the EP program. Licensees may make changes to capabilities described in the emergency plan without creating a reduction in effectiveness, consistent with the requirements in 10 CFR 50.54(q), so long as emergency response performance does not decrease due to the changes in the capabilities.

   b. Performance Objectives (10 CFR 50.160(b)(1)(ii))

      The emergency plan should describe a performance monitoring program to include the following topics:

      (1) The process used to develop performance metrics and objectives for each emergency response function in 10 CFR 50.160(b)(1)(iii), including the methodology used to develop the objectives, the basis for relying on the objectives, and how acceptability or successful achievement is determined;

For example, the methodology used to develop performance objectives and metrics could be:

$$performance\ objective\ metric(\%) = \frac{Number\ of\ correct\ opportunities}{Number\ of\ opportunities} \times 100$$

(2) performance measures used during drills and exercises to determine acceptable performance, including the means for determining quality and timeliness;

(3) reference levels to benchmark performance of each emergency response function in 10 CFR 50.160(b)(1)(iii);

(4) quarterly update of performance objective and metric data and maintenance of these objectives and data for previous eight calendar quarters, or other periodicity as applicable;

(5) performance objective data format and method; and

(6) correction of previous performance objective data.

c. Event Classification and Mitigation (10 CFR 50.160(b)(1)(iii)(A))

The emergency plan should describe:

(1) capabilities to perform event classification and mitigation to include the methods, processes, equipment, specific instruments, parameters, facilities, and personnel;

(2) how the emergency response team will accurately and in a timely manner assess facility conditions and classify events that would warrant an emergency declaration (e.g., the emergency response team would use emergency plan implementing procedures to assess malfunctions and the impact on safety, classify the event, monitor, plan, and repair facility malfunctions in a timely manner to stop accident progression and return the facility to within safety limits or technical specifications.); and

(3) the emergency classification scheme and the associated emergency action levels (EALs), as applicable for the design of the facility, and the technical basis and methodology for the determination of the thresholds corresponding to each of the EALs, including consideration of:

(a) those standard classes (i.e., notification of unusual events, alert, site area emergency, general emergency) appropriate for dealing with accident consequences determined to be credible for the specific facility;

(b) any hazards or initiating conditions (IC) associated with a nearby, adjacent, or contiguous facility where a hazard would adversely impact the implementation of emergency plans; and

(c) the EALs associated with each class of emergency and the particular immediate actions to provide an appropriate graded response (See Table 1 as an example to be expanded and completed).

Table 1. Sample EAL Description

AREA	INITIATING CONDITION	EMERGENCY ACTION LEVELS	THRESHOLD	BASIS
Abnormal Radiological Conditions	High radiological effluents	Gaseous		
		Liquid		
		Unmonitored		
		Areas		
		Processes		
	Inadvertent criticality			
External Hazards or Natural Phenomena	Natural phenomena (high wind speeds, high/low ultimate heat sink, seismic, other)			
	Technical hazards (hazardous gasses, hostile action-based, fire, other industrial)			
	Hazardous chemical releases incident to the processing of licensed material			
System Malfunctions	At power			
	Hot shutdown			
	Cold shutdown			
	Refueling/ Reloading			
	Startup			
Fission Product Barriers	Fuel matrix and cladding			
	Coolant			
	Containment function			
Judgment				

d. Protective Actions (10 CFR 50.160(b)(1)(iii)(B))

(1) The emergency plan should describe capabilities to determine and implement appropriate protective actions for a variety of hazards, to include the methods, processes, equipment, facilities, and personnel.

(2) The emergency plan should describe how the emergency response team should determine the appropriate protective action strategy to protect workers from ionizing radiation, toxic chemicals, or other industrial hazards from a spectrum of predetermined, available protective actions. Examples of protective actions that may be considered include but are not limited to: issuing respiratory protection, issuing protective clothing and equipment, removing non-essential individuals and the public, evacuation, accountability, and search and rescue.

e. Communications (10 CFR 50.160(b)(1)(iii)(C))

The emergency plan should describe:

(1) capabilities to establish and maintain communications among the response facilities, as applicable, and with organizations which may have emergency response responsibilities, to include the methods, processes, equipment, facilities, and personnel;

(2) information that will be provided when alerting site personnel (e.g., nature of the emergency classification and releases, location of the emergency, protective actions that are implemented onsite);

(3) activation and notification of the emergency response team and response organization based on the nature of the emergency condition;

(4) notification procedures for notifying response personnel and organizations which may have responsibilities during emergencies;

(5) notification procedures for notifying response personnel and organizations which may have on-site responsibilities or agreements (e.g., local law enforcement, medical and hospital services, fire response services);

(6) methods used to provide periodic updates on emergency conditions containing pertinent information to response teams, facility staff, and offsite organizations; and

(7) methods used to maintain continuous communications when requested.

f. Command and Control (10 CFR 50.160(b)(1)(iii)(D))

The emergency plan should describe:

(1) the capabilities to perform adequate command and control, to include the methods, processes, equipment, facilities, and personnel;

(2) the supporting organizational structure with defined roles, responsibilities, and authorities for directing and performing emergency response functions; and

(3) qualitative criteria to assess command and control, such as how the emergency response team leader would use emergency plan implementing procedures to demonstrate his or her ability to:

(a) lead and direct the team to perform emergency response functions immediately;

(b) maintain awareness of the emergency conditions;

(c) make timely and unilaterally accurate decisions based on facility conditions to protect the public and environment;

(d) maintain emergency response functions continuously and indefinitely through the termination of the emergency;

(e) transition to resumption of normal operations or shutdown conditions; and

(f) coordinate emergency response functions with other organizations.

g. Staffing and Operations (10 CFR 50.160(b)(1)(iii)(E))

The emergency plan should describe:

(1) the capabilities to adequately staff the emergency response functions within an appropriate timeframe, to include the methods, processes, equipment, facilities, and personnel.

