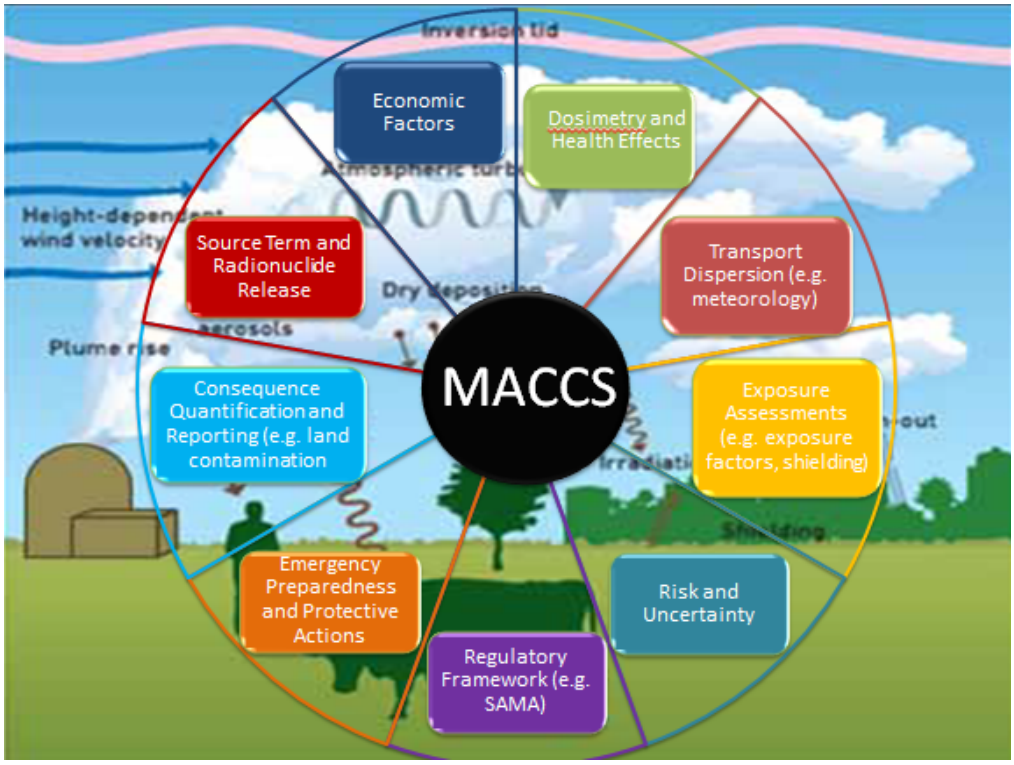
U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Office of Nuclear Regulatory Research

Division of Systems Analysis

Accident Analysis Branch

MACCS Analyst
Training and Qualification Plan, Ver. 2.0



September 29, 2015

Table of Contents

Acronyms

AAB	Accident Analysis Branch
ACRS	Advisory Committee on Reactor Safeguards
BWR	Boiling Water Reactor
CPRR	Containment Protection and Release Reduction
DOE	Department of Energy
DSA	Division of Systems Analysis
EPZ	Emergency Planning Zone
IDCOR	Industry Degraded Core Rulemaking
IDP	Individual Development Plan
IPE	Individual Plant Examination
ISA	Individual Study Activities
LERF	Large Early Release Frequency
LRF	Large Release Frequency
MACCS	MELCOR Accident Consequence Code System
NEI	Nuclear Energy Institute
NRO	Office of New Reactors
NRR	Office of Nuclear Reactor Regulation
OJT	On-the-job Training
PRA	Probabilistic Risk Assessment
PWR	Pressurized Water Reactor
QHO	Quantitative Health Objectives
RES	Office of Nuclear Regulatory Research
SAMA	Severe Accident Mitigation Alternatives
SAMDA	Severe Accident Mitigation Design Alternative
SAMG	Severe Accident Management Guidelines
SME	Subject Matter Expert
SNL	Sandia National Laboratories
SOARCA	State-of-the-Art Reactor Consequence Analyses
SRM	Staff Requirements Memorandum
TMI	Three Mile Island

Document Revision History

Version Number	Date Approved	Approved By	Brief Description
1.0	09/01/2013	Patricia Santiago (Branch Chief), RES/DSA/AAB	• Initial document issuance
2.0	09/29/2015	Patricia Santiago (Branch Chief), RES/DSA/AAB	• Fixed and updated hyperlinks, including links to most recent P-301 training material • Added bibliography • Reordered ISA sections • Added ADAMS ML numbers where applicable • Updated formal training courses section • Editorial changes • Added subject matter expert contact information table • Added document revision history table • Updated acronym list • Added mini-board process

1 Overview of Training Plan

1.1 Policy and Purpose

U.S. Nuclear Regulatory Commission staff in the Office of Nuclear Regulatory Research (RES) furthers the regulatory mission of the NRC by providing technical advice, technical tools, and information for identifying and resolving safety issues, making regulatory decisions, and promulgating regulations and guidance. RES conducts independent experiments and analyses, develops technical bases for supporting realistic safety decisions by the agency, and prepares the agency for the future by evaluating safety issues involving current and new designs and technologies. RES develops its program with consideration of Commission direction and input from the program offices and other stakeholders.

