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Methodological Approach and Considerations for a Technical Analysis to Demonstrate Compliance with the Eligibility Criteria of 10 CFR 73.55(a)(7)

Prepared by the Nuclear Energy Institute
May 2021

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1 PURPOSE

This document provides guidance for performing a technical analysis to demonstrate that a nuclear power reactor applicant or licensee qualifies for the voluntary, performance-based alternatives to certain physical security requirements contained in Title 10 of the Code of Federal Regulations (10 CFR) 73.55, “Requirements for physical protection of licensed activities in nuclear power reactors against radiological sabotage.” To qualify for the alternative requirements, the facility must be either a non-light water reactor (non-LWR) or a small modular reactor (SMR) as defined in § 171.5, “Definitions,” and the applicant or licensee must demonstrate that the nuclear power reactor facility meets one of the three eligibility criteria specified in § 73.55(a)(7)(i). The guidance in this document addresses the elements of the technical analysis required by § 73.55(a)(7)(ii) for any of the three eligibility criteria.

2 TECHNICAL ANALYSIS GUIDELINES

2.1 Overview

The guidance presented in this document is not a template or set of step-by-step instructions for performing a technical analysis required by § 73.55(a)(7)(ii). Rather, the guidance is focused on the general methodology and key considerations for a technical analysis. This approach was taken in recognition of the following:

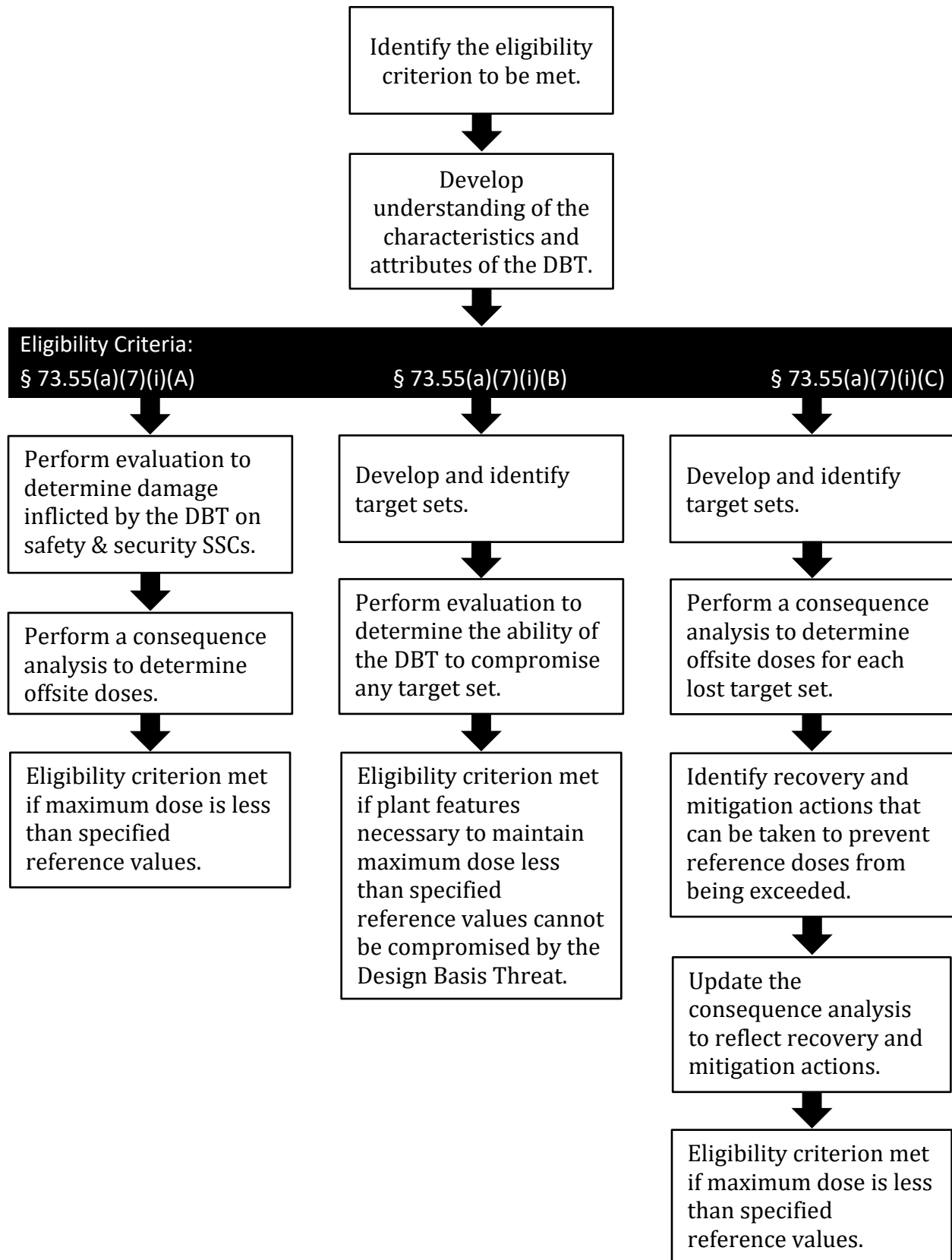
- Several of the topics discussed in this document have not yet been addressed in regulatory guidance applicable to non-LWRs and SMRs (e.g., NRC-endorsed standards for a non-LWR probabilistic risk assessment).
- There are many different advanced reactor technologies under development and a goal of this document was to provide guidance that is technology neutral; therefore, developing guidance beyond a certain level was not feasible or desirable.
- It is expected that the individuals performing an analysis will possess the necessary technical expertise and experience, and would therefore benefit from guidance that is flexible and permits adoption of the latest research and analysis techniques.