(a) The staffing of the response centers and the training for the personnel should be described in the emergency plan, which may reference facility training procedures or other documents as needed. A complete roster of trained and qualified individuals should be maintained and updated on a set periodicity and as personnel are added or removed from positional assignments.

(b) The plan should describe the onshift emergency response staff augmentation process, including maintenance of staffing and succession of leadership for the duration of the emergency response, or expansion of the response as needed.

(c) The plan should describe the analysis used to determine the minimum positions and the corresponding responsibilities to perform the emergency response functions described in the emergency plan, including consideration of the following positions or responsibilities: emergency response team leader, authorization for termination and transition to recovery, recovery operations, authorization for emergency radiation worker exposure, authorization for media and news releases.

(2) the process used to complete training prior to assigning roles and responsibilities on the emergency response team.

(a) Drills are a vehicle to use to train and retrain facility personnel in emergency responsibilities. The drills should be described within the emergency plan including references to a complete list of drill objectives and periodicities for various drill types:

- Integrated drills – drills using multiple facilities or with any offsite organization, which may be used for training and instruction.

- Evaluated exercises – activities that test major portions of the emergency response functions, which may not be used for training and instruction.
- Communication drills – activities that drill the use of communication equipment and procedures to communicate facility status and emergency conditions. Communication drills may be used to verify contact information, protocols, and reliability.
- Fire drills – activities that drill the use of fire suppression technology. (If the facility has a separate program to address fires, the emergency plan only needs to reference that program. Its evaluation will be done externally to the EP program.)
- Medical emergency drills – activities that drill the use of first aid, emergency medical response, contaminated individuals, or other industrial accidents.
- Radiological monitoring drills – activities that drill the use of equipment and procedures to determine the adequacy of equipment, training, and procedures for radiological monitoring of processes, effluents, releases, samples, contamination, and dose assessments.

Drills should allow sufficient free play to determine the adequacy of other emergency response functions with a minimum number of controller intrusions.

h. Radiological Assessment (10 CFR 50.160(b)(1)(iii)(F))

(1) Radiological Conditions (10 CFR 50.160(b)(1)(iii)(F)(*1*))

The emergency plan should describe the capabilities to assess, monitor, and report to the response organization radiological conditions of the facility, such as abnormally high area and process conditions and inadvertent criticality accident conditions as applicable, and onsite locations, to include the methods, processes, equipment, facilities, data, and personnel.

(2) Protective Equipment (10 CFR 50.160(b)(1)(iii)(F)(*2*))

The emergency plan should describe:

(a) capabilities to issue and use protective equipment and expand mitigation and protective action strategies, to include the methods, processes, equipment, facilities, and personnel; and

(b) how the emergency response team will use emergency plan implementing procedures to demonstrate the issuance and correct use of protective equipment.

(3) Core Damage (10 CFR 50.160(b)(1)(iii)(F)(*3*))

The emergency plan should describe:

(a) capabilities to assess, monitor, and report to the emergency team leader the extent of any core or fuel damage, to include the methods, processes, equipment, facilities, and personnel; and

(a) how the emergency response team will use emergency plan implementing procedures to demonstrate assessing, monitoring, and reporting core damage.

(4) Releases (10 CFR 50.160(b)(1)(iii)(F)(*4*))

The emergency plan should describe:

(a) capabilities to assess, monitor, and report to the emergency team leader the extent of any radiological release, including the releases of hazardous chemicals produced from licensed material[2], to include the methods, processes, equipment, facilities, and personnel; and

(b) capabilities to assess, monitor, and report to the emergency team leader the extent of any radiological release, including those from chemical plumes, to include the methods, processes, equipment, facilities, and personnel; and

(c) how the emergency response team will use emergency plan implementing procedures to demonstrate assessing, monitoring, and reporting of all radiological releases.

i. Reentry (10 CFR 50.160(b)(1)(iii)(G))

The emergency plan should describe:

(1) capabilities to develop and implement reentry plans for access to the facility after emergencies and, if applicable, hostile action-based (HAB) events, including the methods, processes, equipment, facilities, and personnel; and

(2) how the emergency response team will use emergency plan implementing procedures to demonstrate the development and implementation of reentry plans.

j. Critique and Corrective Actions (10 CFR 50.160(b)(1)(iii)(H))

The emergency plan should describe:

(1) capabilities to critique emergency response functions and implement effective corrective actions, to include the methods, processes, equipment, facilities, and personnel; and

(2) how the emergency response team will use emergency plan implementing procedures to critique emergency response functions and implement timely corrective actions.