The Division of System Analysis (DSA), Accident Analysis Branch (AAB) plans, develops, and manages analytical and experimental research projects on the progression, response, and offsite consequences of postulated severe accidents, and performs safety analyses of nuclear power plant systems. This work includes safety and security analyses, analyses of thermal-hydraulic transient behavior and interaction with the balance of plant under abnormal and accident conditions, and accident analyses beyond the reactor core, such as postulated accidents from spent fuel storage and transportation. State-of-the-art analytical techniques are used to develop realistic best estimates of the potential effects (consequences) to the public of low-likelihood nuclear power plant and spent fuel storage and transportation accidents which could release radioactive material into the environment. The staff of AAB models accident progression in order to estimate the magnitude and timing of radioactive release into the environment to estimate site-specific consequences (e.g. health effects). The experimental research projects support NRC's knowledge and understanding of severe accidents, and they support NRC's models with experimental data. The branch also provides consultation to NRC offices regarding safety or licensing decisions, development of guidance, or other regulatory needs, and partners with US Department of Energy (DOE), universities, laboratories, and other national and international research centers. AAB manages the NRC long-term research program and research for advanced reactor designs, for example, liquid metal reactor (LMRs).

Staff in the AAB branch use this training plan to gain the knowledge and technical skills required to effectively perform severe accident consequence analysis using the MELCOR Accident Consequence Code System (MACCS) code.

The plan is flexible enough to be used by both new branch members (with or without severe accident analysis experience) and experienced analysts who wish to develop additional expertise. To add flexibility, the plan provides detailed activities and references that an employee completes to meet the technical development goals identified in his or her individual development plan (IDP). Together, supervisors and staff determine the scope of activities needed to develop the desired level of knowledge and skill.

AAB policy supporting this plan includes the following:

1. Staff, upon assignment to the branch, should have in place the administrative resources necessary for efficient integration into the workforce.
2. Staff should complete branch-specific training through formal training, study activities, and work assignments that provide the knowledge and skills necessary for them to perform effectively in their jobs.
3. Staff will be credited for previous work experience and training that demonstrates that the individual possesses knowledge and skills equivalent to that achieved by completing a specific part of the training plan requirements.

1.2 Objectives

The objectives of this training plan are:

1. to define the expectations and develop MACCS analysts,
2. to define the roles and responsibilities for the training of AAB staff,
3. to ensure that AAB staff successfully implement NRC regulatory processes and understand their role in these processes, and
4. to facilitate knowledge transfer.

1.3 Definitions

For a comprehensive list of definitions that are used in Level 1, 2, and 3 probabilistic risk assessment (PRA), which includes the terminology used in consequence assessment (i.e., MACCS) and severe accident analysis (i.e., MELCOR), staff are directed to NUREG-2122.

***Ability*:** A manner of performing tasks that demonstrates an understanding of and an appreciation for the NRC's organizational values of integrity, excellence, service, respect, cooperation, commitment, and openness.

***Equivalency*:** Previous training or work experiences that meet the intent of a given training requirement, demonstrating competence in that area. Such activity need not be included in the employee's personalized plan.

***Individual study activities* (ISA):** Activities designed to direct and focus the employee's efforts toward gaining the appropriate knowledge, skills, and abilities to be successful.

***Knowledge*:** These are the facts, concepts, ideas, and relationships that support successful performance.

***On-the-job training* (OJT):** A training method that uses structured, hands-on activities to develop the required job-related knowledge and skills.

***Qualification*:** This is completion of the qualification program specific to an individual's job function (e.g., reactor technical reviewer). Achieving full qualification allows an individual to be assigned the full scope of job activities to be performed with routine oversight and supervision. A qualified individual may prepare documents for supervisor concurrence and, when assigned, reviews and concurs on documents prepared by other staff and contractors.

***Skill*:** Skill is a demonstrated ability and expertise to perform tasks successfully on the job.

***Subject-matter expert* (SME):** SMEs are assigned to transfer knowledge related to specific ISAs and OJTs. These staff members have expertise in particular topics related to the training plan. SMEs do not determine whether individuals understand the guidance provided; this judgment is made by the supervisor when documenting the completion of activities. A list of SMEs is provided in the table below.

Name	Affiliation	Expertise Area	Contact Information
Nate Bixler	Sandia National Laboratories (SNL)	MACCS Principal Investigator	nbixler@sandia.gov
Matt Dennis	SNL	Training and software development	mldenni@sandia.gov Matthew.Dennis@nrc.gov
Joe Jones	SNL	Emergency planning and evacuation	jojones@sandia.gov
Tina Ghosh	NRC	Uncertainty analysis,	Tina.Ghosh@nrc.gov