An applicant or licensee should use the guidance in this document to inform the development of their technical analysis, recognizing that they may need to change or augment some aspects. It is recommended that the applicant or licensee engage the U.S. Nuclear Regulatory Commission (NRC) staff prior to beginning the analysis to promote alignment on the anticipated approach, key considerations, and use of guidance. Engagements should also be sought to discuss significant technical questions that may arise during performance of the analysis.

An overview of the major steps in a technical analysis is presented in Figure 1.

Additional guidance documents that may support an analysis are listed in Section 6.

Figure 1
Overview of a Technical Analysis



2.2 Design Basis Threat

The threat to be considered in a technical analysis is the design basis threat of radiological sabotage as stated in § 73.1, “Purpose and scope,” and referred to as the DBT.¹ Analysis elements involving consideration of specific DBT capabilities and attributes should be informed by the guidance in Regulatory Guide (RG) 5.69, “Guidance for the Application of Radiological Sabotage Design-Basis Threat in the Design, Development and Implementation of a Physical Security Program that Meets 10 CFR 73.55 Requirements.”² An applicant may use an alternative approach to the deployment of a given capability or attribute in their analysis; however, the alternative approach should be clearly identified and supported with a technical basis.

As required by § 73.1, the threat scenarios used in a technical analysis must also consider the cyber-attack capability of the DBT. This portion of the analysis will need to identify the digital assets that could be exploited to support a physical attack, the potential threat vectors, and the measures put in place to prevent the compromise of critical digital assets. The technical analysis may reference plans and assessments developed for compliance with the cyber security requirements in § 73.54, “Protection of digital computer and communication systems and networks;” there is no need to perform duplicative analyses.

Also required by § 73.1 is consideration of the “knowledgeable inside assistance” given to the DBT adversary (i.e., assistance from an insider). The technical assessment will need to demonstrate that there are sufficient barriers – physical plant features, and programmatic and administrative controls (e.g., access authorization, access control, fitness for duty, etc.) - to mitigate the DBT insider threat. The technical analysis may reference processes and procedures developed for compliance with the fitness-for-duty requirements in 10 CFR 26, “Fitness for Duty Programs” and § 73.56, “Personnel access authorization requirements for nuclear power plants.”

The technical analysis should use appropriately realistic and reasonably conservative parameters, and analytical modeling/simulation and empirical test data in assessing the effects of an attack by the DBT. The analysis should also account for uncertainties in quantifying the damage caused by a DBT adversary.

2.3 Target Sets

As used in this document:

- A “target set” is the minimum combination of equipment or operator actions which, if all are prevented from performing their intended safety function or prevented from being accomplished, would result in offsite doses greater than the reference values in

¹ An applicant planning to analyze a threat different than the DBT will need to seek an exemption from this requirement as part of the facility’s licensing process.

² RG 5.69 contains Safeguards Information (SGI) and is therefore not publicly available.

§§ 50.34(a)(1)(ii)(D) and 52.79(a)(1)(vi).

- An “achievable target set” means a target set that is within the ability of the DBT to compromise, destroy, or render nonfunctional, absent actions by onsite armed responders.

The relationship of a target set to each of the three eligibility criteria presented in § 73.55(a)(7)(i) is shown below.

Eligibility Criterion	Facility Possesses a Target Set?	Facility Possesses an Achievable Target Set?	Mitigation Measures Exist for Loss of a Target Set?
§ 73.55(a)(7)(i)(A)	No	N/A	N/A
§ 73.55(a)(7)(i)(B)	Yes	No	N/A
§ 73.55(a)(7)(i)(C)	Yes	Yes	Yes

As indicated above, an applicant or licensee seeking to meet the eligibility criterion in § 73.55(a)(7)(i)(A) will not need to develop and identify target sets. While a facility meeting this criterion will have equipment or operator actions that perform safety functions, the design is such that the loss of those safety functions will not result in offsite doses exceeding the reference values defined in §§ 50.34(a)(1)(ii)(D) and 52.79(a)(1)(vi). This conclusion will need to be confirmed through a consequence analysis.

An applicant or licensee seeking to meet the eligibility criterion in § 73.55(a)(7)(i)(B) or (C) will need to develop and identify target sets using the definition provided above. Prior to beginning this effort, the applicant or licensee is encouraged to become familiar with the guidance in RG 5.81, “Target Set Identification and Development for Nuclear Power Reactors.” Although RG 5.81 was developed with large LWRs in mind, the discussion on generating target sets, including the use of information and insights from a Probabilistic Risk Assessment (PRA), can help inform the development of target sets for a non-LWR or SMR facility. Additional guidance on establishing target sets may be found in Sandia Report SAND2008-5644, “Vital Area Identification for U.S. Regulatory Nuclear Power Reactor Licensees and New Reactor Applicants,” prepared by Sandia National Laboratories.