[2] As defined in 10 CFR 70.4, *Hazardous chemicals produced from licensed materials* means substances having licensed material as precursor compound(s) or substances that physically or chemically interact with licensed materials; and that are toxic, explosive, flammable, corrosive, or reactive to the extent that they can endanger life or health if not adequately controlled. These include substances commingled with licensed material, and include substances such as hydrogen fluoride that is produced by the reaction of uranium hexafluoride and water, but do not include substances prior to process addition to licensed material or after process separation from licensed material.

Onsite Planning Activities

6. The emergency plan should address the following planning activities. Established NRC guidance for power reactors (e.g., NUREG-0654/FEMA-REP-1) or for NPUFs (e.g., RG 2.6), may be referenced for approaches to implementing the planning activities.

   a. Public Information (10 CFR 50.160(b)(1)(iv)(A)(*1*))

      The emergency plan should describe the planning activities, capabilities, and processes or procedures to support the public information functions of the Federal, local, State and Tribal authorities.

   b. Coordination with Safeguards Contingency Plan (10 CFR 50.160(b)(1)(iv)(A)(*2*))

      The emergency plan should describe the planning activities, capabilities, and processes or procedures to support implementation of the emergency plan in conjunction with the Licensee Safeguards Contingency Plan, including but not limited to:

      (1) initial notifications to law enforcement and other first-responder agencies;

      (2) communication of threat-related information to the NRC;

      (3) coordination of response actions within the licensee organization, and with the Incident Commander[3] and local law enforcement agency personnel;

      (4) coordination with the Incident Commander for deployment of onsite and offsite first responders;

      (5) coordination of onsite radiation protection measures for offsite first responders with the Incident Command Post (ICP);

      (6) support for the operations of an ICP;

      (7) mobilization of the site's emergency staff with security and the ICP, including during reentry; and

      (8) deployment and release of public information.

   c. Communications with the NRC (10 CFR 50.160(b)(1)(iv)(A)(*3*))

      The emergency plan should describe the planning activities, capabilities, and processes or procedures to support briefing offsite authorities and the NRC on facility and emergency response status, and making emergency notifications to the NRC.

   d. Emergency Facility or Facilities (10 CFR 50.160(b)(1)(iv)(A)(*4*))

      The emergency plan should describe each emergency response facility, including, as applicable, descriptions of location, capabilities, size, equipment, and backup locations to transfer the functions in the event of the facility not being habitable or accessible. The emergency plan should

[3] See FEMA - National Incident Management System available at https://www.fema.gov.

also describe the processes, systems, and equipment for collecting and processing data and for decision making to implement the emergency plan.

Offsite Planning Activities

7. The following planning activities are required for only those SMR, non-LWR, and NPUF applicants and licensees who propose a plume exposure pathway EPZ that extends beyond the site boundary. The applicant or licensee should ensure that the following capabilities exist in offsite plans. A crosswalk should be provided at the end of the emergency plan to reference the offsite plans where the capabilities exist. Table 2 provides a sample format.

Table 2. Emergency Preparedness and Planning Crosswalk Requirements to Locations

RULE (10 CFR 50.160)	EMERGENCY PLAN LOCATION	EMERGENCY PLAN IMPLEMENTING PROCEDURE OR FACILITY PROCESS PROCEDURE	LOCATION IN OFFSITE PLANS
50.160(b)(1)(i)			
50.160(b)(1)(ii)			
50.160(b)(1)(iii)			
50.160(b)(1)(iii)(A)			
50.160(b)(1)(iii)(B)			
50.160(b)(1)(iii)(C)			
50.160(b)(1)(iii)(D)			
50.160(b)(1)(iii)(E)			
50.160(b)(1)(iii)(F)(*1*)			
50.160(b)(1)(iii)(F)(*2*)			
50.160(b)(1)(iii)(F)(*3*)			
50.160(b)(1)(iii)(F)(*4*)			
50.160(b)(1)(iii)(G)			
50.160(b)(1)(iii)(H)			
50.160(b)(1)(iv)(A)(*1*)			
50.160(b)(1)(iv)(A)(*2*)			
50.160(b)(1)(iv)(A)(*3*)			
50.160(b)(1)(iv)(A)(*4*)			
50.160(b)(1)(iv)(B)(*1*)			

RULE (10 CFR 50.160)	EMERGENCY PLAN LOCATION	EMERGENCY PLAN IMPLEMENTING PROCEDURE OR FACILITY PROCESS PROCEDURE	LOCATION IN OFFSITE PLANS
50.160(b)(1)(iv)(B)(*2*)			
50.160(b)(1)(iv)(B)(*3*)			
50.160(b)(1)(iv)(B)(*4*)			
50.160(b)(1)(iv)(B)(*5*)			
50.160(b)(1)(iv)(B)(*6*)			
50.160(b)(1)(iv)(B)(*7*)			
50.160(b)(1)(iv)(B)(*8*)			
50.160(b)(1)(iv)(B)(*9*)			
50.160(b)(1)(iv)(B)(*10*)			
50.160(b)(1)(iv)(B)(*11*)			
50.160(b)(2)			
50.160(b)(3)			
50.160(b)(4)			

a. Contacts and Arrangements with Governmental Agencies (10 CFR 50.160(b)(1)(iv)(B)(*1*))

The emergency plan should describe contacts and arrangements made for medical, local law enforcement, fire department, emergency management agencies and other emergency response organizations (EROs) that document the relevant emergency planning and preparations and roles and responsibilities, including:

(1) agency or organization name;

(2) responsibilities for each agency or organization;

(3) capabilities to be planned and prepared;

(4) periodic review of contacts and arrangements; and

(5) references to or attachment of agreements maintained (e.g., describing the services needed, activation of the service, and how to modify or periodically renew the agreements).

b. Notification of Offsite Organizations (10 CFR 50.160(b)(1)(iv)(B)(*2*))

The emergency plan should describe for the organizations listed in Regulatory Guidance C.7.a of this RG:

(1) means of notification;

(2) validation of the notification;

(3) time within which notifications should be completed; and

(4) the primary and secondary notification methods.

c. Protective Measures[4] (10 CFR 50.160(b)(1)(iv)(B)(*3*))

The emergency plan should describe the nature of protective measures to be taken protect the public, including:

(1) organization responsible for notifying the public;

(2) span of protective measures, to include consideration of evacuation time estimates (ETEs);

(3) use of relocation centers;

(4) methods to sustain the evacuation or sheltering and periodic bulletins of ongoing efforts; and

(5) methods to expand, relax, suspend, or terminate the protective actions.

d. Offsite Organization Training (10 CFR 50.160(b)(1)(iv)(B)(*4*))

The emergency plan should describe:

(1) training provided, the expected participants, and the periodicity of training; and

(2) any coordination to ensure that the local law enforcement, medical, and fire services are familiar with the site environs and hazards associated with the site.

(a) Service-specific information concerning the site's capabilities should be shared with the responding service. For example, the locations of important fire mains, hydrants, and suppression systems should be provided to the fire response services if needed to respond to the facility and assist in fire suppression and investigation. Likewise, for local law enforcement and medical services, the services should be aware of the capabilities the site has and locations of key resources.

e. Evacuation Time Estimate Study (10 CFR 50.160(b)(1)(iv)(B)(*5*))

The emergency plan should include an ETE for the plume exposure pathway EPZ. Reasonable adaptation of NRC-approved or endorsed ETE guidance (e.g., NUREG/CR-7002, "Criteria for Development of Evacuation Time Estimate Studies" (Ref. 18)), may be used.

f. Emergency Response Facilities (10 CFR 50.160(b)(1)(iv)(B)(*6*))

The emergency plan should describe:

[4] The 2017 EPA PAG Manual (EPA-400/R-17/001) contains planning guidance and PAGs for considering and implementing protective actions for the public.

(1) the offsite facility, alternative facility, and backup facility, as applicable, from which the licensee coordinates offsite response; and

(2) for one of the offsite facilities, the facility's media and press capabilities including the methods for dissemination of information.

g. Offsite Dose Projections (10 CFR 50.160(b)(1)(iv)(B)(*7*))

The emergency plan should describe:

(1) the capabilities for making offsite dose projections; and

(2) the means of communicating offsite dose projections to offsite coordinating agencies, to include the methods, processes, equipment, facilities, and personnel.

h. Dissemination of Public Information (10 CFR 50.160(b)(1)(iv)(B)(*8*))

The emergency plan should describe:

(1) the capabilities by which information is provided to members of the public concerning emergency planning;

(2) the public alert and notification system; and

(3) any prompt actions that need to be taken by the public, to include the methods, processes, equipment, facilities, and personnel.

i. Reentry (10 CFR 50.160(b)(1)(iv)(B)(*9*))

The emergency plan should describe:

(1) the process to establish reentry into the affected parts of the EPZ and facility during and after termination of an emergency and transition to recovery; and

(a) Capabilities should exist so that specific plans can be developed during an emergency to allow for timely reentry into the affected parts of the EPZ and the facility as conditions warrant.

(2) criteria and processes to authorize emergency dose for volunteers who have been briefed on the health effects of receiving emergency doses.

j. Drills and Exercises (10 CFR 50.160(b)(1)(iv)(B)(*10*))

The emergency plan should:

(1) provide a description of the drill and exercise program with references to the process that will be employed to test and implement major portions of the planning, preparations, capabilities, and coordination with offsite organizations to maintain the key skills of emergency responders;

(2) include a list of the major drills with specific periodicities, as well as the organization and position with whom the licensee coordinates response;

(3) describe arrangements and contacts to facilitate joint planning by all responding organizations for specific drills; and

(4) describe the drill and exercise critique program and correction of identified weaknesses.

k. Emergency Plan Maintenance (10 CFR 50.160(b)(1)(iv)(B)(*11*))

The emergency plan should:

(1) provide a description of the process by which the emergency plan, implementing procedures, forms, and other programmatic documents are maintained at a high quality (i.e., references to the quality assurance program and to existing regulatory guidance may be used);

(2) identify the individual(s) and organizations responsible for ensuring the documents are up-to-date; and

(3) describe the periodicity of review of emergency plan-related documentation and the process for coordinating reviews with any offsite organization which may have emergency response responsibilities.