Name	Affiliation	Expertise Area	Contact Information
		SOARCA	
Jon Barr	NRC	Analyst, containment venting and release reduction, project management, NRC software approval process	Jonathan.Barr@nrc.gov
AJ Nosek	NRC	Analyst, SOARCA, Level 3 PRA project, spent fuel pool consequence assessment	Andrew.Nosek@nrc.gov
Keith Compton	NRC	Analyst, Level 3 PRA project, multi-unit source term, spent fuel pool consequence assessment, MACCS parameter best practices	Keith.Compton@nrc.gov
Ed Fuller	NRC	DSA Senior Level Advisor, severe accident phenomenology, source terms, containment performance, MELCOR, MAAP	Edward.Fuller@nrc.gov
Randy Sullivan	NRC	Emergency planning	Randy.Sullivan@nrc.gov
Michelle Hart	NRC	SAMA/SAMDA analysis, new reactor licensing	Michelle.Hart@nrc.gov

Training journal: This comprises the signature cards and other documents (e.g., training certificates) that document progress and demonstrate the completion of required activities. Forms for documenting the completion of the branch-specific training requirements are found in Section 5. The employee shall initial the signature form on completion of each assigned study activity, training course, or on-the-job activity. The employee's supervisor shall initial the form when they determine that the requirement has been satisfied. The training journal is maintained by the employee.

1.4 Responsibilities and Authorities

1.4.1 Division Director

- Direct branches to develop branch-specific training plans as needed.
- Maintain familiarity with the branch-specific training plans within the division.

1.4.2 Deputy Division Director

- Perform the division director's responsibilities as needed.

1.4.3 Branch Chief

- Establish the positions within the branch that require training plans.
- Supervise the development and revision of branch-specific training plans and approve the use of completed plans.
- Direct the periodic review of branch-specific training plans to ensure that they remain effective and consistent with other training plans and agency policy.

- Discuss branch-specific training plan(s) with new staff and establish the scope and schedule for associated training activities, including the set of activities to perform.
- Designate SMEs to work with staff during the training process. A current list of SMEs is provided in the table below.
- Document, in each individual's training journal, successful completion of training activities.
- Determine the appropriate final activity following completion of the branch-specific training plan (e.g., mini-board, supervisor interview) and perform this activity when staff complete the plan.
- In order to monitor progression to successful completion of training activities, the branch chief may convene mini-boards at regular (e.g., quarterly) intervals during the employee's training. These mini-boards may consist of 2-3 subject matter SMEs, the employee and branch chief. SMEs would conduct a 30 to 60 minute oral exam to assess the employee's progress in the assigned ISAs for that quarter. Feedback and suggestions from the mini-board may be provided to the employee on their successful or unsuccessful mastery of ISA concepts.
- Notify the division director by memorandum (with copies to the individual, the division training coordinator, and the individual's personnel file) when the individual has successfully completed the reliability and risk analyst training plan.

1.4.4 Subject Matter Experts

- Provide guidance to other staff as assigned, including and discussion of experience in actual job situations.

1.4.5 Employee in Training

- With the supervisor, schedule target completion dates for courses and activities.
- Notify the supervisor if schedule adjustments are required, with sufficient time to reschedule.
- Maintain records of the completion of courses and training activities.
- Meet with Subject Matter Expert mentor.

1.4.6 Division Training Coordinator

- Create training certificates.
- If asked by an employee's branch chief, track the employee's progress.

1.5 Prerequisites

Individuals need not complete the office qualification plan before beginning the activities in this training plan. The supervisor and employee should discuss which activities can be pursued in parallel.

Staff may optionally complete either the eight week PWR or BWR technology full series (R-104, 301, 504, 624) or two week reactor technology overview courses R-104/R-201 for PWR and/or BWR prior to taking the required training courses in risk assessment or accident consequences (e.g. P-301). However, enrollment in any reactor technology series courses is at the discretion of the branch chief with consideration of staffing availability, scheduling and need. Staff should refer to NRC's iLearn system for current prerequisites listed for each of the formal training courses listed later in Section 4.

1.6 Equivalency

Previous work experience and training may be accepted as equivalent to the activities in this plan, provided that the individual already possesses the required knowledge or skills normally achieved by completing the activity. Justification for accepting previous experience and training to meet program requirements should be discussed during the development of the employee's personalized training plan. Activities that would duplicate past experience or training need not be included in the employee's plan.

Program requirements including ISAs, formal course work, and OJT are assessed on a case-by-case basis. When determining that an activity need not be completed, careful consideration should be given to the length of time that has passed since the individual completed the training or worked in the related area. Equivalency is determined by the branch chief and no one else.

1.7 Documentation

Documentation of completed training is recorded in the training journal. Individuals are encouraged to maintain records of specific tasks that have been completed.

1.8 Training Plan Revisions

Branch-specific training plans should be revised to reflect changing needs and guidance. In addition, they should be reviewed periodically to confirm that they remain effective and consistent with other plans and agency policies. Staff who completed a previous version of the branch-specific training should review the changes. The branch chief should consider whether to assign any new or revised activities to their staff.

1.9 Performance Measures

Staff will complete branch-specific training within the schedule established with the supervisor. If the employee has not completed branch-specific training in the past, the initial set of activities will generally be completed within the first 18 months. If the employee is pursuing additional branch-specific training for further development, the schedule should be appropriate to the need for training and the employee's workload.