2.4 Probabilistic Risk Assessment Information

A technical analysis may consider information available from a PRA developed to meet facility licensing requirements established by the NRC (e.g., evaluation of severe accidents). RG 1.200, “An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities,” provides an approach that the NRC has found acceptable for developing a PRA suitable for risk-informed regulatory decisions. The guidance in RG 1.200 should be followed to the extent applicable and practical when assessing the acceptability of

probabilistic risk information used in a technical analysis.

Depending upon the type of reactor technology being employed, the guidance in one of these documents should also be reviewed:

- ASME/ANS RA-Sa–2009, “Addenda to ASME/ANS RA-S–2008 - Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications.” This document was developed by the American Society of Mechanical Engineers (ASME). The standard sets forth the requirements for PRAs used to support risk-informed decisions for commercial LWR nuclear power plants and prescribes a method for applying these requirements for specific applications.
- ASME/ANS RA-S-1.4-2021, “Probabilistic Risk Assessment Standard for Advanced Non-Light Water Reactor Nuclear Power Plants.” This document was developed jointly by ASME and the American Nuclear Society (ANS). The standard sets forth requirements for PRAs used to support risk-informed decisions for commercial non-LWR nuclear power plants and prescribes a method for applying these requirements for specific applications.

2.5 Credit for Manual Actions

A manual action performed by the facility staff may be credited³ in a technical analysis intended to meet the eligibility criteria in §§ 73.55(a)(7)(i)(B) or 73.55(a)(7)(i)(C), including actions to enable security features and prevent or mitigate offsite radiological consequences (e.g., operating a piece of safety equipment). The basis for crediting action performance should provide reasonable assurance that the action could be completed under the postulated attack conditions and be documented in the analysis. For example, a manual action to change the position of a barrier or arming a delay feature could be credited provided the facility’s layout, staffing and physical security features give reasonable assurance that the action can be completed during an attack.

Guidance for assessing the credibility (and thus acceptability) of a proposed manual action can be found in RG 5.81.⁴ As noted above, RG 5.81 was developed with large LWRs in mind; however, the guidance on assessing the credibility of a manual action is generally applicable to non-LWR and SMR facilities. The assessment of a proposed manual action would need to consider the following criteria:

- a. The time available to implement the action prior to conditions leading to offsite doses

³ As used in this document, “credit” means a determination that a proposed action or activity can be performed in response to a potential or actual attack, thereby permitting the action or activity to be relied upon to support conclusions in the analysis. The determination should meet a “reasonable assurance” standard.

⁴ RG 5.81 uses the term “operator action.” This document uses the term “manual action” since the intent is to permit the assignment of an action to any member of the facility staff provided there is reasonable assurance that the action will be performed as described in the analysis.

exceeding §§ 50.34(a)(1)(ii)(D) and 52.79(a)(1)(vi).

- b. The environmental conditions in traversed and action performance areas, including potential changes to those conditions over time.
- c. The ability of an adversary to interrupt the action.
- d. The readiness of equipment to perform the action.
- e. The availability of procedures to instruct the action.
- f. The training provided to personnel on the action.

The technical analysis should also confirm that a position assigned to perform a manual action will be staffed on a continuous basis (or continuously during the periods when the action might need to be performed) and does not have other assigned responsibilities that would prevent timely performance (i.e., the position does not have concurrent duties that might inhibit performance of the manual action).

A manual action initiated from a remote location may also be credited. In this case, the basis should address potential challenges to timely performance of the action and mitigative measures. Topics to consider include cyber security, reliability and redundancy of communications and control systems, potential actions of the DBT to disrupt remote performance of the action, and potential collateral duties of personnel at the remote location.

Finally, it is important to understand the differences between an “armed responder,” an “armed security officer,” a “security officer,” and a “Remotely Operated Weapons Systems (ROWS) Operator.” These terms are defined in NUREG-2203, “Glossary of Security Terms for Nuclear Power Reactors.” A technical analysis may not credit any manual action by an onsite armed responder; however, an action assigned to a security officer or armed security officer could be credited as long as the action does not entail the planned interdiction and neutralization of an adversary (e.g., responding to a defensive fighting position and using a hand-held weapon to engage an adversary).⁵ Modelling or tabletop assessment results indicating that an armed security officer could interdict and neutralize an adversary during a given scenario are acceptable provided that outcome is not essential to facility compliance with an eligibility criterion. For a technical analysis required by § 73.55(a)(7)(ii), a ROWS Operator may be located onsite but is not considered to be an armed responder.

2.6 Safety/Security Interface

The performance of physical protection elements described in a technical analysis must be consistent with the requirements in § 73.58, “Safety/security interface requirements for

⁵ A security officer or armed security officer may be assigned other security-related functions such as contraband searches, visitor escorting, intrusion assessment, and notification duties; and duties that prevent the theft or diversion of special nuclear material.

nuclear power reactors.” Specifically, the design and performance of these elements cannot adversely affect reactor safety and, conversely, plant and operator responses to the event (e.g., changes in equipment configuration) cannot adversely affect physical protection elements. Further guidance on this topic can be found in RG 5.74, “Managing the Safety/Security Interface.”