Hazard Analysis of Nearby, Adjacent, or Contiguous Facilities

8. The emergency plan should describe the results of a hazard analysis of any nearby, adjacent, or contiguous facility. The emergency plan should describe planning activities or emergency response functions that will address any credible hazard that would adversely impact the implementation of emergency plans. The analysis should:

a. identify and characterize the site-specific hazards posed by multi-modular and nuclear units, nearby, adjacent, or contiguous facilities that could complicate the SMR, non-LWR, or NPUF's emergency response (e.g., nature of the challenge in terms of timing, severity, and persistence);

b. evaluate the impacts of the identified hazards (e.g., realistic response timeline, functional threats caused by the hazard, strategies needed to address the hazard); and,

c. describe the planning activities or emergency response functions that will mitigate the impacts of the identified hazards (e.g., see the guidance under Regulatory Guidance C.5.c.3.b of this RG).

D. IMPLEMENTATION

The NRC staff may use this regulatory guide as a reference in its regulatory processes, such as licensing, inspection, or enforcement. However, the NRC staff does not intend to use the guidance in this regulatory guide to support NRC staff actions in a manner that would constitute backfitting as that term is defined in 10 CFR 50.109, "Backfitting," and as described in NRC Management Directive 8.4, "Management of Backfitting, Forward Fitting, Issue Finality, and Information Requests," (Ref. 19), nor does the NRC staff intend to use the guidance to affect the issue finality of an approval issued under 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants." The staff also does not intend to use the guidance to support NRC staff actions in a manner that constitutes forward fitting as that term is defined and described in Management Directive 8.4. If a licensee believes that the NRC is using this regulatory guide in a manner inconsistent with the discussion in this Implementation section, then the licensee may file a backfitting or forward fitting appeal with the NRC in accordance with the process in Management Directive 8.4.

GLOSSARY

Consequence-oriented	The principle of basing decisions of the extent of EP required upon the level and severity of the consequences of a credible radiological accident occurring.
Hostile action	As defined in Section IV.A.7 of Appendix E to 10 CFR Part 50, an act directed toward a NPP or its personnel that includes the use of violent force to destroy equipment, take hostages, and/or intimidate the licensee to achieve an end. This includes attack by air, land, or water using guns, explosives, projectiles, vehicles, or other devices used to deliver destructive force.
Non-light-water reactor	A nuclear power reactor using a coolant other than light water.
Non-power production or utilization facility	A production or utilization facility, licensed under 10 CFR 50.21(a), 10 CFR 50.21(c), or 10 CFR 50.22, as applicable, that is not a nuclear power reactor or production facility as defined under paragraphs (1) and (2) of the definition of *Production facility* in § 50.2.
Performance-based	The principle of basing the adequacy of EP and planning upon the NRC's identification of emergency response functions that affect the protection of public health and safety and the licensee's successful execution of those functions.
Small modular reactor	A power reactor, licensed under 10 CFR 50.21 or 50.22 to produce heat energy up to 1,000 megawatts thermal (MWt), which may be of modular design as defined in 10 CFR 52.1.
Site boundary	As defined in 10 CFR Part 20, "Standards for Protection Against Radiation," (Ref. 20), specifically Section 20.1003, that line beyond which the land or property is not owned, leased, or otherwise controlled by the licensee.
Technology-inclusive	The principle of establishing performance requirements for any SMR, non-LWR, or NPUF applicant or licensee to use in its emergency plan.

REFERENCES [5]

1. *U.S. Code of Federal Regulations* (CFR), "Domestic Licensing of Production and Utilization Facilities," Part 50, Chapter I, Title 10, "Energy."

2. CFR, "Licenses, Certifications, and Approvals for Nuclear Power Plants," Part 52, Chapter I, Title 10, "Energy."

3. U.S. Nuclear Regulatory Commission (NRC), Regulatory Guide (RG) 1.174, "An Approach for Using Probabilistic Risk Assessment In Risk-Informed Decisions on Plant Specific Changes to the Licensing Basis," Washington, DC.

4. NRC, RG. 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Plants," Washington, DC.

5. NRC, RG 1.200, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," Washington, DC.

6. NRC, RG 1.206, "Combined License Applications for Nuclear Power Plants," Washington, DC.

7. NRC, RG 1.219, "Guidance on Making Changes to Emergency Plans for Nuclear Power Reactors," Washington, DC.

8. NRC, RG 2.6, "Emergency Planning for Research and Test Reactors and Other Non-Power Production and Utilization Facilities," Washington, DC.

9. NRC and the U.S. Environmental Protection Agency (EPA) Task Force on Emergency Planning, NUREG-0396 (EPA 520/1-78-016), "Planning Basis for the Development of State and Local Government Radiological Emergency Response Plans in Support of Light-Water Nuclear Power Plants," December 1978.

10. NRC and the Federal Emergency Management Agency (FEMA), NUREG-0654/FEMA-REP-1, "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants," November 1980. [6]

11. NRC, NUREG-0800, Chapter 13.3, Rev. 3, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition – Emergency Planning," Washington, DC.

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[5] Publicly available NRC published documents are available electronically through the NRC Library on the NRC's public Web site at http://www.nrc.gov/reading-rm/doc-collections/ and through the NRC's Agencywide Documents Access and Management System (ADAMS) at http://www.nrc.gov/reading-rm/adams.html. The documents can also be viewed online or printed for a fee in the NRC's Public Document Room (PDR) at 11555 Rockville Pike, Rockville, MD. For problems with ADAMS, contact the PDR staff at 301-415-4737 or (800) 397-4209; fax (301) 415-3548; or e-mail pdr.resource@nrc.gov.