In addition to the time allotted for completion of study activities, training courses and on-the-job activities discussed in Section 3 and 4 respectively will dictate the final completion date as a MACCS analyst. However, since training courses and on-the-job activities occur in parallel to study activities, it is anticipated that a new staff member can become qualified in approximately two years. The following table indicates the anticipated training schedule for a new staff member including independent study activities, mini-boards to assess comprehension of fundamentals, and final board examination for qualification.

Duration (months)	Activity	Description
3	ISA 1 to 3	64 hours anticipated independent study
1	Mini-board exam	Schedule oral examination with 2-3 SMEs and Branch Chief
3	ISA 4 to 6	88 hours anticipated independent study
1	Mini-board exam	Schedule oral examination with 2-3 SMEs and Branch Chief
3	ISA 7 to 9	104 hours anticipated independent study
1	Mini-board exam	Schedule oral examination with 2-3 SMEs and Branch Chief
3	ISA 10 to 12	40 hours anticipated independent study
1	Mini-board exam	Schedule oral examination with 2-3 SMEs and Branch Chief
3	ISA 13 to 14	16 hours anticipated independent study
1	Mini-board exam	Schedule oral examination with 2-3 SMEs and Branch Chief
1	Final board exam	Schedule oral examination with 2-3 SMEs and Branch Chief
± 21	Total months	

2 Individual Study Activities

Fourteen ISAs are listed on the following pages. As discussed above, the supervisor and employee will determine which ISAs should be performed to develop the technical background needed as a MACCS analyst.

For each ISA, your tasks are to:

- Review the references in sufficient depth to meet the listed evaluation criteria.
- Meet with a qualified MACCS analyst to discuss any questions that may arise during the self-study exercise. Your supervisor, the senior level advisor of DSA, or other knowledgeable individuals may also be consulted as appropriate.
- Discuss the listed criteria with the SME or your supervisor.
- Perform any follow-on work assigned to remediate any identified weaknesses in knowledge or understanding.

(MACCS-ISA-1) Severe Accident Consequence Assessment Overview

PURPOSE: The purpose of this activity is to become familiar with severe accident consequence assessment and Level 3 PRA. Severe accident consequence analysts must understand what constitutes reactor severe accident consequence assessment and Level 3 PRA.

LEVEL OF EFFORT: 40 hours

REFERENCES:

1. *Radiological Assessment: A Textbook on Environmental Dose Analysis*, NUREG/CR-3332 (ML091770419), Forward and Introduction

   Or

   Till and Grogan, Radiological Risk Assessment and Environmental Analysis, Oxford University Press (2008), Chapter 1, "The Radiological Assessment Process"

   Or

   Fjeld, Eisenberg and Compton, *Quantitative Environmental Risk Analysis for Human Health*, Wiley (2007), Chapter 1, "Introduction"
2. Level 3 PRA Seminar video (ML11217A206) and associated slides (ML11217A204)
3. P-301 course manual, Section 1, "Purpose and Scope of Level-3 PRA Analysis"
4. P-301 course manual, Section 4, "Overview of MACCS"
5. MACCS model description (ML063560409), Chapter 1, "Introduction"
6. MACCS user's guide, Chapter 1, "Introduction"

CRITERIA: At the completion of this activity, you should be able to:

1. Discuss the purpose of a severe accident consequence assessment.
2. Discuss the relationship of a severe accident consequence assessment to the PRA.
3. Discuss the components of a severe accident consequence assessment.

(MACCS-ISA-2) History of Severe Accident Regulation and Research

PURPOSE: The purpose of this activity is to become familiar with the history of severe accident research, as well as the regulations that govern the review of severe accidents.

LEVEL OF EFFORT: 16 hours

REFERENCES:

1. NUREG-1150 (ML120960691), Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants, December 1990, *Chapter 1*
2. NUREG/CR-6042 (ML021080026), Perspectives on Reactor Safety, Revision 2, *Pages 27-29*
3. NUREG-75/014 (ML083570090), The Reactor Safety Study (WASH-1400), October 1975, *Executive Summary*
4. SECY-00-0077 (ML003684288), Modifications to the Reactor Safety Goal Policy Statement, and associated SRM (ML003727206)
5. 50 FR 32138 (ML003711521), Policy Statement on Severe Reactor Accidents Regarding Future Designs and Existing Plants, August 8, 1985
6. SECY-89-102, Implementation of the Safety Goals, and associated SRM (ML051660712) [NON-PUBLIC]
7. History of Severe Accident Regulation and Research Seminar video (ML101460608) and associated slides (ML101370748)

CRITERIA: At the completion of this activity, you should be able to discuss:

1. The importance of the Reactor Safety Study.
2. The significance of Industry Degraded Core Rulemaking (IDCOR) after Three Mile Island (TMI).
3. The two integral severe accident codes and their capabilities.
4. How the Commission's policy statements evolved from the original Severe Accident Policy Statement to SRM-SECY-00-0077.
5. The Individual Plant Examination (IPE) process and outcomes.

(MACCS-ISA-3) Severe Accident Phenomena

PURPOSE: The purpose of this activity is to become familiar with various types of severe accident phenomena, and how they affect the progression of a severe accident.