2.7 Hazards from Adjacent Facilities and Transportation Routes

When applicable, the technical analysis should identify and evaluate hazards from an adjacent non-nuclear facility that could potentially affect the safety or security features relied upon to meet an eligibility criterion. The analysis should also examine similar hazards emanating from an onsite or nearby transportation route (e.g., a roadway or rail line). The evaluation should consider hazardous conditions that could be created by the DBT to support an attack as well as conditions arising from other causes (e.g., natural phenomena, industrial accident, etc.). Sources of hazards to consider include, but are not limited to:

- steam releases;
- chemical explosions, releases, or spills;
- fires; and
- misuse of industrial radiation sources.

The characteristics of each hazard, such as timing, severity, and persistence, should be determined. The technical analysis should then describe the design provisions and/or response actions that will mitigate the impacts of each hazard and ensure that the capability to meet the eligibility criterion is maintained. Hazard analyses performed to meet other NRC licensing requirements (e.g., reactor siting criteria) may be referenced as applicable; there is no need to perform duplicative analyses.

2.8 Plant Configuration/Mode Changes

As appropriate to the facility design and features, a technical analysis should consider the effects from planned (routine) changes to the plant configuration, or mode of operation, on the ability to continuously meet the applicable eligibility criterion. If needed, the analysis should describe the controls that will be implemented to ensure that the eligibility criterion will remain met at all times. Alternatively, a technical analysis could be directed at two eligibility criteria whereby one eligibility criterion is met in one plant configuration or mode, and another criterion is met in a different configuration or mode. For example, a facility may meet the eligibility criterion in § 73.55(a)(7)(i)(B) during power operations and § 73.55(a)(7)(i)(A) or § 73.55(a)(7)(i)(C) at times when the facility is shut down for refueling and maintenance.

2.9 Security Assessment Guidance

A technical analysis for any of the three eligibility criteria will require a description of the

security features for detecting and assessing an intrusion, and the capability of the facility staff to notify law enforcement (or activate offsite armed responders maintained by the licensee). The analysis should describe the selection of the evaluated adversary pathways (e.g., selection criteria, entry points, and travel distances) and the timing of detection and assessment functions for each pathway. The analysis should also discuss the assessment of potential blast and breaching locations associated with each pathway. In addition to breaches caused by the DBT, breaches in structures, systems and components created by physical and chemical processes should also be identified (e.g., arising from a loss of decay heat removal systems).

Prior to beginning a technical analysis, an applicant is encouraged to become familiar with the guidance in NUREG/CR-7145, “Nuclear Power Plant Security Assessment Guide.” NUREG/CR-7145 provides guidance to design certification and combined license applicants for optimizing physical security during the design phase and minimizing reliance on operational programs (human actions). Although the document was developed with large LWRs in mind, the material in NUREG/CR-7145 can help inform the content of a technical analysis performed to demonstrate compliance with § 73.55(a)(7).

Another useful document to review is Sandia Report SAND2021-0768, “U.S. Domestic Small Modular Reactor Security by Design,” prepared by Sandia National Laboratories. This report describes an iterative process for identifying opportunities to further enhance the physical security of a facility through the addition or modification of engineered features. The process may be helpful in addressing gaps to meeting an eligibility criterion that could become apparent during the early phase of a technical analysis (e.g., when additional delay time is needed).

2.10 Use of Security Modelling Tools

An applicant or licensee may employ a computer application in a technical analysis to model security-related aspects of an attack on the facility. For example, a computer application could be used to evaluate the detection and delay capabilities described in the analysis. For additional information on security assessment modeling tools, see Sandia National Laboratories Report SAND2007-5591, “Nuclear Power Plant Security Assessment Technical Manual.”

3 ELIGIBILITY CRITERIA

3.1 Eligibility Criterion § 73.55(a)(7)(i)(A)

This eligibility criterion states:

The radiological consequences from a hypothetical, unmitigated event involving the loss of engineered systems for decay heat removal and possible breaches in physical structures surrounding the reactor, spent fuel, and other inventories of radioactive materials result in offsite doses below the reference values defined in §§ 50.34(a)(1)(ii)(D) and 52.79(a)(1)(vi) of this chapter.

To meet this eligibility criterion, a facility must have no combination of structures, systems and

components that, if prevented from performing intended safety functions by the DBT adversary, would result in offsite doses exceeding the cited reference values (i.e., the facility does not have a target set). An applicant can demonstrate compliance with this criterion through a technical analysis based on a consequence analysis that determines offsite doses from the postulated security event do not exceed the reference values defined in §§ 50.34(a)(1)(ii)(D) and 52.79(a)(1)(vi). No manual actions may be credited in a technical analysis performed to meet eligibility criterion in § 73.55(a)(7)(i)(A). In addition, no mitigation strategies implemented after control of the facility is recovered from the adversary may be considered (e.g., strategies to prevent or mitigate offsite radiological consequences).

Guidelines for performing a consequence analysis are presented in section 4 of this document.

3.2 Eligibility Criterion § 73.55(a)(7)(i)(B)

This eligibility criterion states:

The plant features necessary to mitigate an event and maintain offsite doses below the reference values in §§ 50.34(a)(1)(ii)(D) and 52.79(a)(1)(vi) of this chapter cannot reasonably be compromised by an adversary as defined by the design basis threat for radiological sabotage.