[6] Copies of Federal Emergency Management (FEMA) documents may be obtained from FEMA's Web site (http://www.fema.gov/); or by mail at Federal Emergency Management Agency, P.O. Box 10055, Hyattsville, MD 20782; telephone (800) 745-0243; fax (800) 827-8112.

12. NRC, NUREG-0800, Chapter 15, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition – Transient and Accident Analysis," Washington, DC.

13. NRC, NUREG-0800, Chapter 19, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition – Severe Accidents," Washington, DC.

14. NRC, NUREG-1855, "Guidance on the Treatment of Uncertainties Associated with PRAs in Risk-Informed Decision Making," Washington, DC.

15. FEMA, "Nuclear/Radiological Incident Annex," National Response Framework, October 2016.

16. EPA-400/R-17/001, "PAG Manual: Protective Action Guides and Planning Guidance for Radiological Incidents," January 2017.[7]

17. IAEA Safety Standards, "General Safety Requirements Part 7 (GSR Part 7), "Preparedness and Response for a Nuclear or Radiological Emergency," Vienna, Austria, 2015. [8]

18. NRC, NUREG/CR-7002, "Criteria for Development of Evacuation Time Estimate Studies," Washington, DC.

19. NRC, Management Directive 8.4, "Management Backfitting, Forward Fitting, Issue Finality, and Information Requests," Washington, DC.

20. CFR, "Standards for Protection Against Radiation," Part 20, Chapter I, Title 10, "Energy."

[7] Copies of Environmental Protection Agency (EPA) documents may be obtained from EPA's Web site EPA's Web site or directly PAG Manual: Protective Action Guides and Planning Guidance for Radiological Incidents.

[8] Copies of International Atomic Energy Agency (IAEA) documents may be obtained through their Web site: WWW.IAEA.Org/ or by writing the International Atomic Energy Agency, P.O. Box 100 Wagramer Strasse 5, A-1400 Vienna, Austria.

APPENDIX A

GENERAL METHODOLOGY FOR ESTABLISHING PLUME EXPOSURE PATHWAY EPZ SIZE

A-1. Introduction

This appendix describes an acceptable approach for setting a plume exposure EPZ size based on determining the area within which public dose, as defined in 10 CFR Part 20, "Standards for Protection Against Radiation," Section 20.1003, "Definitions," is projected to exceed 10 millisieverts (mSv) [1 roentgen equivalent man (rem)] total effective dose equivalent (TEDE) over 96 hours from the release of radioactive materials, resulting from a spectrum of accidents credible for the facility. This approach has been generalized from the dose assessment methodologies that informed EPZ size determinations in NUREG-0396, "Planning Basis for the Development of State and Local Government Radiological Emergency Response Plans in Support of Light-Water Nuclear Power Plants." For the plume exposure pathway EPZ determination, the applicant and licensee should demonstrate the following in the technical analysis:

a. The size of the EPZ should encompass an area where it may be expected that prompt protective measures, such as evacuation and sheltering, may be needed to minimize the exposure to individuals.

b. If the applicant and licensee demonstrates that prompt protective measures are not required due to timing of releases from a credible accident or that extended time exists after a release prior to reaching the need for evacuation or sheltering, such that an all hazards emergency management plan could initiate actions in sufficient time to adequately protect the public safety and health, such accidents may be excluded from consideration in determining the size of the EPZ.

c. If the proposed plume exposure pathway EPZ extends beyond the site boundary and if the application is for an operating license (OL), combined license (COL), an early site permit (ESP) that contains plans for coping with emergencies under 10 CFR 52.17(b)(2)(ii), or an ESP that proposes major features of the emergency plans and describes the EPZ, then the exact shape of the plume exposure pathway EPZ would need to be determined in relation to local emergency response needs and capabilities as they are affected by such conditions as demography, topography, land characteristics, access routes, and jurisdictional boundaries.

A-2. Methodology Basis/Assumptions

The following generalized methodology has been developed to be consistent with the approaches used in the NUREG-0396 quantitative analyses, to the extent that the details of those analyses could be discerned." Key assumptions of the generalized methodology include the following:

a. Adequate information on radiological source terms and, as appropriate, probabilistic risk assessment (PRA) is assumed to be available. See Appendix B for more information on the development of radiological source terms and PRA.

b. The atmospheric release pathway is assumed to be the risk-dominant contributor to offsite doses (i.e., no consideration of direct exposures or releases to liquid pathways).

c. The atmospheric release is assumed to consist of neutral density non-reactive aerosols or gasses (with radioactive decay and in-growth corrections as appropriate). If a release pathway requires more complex atmospheric transport modeling, additional analyses may be needed.

d. Use of a straight-line Gaussian plume segment-type atmospheric dispersion model (with modifications as needed to account for near-field dispersion phenomena) to estimate atmospheric concentrations is assumed to be appropriate. If a more advanced method for dispersion modeling is used, the details of the methodology described in this document may need to be adapted to account for the use of such models.

e. A specified exposure duration must be assumed to estimate doses, and no credit for protective actions is assumed over the specified exposure period.

A-3. Generalized Methodology

A-3.1 Source Terms

For each release scenario for which doses are assessed, a quantitative radiological source term would be developed by specifying atmospheric release characteristics such as the time dependent isotopic release rates to the atmosphere, release durations, release locations, physical/chemical form, and plume buoyancy.