LEVEL OF EFFORT: 8 hours

REFERENCES:

1. SECY-90-016 (ML003707849), Evolutionary Light Water Reactor Certification Issues and Their Relationship to Current Regulatory Requirements, and associated SRM (ML003707885)
2. SECY-93-087 (ML003708021), Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs, and associated SRM (ML003708056)
3. NUREG/CR-6042 (ML021080026), Perspectives on Reactor Safety, Revision 2, pages 27-29
4. Severe Accident Phenomena video (ML101730589) and associated slides (ML101610775)

CRITERIA: At the completion of this activity, you should be able to discuss:

1. The main phenomena considered in primary systems.
2. The various phenomena considered in containment buildings.
3. Experimental programs that have increased the understanding of severe accident phenomena.
4. Specific phenomena for BWR and PWRs.

(MACCS-ISA-4) Severe Accident Progressions in PWRs and BWRs

PURPOSE: The purpose of this activity is to become familiar with how severe accidents progress in PWRs and BWRs, as well as the progression of the TMI accident.

LEVEL OF EFFORT: 8 hours

REFERENCES:

1. SECY-90-016 (ML003707849), Evolutionary Light Water Reactor Certification Issues and Their Relationship to Current Regulatory Requirements, and associated SRM (ML003707885)
2. SECY-93-087 (ML003708021), Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs, and associated SRM (ML003708056)
3. Severe Accident Progression in PWRs and BWRs video (ML101610781) and associated slides (ML101460614)

CRITERIA: At the completion of this activity, you should be able to discuss:

1. The accident progression that occurred at TMI.
2. The factors that are considered when looking at severe accident progression.
3. The factors that affect the release and transport of radionuclides.
4. The effects of differences in the design of PWRs and BWRs in severe accident response.
5. The phenomena that challenge the reactor vessel and containment.

(MACCS-ISA-5) Severe Accident Source Terms

PURPOSE: The purpose of this activity is to become familiar with severe accident radiological source terms for consequence assessment. Severe accident consequence analysts must understand how severe accident radiological source terms are estimated and used in a severe accident consequence assessment.

LEVEL OF EFFORT: 40 hours

REFERENCES:

1. *Radiological Assessment: A Textbook on Environmental Dose Analysis*, NUREG/CR-3332 (ML091770419), Chapter 1, "Source Terms for Nuclear Facilities, and Medical and Industrial Sites"

   Or

   Till and Grogan, Radiological Risk Assessment and Environmental Analysis, Oxford University Press (2008), Chapter 2, "Radionuclide Source Terms"

   Or

   Fjeld, Eisenberg and Compton, *Quantitative Environmental Risk Analysis for Human Health*, Wiley (2007), Chapter 3, "Release Assessment"
2. Level 3 PRA Seminar video (ML11217A206) and associated slides (ML11217A204)
3. P-301 course manual, Section 3, "Interface with Level-2 PRA Analysis"

CRITERIA: At the completion of this activity, you should be able to:

1. Discuss the relationship of severe accident radiological source terms to Level 2 PRA.
2. Discuss the relationship of severe accident radiological source terms to initiating events.
3. Discuss severe accident release categories.
4. Discuss the characteristics of reactor severe accident releases.

(MACCS-ISA-6) Atmospheric Transport and Dispersion

PURPOSE: The purpose of this activity is to become familiar with how atmospheric transport and dispersion are modeled in the MACCS/WinMACCS code. Severe accident consequence analysts must understand the basics of atmospheric transport and dispersion for severe accident consequence assessment.

LEVEL OF EFFORT: 40 hours

REFERENCES:

1. *Radiological Assessment: A Textbook on Environmental Dose Analysis*, NUREG/CR-3332 (ML091770419), Chapter 2, "Transport of Radionuclides in the Atmosphere"

   Or

   Till and Grogan, Radiological Risk Assessment and Environmental Analysis, Oxford University Press (2008), Chapter 3, "Atmospheric Transport of Radionuclides"

   Or

   Fjeld, Eisenberg and Compton, *Quantitative Environmental Risk Analysis for Human Health*, Wiley (2007), Chapter 7, "Atmospheric Transport"
2. P-301 course manual, Section 5, "Atmospheric Dispersion"
3. MACCS model description (ML063560409), Section 1.2.2, "Atmospheric Dispersion and Transport"
4. MACCS model description (ML063560409), Section 1.2.3, "Deposition, Weathering, Resuspension, and Decay"
5. MACCS model description (ML063560409), Section 1.2.4, "Weather Data"
6. MACCS user's guide, Chapter 5, "ATMOS Input File"

CRITERIA: At the completion of this activity, you should be able to:

1. Discuss the basics of atmospheric transport and dispersion.
2. Discuss the modeling of atmospheric transport and dispersion as used in the MACCS/WinMACCS code.
3. Discuss meteorological data needed and sources of the data.
4. Discuss the variables related to radiological release transport and dispersion, other than meteorological data.