To meet this eligibility criterion, a facility must not have any target set that can be compromised by the DBT adversary to the extent necessary to result in offsite doses exceeding the cited reference values (i.e., the facility does not have an achievable target set). An applicant can meet this criterion through a technical analysis that identifies plant target sets and demonstrates the capability of safety and security features to prevent the DBT adversary from compromising any target set. Any engineered structure, system or component described in the facility licensing basis may be considered in the analysis, including both active and passive safety and security features. This also includes automated or remotely controlled features that perform security response functions (e.g., automatic or remotely controlled placement of a barrier).

The technical analysis may credit manual actions except those performed by an onsite armed responder. The analysis need not postulate coincident events (e.g., a seismic or flooding event) or failures of structures, systems, or components unrelated to the attack. Security features that may be considered in the analysis include, but are not limited to:

- a. access control measures,
- b. detection and assessment capabilities,
- c. delay and barrier features, and
- d. a remotely operated weapons system (ROWS).

It is recognized that after a certain amount of time, a licensee can reasonably expect to have

resources available to support the facility in defending against the DBT (e.g., a law enforcement agency and/or a remotely located armed responders). These are resources that would arrive onsite sometime after the attack is initiated (i.e., the individuals are offsite and would respond to the site upon being notified of the attack) and ultimately neutralize the threat. The technical analysis may credit the availability of such resources. When developing a basis for this credit, the applicant or licensee should refer to the informing guidance in:

- RG 5.76, “Physical Protection Programs at Nuclear Power Reactors,” (*in particular, the discussion on the Reasonable Assurance of Protection Time*), and
- NEI White Paper, “Determination of a Site-Specific Security Bounding Time,” dated September 2019.

3.3 Eligibility Criterion § 73.55(a)(7)(i)(C)

This eligibility criterion states:

Plant features include inherent reactor characteristics combined with engineered safety and security features that allow for facility recovery and mitigation strategy implementation if a target set is compromised, destroyed, or rendered nonfunctional, such that offsite radiological consequences are maintained below the reference values defined in §§ 50.34(a)(1)(ii)(D) and 52.79(a)(1)(vi) of this chapter.

To meet this eligibility criterion, a facility must have a reactor design with a slow progression from the loss of safety equipment to the degradation of fission product barriers and release of radionuclides from the facility. An applicant can demonstrate compliance with this criterion through a technical analysis based on a consequence analysis that determines the shortest elapsed time from event initiation to the onset of conditions that would produce a release with offsite radiological consequences exceeding the cited reference values. The analysis would then need to describe the planned mitigation strategies that can be performed, within the time available, to prevent offsite radiological consequences from exceeding the cited reference values.⁶

Guidelines for performing a consequence analysis are presented in section 4 of this document.

The technical analysis should include an integrated timeline of events that describes:

- a. the progression of the attack,
- b. the plant and staff response,

⁶ It should be noted that the mitigation strategies addressed by eligibility criterion § 73.55(a)(7)(i)(C) are those performed after facility recovery; however, a technical analysis for this criterion can also credit a manual action performed at any point after the attack begins provided it meets the guidance in section 2.5. This includes manual actions to prevent or mitigate a radiological release (e.g., actions directed by an operating procedure).

- c. radiological releases,
- d. the response by a law enforcement agency, or licensee armed responders initially positioned at an offsite location, to recover the facility, and
- e. the implementation of mitigation strategies after completion of facility recovery actions.

The integrated timeline should demonstrate that the required facility recovery and mitigation strategy tasks can be completed before the occurrence of conditions irreversibly leading to a release with offsite radiological consequences exceeding the reference values defined in §§ 50.34(a)(1)(ii)(D) and 52.79(a)(1)(vi). For example, if conditions irreversibly leading to a release with offsite radiological consequences exceeding the cited reference values occur at 8 hours after attack initiation, the analysis should demonstrate that provisions are in place to complete all tasks for recovering the facility and implementing a mitigation strategy prior to 8 hours.

A “mitigation strategy” is a plan of action for maintaining or restoring a “safety function.” A strategy can be implemented by one or more methods. A “method” is a series of actions designed to implement a specific strategy. As an illustrative example of these terms, consider that placing a portable pump in service (a method) to inject water into a reactor vessel (a strategy) would maintain or restore core cooling (a safety function). The technical analysis should demonstrate that the manual actions necessary to implement a mitigation strategy can be performed during the conditions expected to exist on the site and in the facility. The guidance for assessing manual actions is discussed in section 2.5 of this document.

The description of a mitigation strategy should identify the safety function performed, the conditions that would prompt implementation, the anticipated time for performance in a reasonably expected post-recovery site environment, and the following elements needed for execution, as applicable.

- a. Equipment (e.g., portable pumps, generators, hoses, cables, etc.)
- b. Storage locations (onsite and/or offsite)
- c. Transport and deployment arrangements (i.e., provisions for moving the equipment from a storage location to the location where it will be placed into service)
- d. Key actions to place equipment in service
- e. Staffing
- f. Communications capabilities to support deployment and operation

The term “facility recovery” means completion of the actions necessary to neutralize the DBT adversary and regain control of the facility sufficiently to enable implementation of mitigation strategies that prevent offsite doses exceeding the reference values defined in §§ 50.34(a)(1)(ii)(D) and 52.79(a)(1)(vi). Actions to accomplish facility recovery and enable

implementation of mitigation strategies may be performed by either a law enforcement agency or licensee armed responders arriving from a remote location. Mitigation strategies may not commence until the prerequisite facility recovery actions are completed. The technical analysis should demonstrate that the tasks necessary for facility recovery can be performed during the conditions expected to exist on the site and in the facility.