A-3.2 Meteorological Input

An analysis to develop meteorological data may be needed to evaluate a range of meteorological conditions in a probabilistic fashion. Alternately, conservative transport and dispersion conditions may be assumed, although the conservatism of the selected conditions should be evaluated to ensure that the combination of parameters selected for transport and dispersion modeling was in fact conservative. The data needs of the selected atmospheric transport model (see Section A-3.3) should be considered in the selection of meteorological data. Selection of a source of meteorological data would include evaluation of data such as wind speeds, atmospheric stability, precipitation, mixing height, etc., for temporal and geographical representativeness. The quality and completeness of the meteorological data should be assessed. It should be noted that meteorological data is site specific. However, some applications could involve assessments that are not site specific. An explanation of the appropriateness of the meteorological data used for such assessments would be needed to evaluate the analysis.

A-3.3 Atmospheric Transport Modeling

An atmospheric transport model appropriate for the range of distances under consideration should be identified. In NUREG-0396, Gaussian-type models were used for atmospheric transport. For these types of models, dispersion parameters appropriate to the characteristics of the area and distance ranges under consideration should be identified, and conceptual approaches for the treatment of near-field effects such as elevated releases, building wake effects, plume meander, plume rise, etc. should also be identified. The selection of an atmospheric transport model should also involve selection of a conceptual approach for treatment of wet and dry deposition. Any

assumptions made in the atmospheric transport model should be identified so that the analyst can evaluate the suitability of the model for their particular application.

A-3.4 Exposure Parameters

The relevant exposure pathways should be identified. For example, exposure to both airborne and deposited radioactivity from atmospheric releases would involve both external (groundshine and cloudshine) and internal (inhalation of airborne material during cloud passage or as a result of resuspension) exposure.

Assumptions regarding the geographic distribution of the receptor population, if any, should be identified. Estimation of peak centerline doses as a function of distance only implicitly assumes that no credit is being taken for the distribution of population around the site.

In order to assess the dose, the exposure parameters (e.g., shielding factors, breathing rates, exposure durations, etc.) would need to be characterized. No credit for pre-planned protective actions such as evacuation or sheltering should be assumed in the development of factors such as the exposure durations and shielding factors.

A-3.5 Dose Estimation for Pathway Contributors

The dose estimation is carried out by combining the results of the release, transport, and exposure assessment with a recognized source of dose conversion factors to estimate dose-distance curves for comparison to the one rem total effective dose equivalent (TEDE) criteria. The distance at which the doses are evaluated should be identified and explained. For example, the dose may simply be estimated at the site boundary to demonstrate that it is sufficiently low, or may be evaluated over a range of distances from the site boundary.