(MACCS-ISA-7) Health Effects and Risk

PURPOSE: The purpose of this activity is to become familiar with the modeling of health effects from radiological release. Severe accident consequence analysts must understand how radiological health effects are estimated and modeled in a severe accident consequence assessment.

LEVEL OF EFFORT: 40 hours

REFERENCES:

1. *Radiological Assessment: A Textbook on Environmental Dose Analysis*, NUREG/CR-3332 (ML091770419), Chapter 10, "Calculation of Health Effects in Irradiated Populations"

   Or

   Till and Grogan, *Radiological Risk Assessment and Environmental Analysis*, Oxford University Press (2008), Chapters 8, 9, 10 and 12

   Or

   Fjeld, Eisenberg and Compton, *Quantitative Environmental Risk Analysis for Human Health*, Wiley (2007), Chapter 9, "Exposure Assessment" and Chapter 11, "Dose-Response and Risk Characterization"
2. P-301 course manual, Section 6, "Health Effects and Economic Consequences"
3. MACCS user's guide, Chapter 6, "EARLY Input File"
4. MACCS user's guide, Sections 7.10 – 7.12
5. MACCS model description (ML063560409), Section 1.2.5, "Dosimetry"
6. MACCS model description (ML063560409), Section 1.2.6, "Health Effects"

CRITERIA: At the completion of this activity, you should be able to:

1. Discuss how health effects of radiological releases are estimated in a severe accident consequence assessment.
2. Discuss dose conversion factors and risk coefficients.
3. Discuss dose pathways.

(MACCS-ISA-8) Economic Modeling

PURPOSE: The purpose of this activity is to become familiar with economic modeling in severe accident consequence assessment. Severe accident consequence analysts must understand how economic modeling is done in severe accident consequence assessment for regulatory activities.

LEVEL OF EFFORT: 40 hours

REFERENCES:

1. SECY-12-0110 (ML12173A478), "Consideration of Economic Consequences Within the U.S. Nuclear Regulatory Commission's Regulatory Framework," Main text (ML12173A479)
2. SECY-12-0110, Enclosure 5 (ML12173A493), "Regulatory and Backfit Analysis"
3. SECY-12-0110, Enclosure 6 (ML12173A494), "Environmental and NUREG-0800 Standard Review Plan Chapter 19 Analyses"
4. SECY-12-0110, Enclosure 7 (ML12173A501), "Relationship Between the Value of a Person-Rem Averted and Offsite Property Damage"
5. SECY-12-0110, Enclosure 8 (ML12173A505), "Current Staff Initiatives to Update the Dollar per Person-Rem Conversion Factor Policy and Replacement Power Costs"
6. SECY-12-0110, Enclosure 9 (ML12173A509), "MELCOR Accident Consequence Code System, Version 2 (MACCS2)"
7. NUREG/BR-0058 (ML042820192), "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission"
8. NUREG/BR-0184 (ML050190193), Regulatory Analysis Technical Evaluation Handbook, January 1997
9. P-301 course manual, Section 6, "Health Effects and Economic Consequences"
10. MACCS user's guide, Chapter 7, "CHRONC Input File"

CRITERIA: At the completion of this activity, you should be able to:

1. Discuss which regulatory processes require economic consequence estimation.
2. Discuss the economic factors that are considered in a severe accident consequence assessment and the sources of that information.

(MACCS-ISA-9) Large Release Frequency and Large Early Release Frequency

PURPOSE: The purpose of this activity is to become familiar with the development of the large release frequency (LRF) and large early release frequency (LERF) metrics, and their use and limitations in risk applications.

LEVEL OF EFFORT: 24 hours

REFERENCES:

1. RG 1.174 (ML023240437), An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions of Plant-Specific Changes to the Licensing Basis, November 2002, *Sections 1.4, 2.0, and 2.2.4*
2. NUREG/CR-6595 (ML043240040), An Approach for Estimating the Frequencies of Various Containment Failure Modes and Bypass Events, Revision 1, October 2004, *Sections 1, 2 and 3 (review the subsections for a selected PWR and BWR containment), 4, and Appendix A*
3. NUREG-1860 (ML080440170, ML080440215), Feasibility Study for a Risk-Informed and Performance-Based Regulatory Structure for Future Plant Licensing, December 2007
4. SECY-90-016 (ML003707849), Evolutionary Light Water Reactor (LWR) Certification Issues and their Relationship to Current Regulatory Requirements, and associated SRM (ML003707885), *Issues IA (ALWR Public Safety Goal), and IIID (Containment Performance)*
5. SECY-93-087 (ML003708021), Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs, and associated SRM (ML003708056), *Issue J (Containment Performance)*
6. SECY-93-138 (ML082880044), Recommendation on Large Release Definition, and associated SRM (ML12297A782) [NON-PUBLIC]
7. SECY-13-0029 (ML13022A207), History of and the Use and Consideration of the Large Release Frequency Metric by the U.S. Nuclear Regulatory Commission

CRITERIA: At the completion of this activity, you should be able to discuss:

1. The LERF concept and alternative definitions of LERF.
2. The use of the LERF metric as a surrogate for the early fatality quantitative health objective (QHO).