The technical analysis is conducted assuming there are no onsite armed responders when the attack is initiated. Therefore, the analysis must demonstrate, with reasonable assurance, that a subsequent armed response capability, coming from an offsite location after the attack has commenced, can recover the facility in time to enable the performance of mitigation strategies. The analysis must also demonstrate that the equipment necessary to implement mitigation strategies, whether stored onsite or offsite, will be available for use (e.g., not subject to damage or sabotage by the DBT adversary).

As noted above, the technical analysis may credit support from a law enforcement agency, or an offsite armed response force maintained by the licensee, to neutralize the threat. To do this, the analysis will need to address the following topics:

- a. Response (mission) objectives of the law enforcement agency or armed responders
- b. Response planning and procedure development
- c. Response team composition and capabilities
- d. Verification and validation of response plan and procedures
- e. Periodic response training and drills
- f. Documentation for inspection (e.g., a letter of agreement, training records, etc.)

When developing a basis for the credit, the applicant or licensee should refer to the informing guidance in:

- RG 5.76, “Physical Protection Programs at Nuclear Power Reactors,” (*in particular, the discussion on the Reasonable Assurance of Protection Time*), and
- NEI White Paper, “Determination of a Site-Specific Security Bounding Time,” dated September 2019.

A facility meeting the eligibility criterion in § 73.55(a)(7)(i)(C) will need to perform periodic administrative and maintenance activities that support the ongoing capability to implement facility recovery and mitigation strategies. To this end, the technical analysis should discuss the following items.

- a. Documentation of support from offsite resource providers (e.g., letter of agreement, memorandum of understanding, contract, etc.) and how this documentation will be

periodically verified and updated

- b. Plant design change and configuration control measures to ensure that credited strategies can be readily implemented or modified as needed
- c. Periodic reviews of implementing plans, processes and procedures
- d. Maintenance and testing of equipment
- e. Training and drills to validate strategies and maintain proficiency of personnel

When developing mitigation capabilities, the applicant or licensee should refer to the guidance in NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide." This document is endorsed in RG 1.226, "Flexible Mitigation Strategies for Beyond-Design-Basis Events" and provides methods for compliance with NRC regulations in § 50.155, "Mitigation of beyond-design-basis events." While directed primarily at large LWR facilities, the material in NEI 12-06 can help inform the development of mitigation strategies described in a technical analysis.

4 CONSEQUENCE ANALYSIS GUIDELINES

For the purpose of this document, a consequence analysis is an activity performed by the applicant or licensee to determine radiation doses at the boundary of the exclusion area and the boundary of the low population zone. As noted above, a consequence analysis is needed to support demonstration of compliance with eligibility criteria §§ 73.55(a)(7)(i)(A) and 73.55(a)(7)(i)(C). The analysis will be based on a systematic evaluation of credible event (attack) sequences (also called scenarios) initiated by the DBT adversary and directed against the inventories of radioactive material assessed as part of analyses to demonstrate compliance with §§ 50.34(a)(1)(ii)(D) and 52.79(a)(1)(vi).

The consequence analysis should describe the event sequence(s) and identify the effects of the attack on the availability and functionality of plant structures, systems and components that perform safety and security functions. For example, the effects of mechanical or explosive breaching on safety equipment used for accident mitigation and prevention of off-site radiological releases should be assessed. When directed at eligibility criterion § 73.55(a)(7)(i)(C), the analysis should also identify the elements of the compromised target set and subsequent responses by the facility staff and supporting offsite organizations and agencies. With this information, the analysis should then determine the type and amount of radioactivity released to the environment, and the offsite consequences.

A consequence analysis may use a deterministic or probabilistic approach, or a blend of the two. In this context, "deterministic" means an analysis based on a predetermined bounding subset of event sequences (or "enveloping" sequences). The term "probabilistic" means an analysis that explicitly accounts for the likelihood of possible event sequences in an integrated fashion.

4.1 General Assumptions and Considerations

The following assumptions and considerations should be employed in a consequence analysis.

- a. As appropriate to the technology and site characteristics, the analysis should identify the risk-dominant contributor to doses at the exclusion area boundary and the boundary of the low population zone (e.g., an atmospheric release, a liquid release or direct exposure).
- b. Any engineered structure, system or component described in the facility licensing basis may be considered in the analysis. In addition, the properties of the fuel material (e.g., composition, form and enrichment) should also be described and considered. Security features that may be considered in the analysis include, but are not limited to:
 - 1) access control measures,
 - 2) detection and assessment capabilities, and
 - 3) delay and barrier features
- c. Both active and passive safety and security features may be considered in the analysis; however, as noted above, a consequence analysis for eligibility criterion § 73.55(a)(7)(i)(A) cannot consider any feature that requires a manual action to initiate/actuate.
- d. Automated engineered security systems that perform security response functions (e.g., automatic placement of a barrier) may be considered. Additionally, an analysis directed towards § 73.55(a)(7)(i)(C) may also consider remotely controlled systems (e.g., a ROWS).
- e. The physical properties of the source term and released radioactive material should be described. The analysis should also address potential changes to these physical properties from actions that could be taken by the DBT adversary during an attack (e.g., large explosions or fires, or incendiary devices) and how transport may be affected.
- f. Physical and chemical processes affecting the timing, composition and magnitude of the release should be addressed, such as convective or conductive cooling, radioactive decay and in-growth corrections, and plate out.
- g. The applicant or licensee should consider using a straight-line Gaussian plume segment-type atmospheric dispersion model to estimate atmospheric concentrations, with modifications as needed to account for near-field dispersion phenomena. Such models are generally most suitable for relatively simple transport situations, such as open and level terrain, relatively steady meteorology, and relatively close distances (<10 km). For facilities with relatively small exclusion areas, a straight-line Gaussian plume model may overestimate near-field radiological consequences.