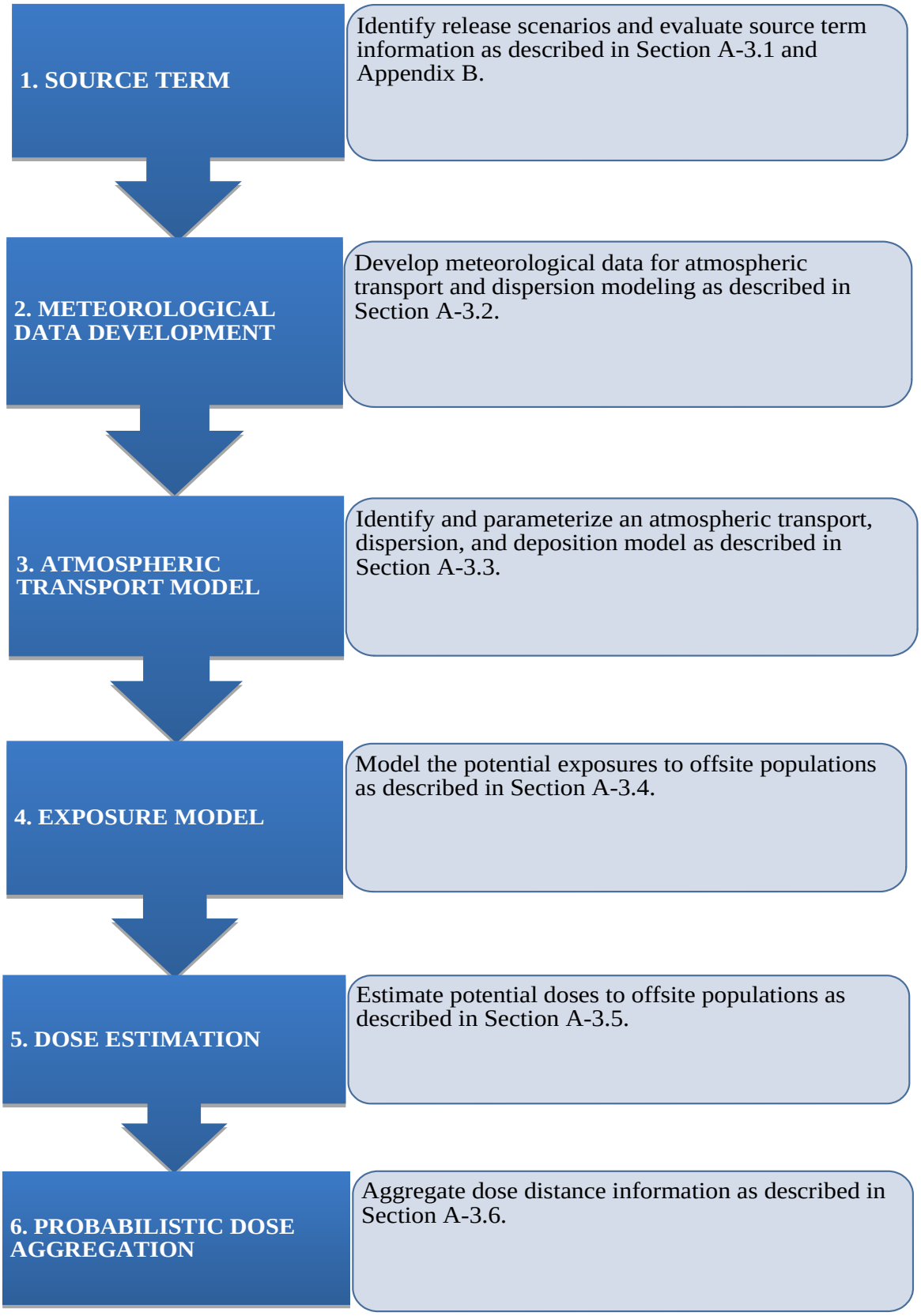
A-3.6 Probabilistic Dose Aggregation

The method for aggregating doses from different source terms, given consideration of their frequencies, should be identified. For example, analyses with design-basis-accident source terms may simply present dose-distance curves conditional upon the occurrence of the source term without consideration of frequency. For beyond design basis accidents (BDBA), dose-distance results may be aggregated using frequency information developed as described in Appendix B to evaluate the likelihood of exceeding a TEDE of one rem as a function of distance.

The likelihood of exceeding a TEDE of one rem due to variability in meteorological conditions should be discussed. Methods used to compare the dose assessment results (which would be characterized by a distribution reflecting variability in meteorological conditions) to the dosimetric criteria (which is a single dose value) should be identified. For example, the dosimetric criteria may be compared to the mean, median, maximum, or some other statistic of the distribution.

Because there can be uncertainties in each of the analyses supporting the evaluation, any significant uncertainties that could affect this comparison should be identified and characterized.

Figure A-1. Analyses to Support Radiological Dose Assessment for EPZ Size Evaluation



APPENDIX B

DEVELOPMENT OF INFORMATION ON SOURCE TERMS

This appendix provides guidance for establishing source terms that are acceptable to the staff associated with a technology-inclusive, risk-informed approach to support radiological dose assessment for emergency planning zone (EPZ) size evaluation.

B-1. Each applicant should develop potential source terms from credible accidents for its facility. The NRC staff evaluates these source terms in various areas of its application review, such as the review of design basis accident (DBA) and beyond design basis accident (BDBA) analyses for power reactors. For the source term evaluation, the applicant should identify in the analysis the release scenarios for which doses would be assessed by considering a spectrum of accidents credible for the facility. For BDBA scenarios, the applicant should evaluate the frequencies to allow quantitative consideration of the relative likelihood of a range of accidents. In developing information on release scenarios and their frequencies, the applicant should consider information developed in the safety analysis report for design basis accidents and severe accidents, as well as information in the environmental report on the consequences of severe accidents, as applicable.

B-2. If the applicant intends to use a probabilistic risk assessment (PRA) to define the spectrum of credible accidents for the facility, the applicant should apply a risk-informed integrated decision making process.[9] The integrated decision making process should consider the defense-in-depth philosophy, maintain sufficient safety margins, and include treatment of uncertainties. In addition, the applicant should justify that the PRA is acceptable for this use, and that it considers internal and external hazards, all modes of operation, and all significant radionuclide sources. The PRA should also include event sequences involving single or multiple modules/units, if applicable, to provide useful risk insights into the source term selection process. The treatment of uncertainties in the PRA should provide a quantification of the impacts of uncertainties using quantitative uncertainty analyses and supported by sensitivity analyses.[10]

B-3. A technical basis for the screening of any identified release scenarios from quantitative consideration (for example, on the basis of low likelihood or very long accident progression times) would need to be provided. The categorization of accidents, including any category bounds based on frequency including consideration of uncertainty, should be explained. If based on PRA, the use of a low frequency "cut off" should include consideration of uncertainty. Event sequences with frequencies below the "cut off" should be retained in the PRA results and used to confirm that there are no cliff edge effects and that there is adequate defense-in-depth.

B-4. The accident radiological source terms should be estimated for the specific facility using accepted analysis methods and codes, such as the MELCOR or MAAP codes. The source term calculations should reflect the performance of the facility under normal and off-normal conditions, include sufficient data on the facility performance, and model the transport of fission products across all barriers and pathways to the environs.

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[9] RG 1.174, "An Approach for Using Probabilistic Risk Assessment In Risk-Informed Decisions on Plant Specific Changes to the Licensing Basis," describes an integrated decision making approach that the NRC has found acceptable.

[10] NUREG-1855, "Guidance on the Treatment of Uncertainties Associated with PRAs in Risk-Informed Decision Making," provides further guidance on addressing uncertainties.

B-5. The PRA and source term models should be as realistic as possible so that the values and limitations of any mechanism or barrier are not obscured.