3. The limitations of the LERF metric and the need to consider other containment performance metrics (e.g., late containment failure frequency) in risk-informed decision-making.
4. The use of Large Release Frequency for new reactors.
5. The deterministic and probabilistic containment performance goals for new reactors.

(MACCS-ISA-10) Accident Management Programs

PURPOSE: The purpose of this activity is to become familiar with the history and purposes of severe accident management programs.

LEVEL OF EFFORT: 8 hours

REFERENCES:

1. SECY-90-016 (ML003707849), Evolutionary Light Water Reactor Certification Issues and Their Relationship to Current Regulatory Requirements, and associated SRM (ML003707885)
2. SECY-93-087 (ML003708021), Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs, and associated SRM (ML003708056)
3. NEI 91-04 (ML072850981), Severe Accident Issue Closure Guidelines, Revision 1, background only
4. The US Accident Management Program video (ML101670478) and associated slides (ML101530624)

CRITERIA: At the completion of this activity, you should be able to discuss:

1. The purpose of accident management.
2. The major elements of accident management.
3. The NRC activities that took place regarding accident management.
4. The industry activities that took place regarding accident management.
5. The way accident management guidelines are implemented by the industry and evaluated by the NRC.

(MACCS-ISA-11) Severe Accident Mitigation Alternatives

PURPOSE: The purpose of this activity is to become familiar with severe accident mitigation design alternatives (SAMDA) and severe accident mitigation alternatives (SAMA), how they are analyzed, and how the results are reviewed.

LEVEL OF EFFORT: 8 hours

REFERENCES:

1. Severe Reactor Accident Policy Statement (50 FR 32138, August 8, 1985)
2. SECY-90-16, Evolutionary Light Water Reactor Certification Issues and Their Relationship to Current Regulatory Requirements, and associated SRM (ML003707885)
3. Limerick Ecology Action, Inc. v. NRC (869 F.2d 719)
4. NUREG/BR-0184 (ML050190193), Regulatory Analysis Technical Evaluation Handbook, January 1997, Chapter 5
5. Perspectives on Severe Accident Mitigation Alternatives for US Plant License Renewal video (ML101370757) and associated slides (ML101370753)

CRITERIA: At the completion of this activity, you should be able to discuss:

1. The history behind SAMA/SAMDA analysis.
2. The major elements of a SAMDA/SAMA analysis.
3. The difference between a SAMDA and a SAMA analysis.
4. The major steps in a SAMDA/SAMA evaluation.

(MACCS-ISA-12) Modeling Emergency Planning

PURPOSE: The purpose of this activity is to become familiar with the modeling of emergency preparedness and plans during severe accidents.

LEVEL OF EFFORT: 24 hours

REFERENCES:

1. P-301 course manual, Section 7, “Protective Measures”
2. MACCS user’s guide, Chapter 6, “Evacuation Zone Data” and Sections 7.1 – 7.9.
3. MACCS model description (ML063560409), Chapter 5, “Mitigative Actions ”
4. 10 CFR Part 50.47, “Emergency Plans”
5. NUREG/BR-0359 (ML12347A049), Modeling Potential Reactor Accident Consequences, State-of-the-Art Reactor Consequence Analyses: Using decades of research and experience to model accident progression, mitigation, emergency response, and health effects, Revision 1, Chapter 5
6. NUREG-1150 (ML120960691), Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants, December 1990
7. NUREG/CR-7154 (ML13031A500), Risk Informing Emergency Preparedness Oversight: Evaluation of Emergency Action Levels - A Pilot Study of Peach Bottom, Surry and Sequoyah, Volume 1
8. NUREG/CR-7160 (ML13164A285), Emergency Preparedness Significance Quantification Process: Proof of Concepts
9. NUGREG/CR-6525 (ML032310279), SECPOP2000: Sector Population, Land Fraction, and Economic Estimation Program, Revision 1 (or latest edition)

CRITERIA: At the completion of this activity, you should be able to:

1. Describe what constitutes emergency planning and the Emergency Planning Zone (EPZ), onsite and offsite objectives and associated NRC regulations.
2. Describe the three emergency phases and associated mitigating emergency response actions with each phase.
3. Describe information included in emergency plan modeling including sector population data.
4. Describe how different portions of the public can be treated via different emergency scenarios.

5. Describe what modeling can demonstrate about emergency planning.

(MACCS-ISA-13) Risk Communication

PURPOSE: The purpose of this activity is to become familiar with the NRC's guidance for external and internal risk communication.

LEVEL OF EFFORT: 8 hours

REFERENCES:

1. NUREG/BR-0308 (ML040690412), Effective Risk Communication: The Nuclear Regulatory Commission's Guideline for External Risk Communication, January 2004
2. NUREG/BR-0318 (ML050960339), Effective Risk Communication: Guidelines for Internal Risk Communication, December 2004
3. "Non-NRC References" listed on the NRC internal risk communication website

CRITERIA: At the completion of this activity, you should be able to:

1. Discuss the audiences and their needs for both internal and external risk communication.
2. Discuss the steps to craft effective messages for external risk communication.
3. Discuss several methods for coping with controversy and answering difficult questions.
4. Describe methods for communicating technical information to the general public.
5. Discuss the positive and negative aspects of comparing the risk from different sources.