Should an applicant or licensee determine that a Gaussian model is not ideal or practicable for their consequence analysis, they may choose to employ a different type of dispersion model with an adequate technical basis. The choice may require a different set of assumptions or methodological steps than those described in this document.

- h. The exposure durations must be the durations specified in §§ 50.34(a)(1)(ii)(D) and 52.79(a)(1)(vi).
- i. There is no analysis consideration for pre-planned offsite protective actions such as evacuation or sheltering.
- j. The analysis should determine the offsite doses from an attack occurring during each expected routine configuration/mode of operation.
- k. The analysis need not postulate coincident events (e.g., a seismic or flooding event), or failures of structures, systems or components unrelated to the event.

4.2 Source Term

For the release scenarios and dose projections, a quantitative radiological source term should 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, plume buoyancy, etc. The radiological source term should be estimated using analysis methods and codes endorsed by the NRC or evaluated by an NRC-accepted process. In cases where this is not feasible (e.g., a novel non-LWR technology), the applicant or licensee may estimate the source term using methods and codes supported by an adequate technical basis. If more than one release scenario is identified, the consequence analysis may use a bounding scenario (source term) that produces the greatest offsite dose at the boundaries of the exclusion area and low population zones. The basis for the identification of a bounding scenario should be provided.

4.3 Meteorological Parameters

Meteorological parameters will be needed to perform the consequence analysis. These parameters may be developed using a probabilistic approach or, alternatively, may be conservatively assumed. In the latter case, 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.

Selection of a source of meteorological data would include an evaluation of data needs 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, and significant uncertainties identified and characterized. It is expected that site-specific meteorological data will be used; however, there may be instances where site-

specific data is not available or of sufficient quality and completeness. In these cases, there should be an explanation of the appropriateness of the meteorological data used for the analysis.

4.4 Atmospheric Transport Modeling

An atmospheric transport model appropriate for the range of distances under consideration should be identified. For Gaussian-type 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.

4.5 Exposure Parameters

The relevant exposure pathway(s) should be identified. For example, exposure to airborne and deposited radioactive material 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. In order to assess the dose, the exposure parameters (e.g., breathing rates and exposure durations) would need to be characterized. Dose estimations should be carried out by combining the results of the release, transport, and exposure assessment with dose conversion factors to estimate the doses at the boundaries of the exclusion area and low population zone. Acceptable sources of dose conversion factors are Federal Guidance Report (FGR)-11 or FGR-12 issued by the U.S. Environmental Protection Agency. Factors from other recognized sources may be used with adequate justification (e.g., from the International Commission on Radiological Protection).

5 TECHNICAL ANALYSIS UPDATES

A technical analysis approved by the NRC should be updated to reflect changes to the facility features or offsite support resources described in the analysis. The NRC should be notified of a change that affects compliance with an applicable eligibility criterion (e.g., an anticipated change will result in the eligibility criterion no longer being met).

Documentation of support from offsite resource providers should be verified on an annual basis. Depending upon the contents of the technical analysis, such providers may include, but are not limited to, a local first responder agency such as a law enforcement department, a fire department, or a hazardous materials response team; offsite response organizations at the Federal, State or local level; and the National SAFER Response Center (if the applicant or licensee is a SAFER member).

6 GUIDANCE DOCUMENTS SUPPORTING A TECHNICAL ANALYSIS

Notes

1. Some of the documents listed below may not be publicly available due to their proprietary nature or government agency security controls.
2. When contacting an organization or agency to obtain a document, ensure that the latest/most current revision is provided.
3. Some of these documents were developed with large LWRs in mind; however, the contents may still help inform the development of a technical analysis.

Ballistics

1. NIJ Standard 0108.01, "Ballistic-Resistant Protective Materials," National Institute of Justice
2. UL 752, "Standard for Bullet-Resisting Equipment," Underwriters' Laboratories

Blast Analysis/Effects

1. Air Force Manual (AFMAN) 91-201, "Explosive Safety Standard," U.S. Air Force
2. Conventional Weapons Effects (CONWEP) Software and Manual, U.S. Army Corps of Engineers
3. DOETIC-11268, "Manual for the Prediction of Blast and Fragment Loading for Structures," U.S. Department of Energy
4. "Guidance for Using Underwater Explosion (UNDEX) Data for Estimating Loads on Submerged Targets," D. Sulfridge, Oak Ridge National Laboratory
5. FM 5-250, "Explosives and Demolitions," U.S. Department of the Army
6. NIJ Standard 0108.01, "Ballistic Resistant Protective Materials," National Institute of Justice
7. NUREG/CR-7201, "Characterizing Explosive Effects on Underground Structures," U.S. Nuclear Regulatory Commission
8. PDC-TR-01-01, Revision 1, "Structural Assessment of Spent Fuel Pools Attacked with a Sophisticated Sabotage Threat," U.S. Army Corps of Engineers

9. PDC-TR-01-02, Revision 1, "Structural Assessment of Spent Fuel Pools Attacked with an Unsophisticated Sabotage Threat," U.S. Army Corps of Engineers
10. Regulatory Information Summary 2005-09, "High-Security Protected and Vital Area Barrier Breaching Analysis," U.S. Nuclear Regulatory Commission
11. SAND99-2486, "Explosives Protection," Sandia National Laboratories
12. Single Degree of Freedom Blast Effects Design Spreadsheet (SBEDS) Software and Methodology Manual, U.S. Army Corps of Engineers
13. TM 5-1300, "Structures to Resist the Effects of Accidental Explosions," U.S. Department of Defense (Also designated as Air Force AFR 08-22 and Navy NAVFAC P-3897)
14. Unified Facilities Criteria (UFC) 3-340-02, "Structures to Resist the Effects of Accidental Explosions," U.S. Department of Defense
15. "Waterborne Sub-Surface Blast Effects to the Design-Basis Threat," D. Sulfredge, Oak Ridge National Laboratory
16. "Waterborne Surface Blast Effects to the Design Basis Threat," D. Sulfredge, Oak Ridge National Laboratory
17. Window Glazing Analysis Response and Design (WINGARD) Software, U.S. General Services Administration (GSA) (Available at www.oca.gsa.gov.)

Consequence Analysis

1. NUREG-1368, "Preapplication Safety Evaluation Report for the Power Reactor Innovative Small Module (PRISM) Liquid-Metal Reactor," U.S. Nuclear Regulatory Commission
2. NUREG-1465, "Accident Source Terms for Light-Water Nuclear Power Plants," U.S. Nuclear Regulatory Commission
3. NUREG-1855, "Guidance on the Treatment of Uncertainties Associated with PRAs in Risk-Informed Decisionmaking," U.S. Nuclear Regulatory Commission
4. Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," U.S. Nuclear Regulatory Commission
5. Regulatory Guide 1.203, "Transient and Accident Analysis Methods," U.S. Nuclear Regulatory Commission
6. Regulatory Guide 1.233, "Guidance for a Technology-Inclusive, Risk-Informed, and Performance-Based Methodology to Inform the Licensing Basis and Content of

Applications for Licenses, Certifications, and Approvals for Non-Light-Water Reactors,"
U.S. Nuclear Regulatory Commission

Cyber Security

1. NEI 08-09, "Cyber Security Plan for Nuclear Power Reactors," Nuclear Energy Institute
2. NEI 10-04, "Identifying Systems and Assets Subject to the Cyber Security Rule," Nuclear Energy Institute
3. NEI 13-10, "Cyber Security Control Assessments," Nuclear Energy Institute
4. Regulatory Guide 5.71, "Cyber Security Programs for Nuclear Facilities," U.S. Nuclear Regulatory Commission

Detection, Delay, Communications, Security Systems, etc.

1. Regulatory Information Summary 2003-06, "High-Security Protected and Vital Area Barrier/ Equipment Penetration Manual," U.S. Nuclear Regulatory Commission
2. SAND2001-2168, "Technology Transfer Manual - Access Delay, Volume 1," Sandia National Laboratories. In addition, the entire Technology Transfer Manual Series: SAND99-2390, SAND-2000-2142, SAND2004-2815P, SAND99-391, SAND99-2388, SAND99-2392, and SAND99-2389

Insider Mitigation

1. Regulatory Guide 5.77, "Insider Mitigation Program," U.S. Nuclear Regulatory Commission

Meteorological Data Collection and Assessment

1. D. Atkinson and R.F. Lee, "Procedures for Substituting Values for Missing NWS Meteorological Data for Use in Regulatory Air Quality Models," U.S. Environmental Protection Agency
2. NUREG-0800, "Standard Review Plan," Section 2.3.4, "Short-Term Atmospheric Dispersion Estimates for Accident Releases," U.S. Nuclear Regulatory Commission
3. NUREG-0917, "Nuclear Regulatory Commission Staff Computer Programs for Use with Meteorological Data," U.S. Nuclear Regulatory Commission
4. Regulatory Guide 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," U.S. Nuclear Regulatory Commission
5. Regulatory Guide 1.23, "Meteorological Monitoring Programs for Nuclear Power

Plants,” U.S. Nuclear Regulatory Commission

Vehicle Barrier Systems

1. ASTM F2656-07, “Standard Test Method for Vehicle Crash Testing of Perimeter Barriers,” American Society for Testing and Materials
2. Department of Defense and Department of State Certified Vehicle Barrier List (updated periodically, available at <https://pdc.usace.army.mil/library/BarrierCertification/>)
3. NUREG/CR-6190, “Protection Against Malevolent Use of Vehicles at Nuclear Power Plants,” U.S. Army Corps of Engineers
4. NUREG/CR-4250, “Vehicle Barriers: Emphasis on Natural Features,” U.S. Nuclear Regulatory Commission
5. SD-STD-02.01, “Certification Standard, Test Method for Vehicle Crash Testing of Perimeter Barriers and Gates,” U.S. Department of State