(MACCS-ISA-14) NRC Reference Sources

PURPOSE: The purpose of this activity is to become familiar with the various severe accident related reference sources available to NRC staff and to ensure that important references are added as needed.

LEVEL OF EFFORT: 8 hours

REFERENCES:

1. AAB SharePoint site (e.g. MACCS slides)
2. Communication Plan
3. NRO Licensing Library, especially for SRP Sections 17.4, 17.6, 19.0, 19.1, and 19.3
4. Risk-Informed Regulation Community of Practice
5. Risk Assessment Standardization Project (RASP) Toolbox: RASP handbooks, reference documents, presentations, and software information
6. NRR Division of Risk Assessment (DRA) website
7. SOARCA Public Website
8. Containment Protection and Release Reduction (CPRR) for Mark I and Mark II BWRs Public Website, in particular SECY-15-0085 (ML15005A079)
9. NUREG-2161 (ML14255A365), Consequence Study of a Beyond-Design-Basis Earthquake Affecting the Spent Fuel Pool for a U.S. Mark I Boiling Water Reactor, September 2014
10. NUREG-2122 (ML13311A353), Glossary of Risk-Related Terms in Support of Risk-Informed Decisionmaking, November 2013

CRITERIA: Access, bookmark, and explore each of the reference sources above. At the completion of this activity, you should be familiar with the types of documents available at each. If you have identified other valuable references, provide those links to your supervisor and to the owner of the Licensing Library, Jan Mazza.

3 Optional On-the-Job (OJT) Training Activities

The on-the-job training activities, combined with the technical study activities in the previous section, are sufficient to understand the routine work undertaken in the branch. However, the following additional experiences may provide important perspectives for MACCS analysts. Staff should discuss these OJT activities with their supervisor and determine which are appropriate and feasible.

- **Advisory Committee on Reactor Safeguards (ACRS) meeting**

  The Advisory Committee on Reactor Safeguards (ACRS) advises the Commission on the safety aspects of proposed and existing nuclear facilities and the adequacy of proposed reactor safety standards and performs such other duties as the Commission may request. AAB staff may find useful, in particular, hearings which involve the ACRS Reliability and Probabilistic Risk Assessment Subcommittee, as well as the Thermal Hydraulic Phenomena Subcommittee, among others. However, attendance at any ACRS full or committee or subcommittee meeting will provide an understanding of the process and scope of questioning. Meeting schedules and transcripts can be found on the ACRS website.

- **Demonstrate Competency in MACCS**

  A MACCS analyst needs to demonstrate their knowledge of the MACCS code and their ability to use the MACCS code by either reworking a previous study performed using MACCS or performing a new study using MACCS. This OJT will be used to show the analysts competency in regards to taking a MELCOR plot file and using MELMACCS to generate a MACCS input file and then running a MACCS analysis and defending the parameters that were chosen in the analysis.

- **Temporary assignment in model development or review**

  The Office of Nuclear Regulatory Research (RES) and Sandia National Laboratories (SNL) develop the MELCOR and MACCS codes. A temporary assignment with SNL in order to gain further familiarity with MELCOR or MACCS could be proposed. Additionally, ongoing code developments for MACCS could benefit from NRC staff review during development.

- **Rotation to another NRC branch**

  PRA branches across the NRC apply the same basic principles of risk-informed regulation to specific applications. A rotation in one of these branches provides additional foundation in PRA concepts and a broader understanding of the use of PRA at the NRC. The greatest overlap would be with the Division of Risk Assessment in NRR or RES, but risk concepts are also used in the Office of Nuclear Material Safety and Safeguards (NMSS) and in other parts of the NRC.

- **Regional rotation**

  Regional rotations provide valuable understanding of the NRC's oversight process. A rotation related to operating reactors, whether as a resident or region-based inspector, helps the employee understand the NRC's daily contact with licensees. A rotation related to new reactor construction (Region II) would give insights into the inspection program being developed for new reactors and the potential responsibilities of NRO staff related to inspection prioritization and findings. These rotations must be planned carefully because of their high cost.

4 Formal Training Courses

Staff should discuss these training courses with their supervisor and determine which are appropriate. Many of the courses are only offered once a year, so training should be scheduled well in advance. Additional topics of interest may be available through external training.

- **P-105: PRA Basics for Regulatory Applications**

  This 3 day course addresses the special needs of the regulator who requires knowledge of probabilistic risk assessment (PRA) issues and insights to better evaluate the effects of design, testing, maintenance, and operating strategies on system reliability. The full range of PRA topics is presented in abbreviated form with the goal of introducing the regulatory staffs to the basic concepts and terminology of PRA as applied to the inspection process. The course uses actual plant PRAs and IPEs and stresses the uses and applications of these publications in planning audits and inspections and evaluating plant safety issues.

- **P-105: PRA Basics for Regulatory Applications**

  This 3 day course addresses the special needs of the regulator who requires knowledge of probabilistic risk assessment (PRA) issues and insights to better evaluate the effects of design, testing, maintenance, and operating strategies on system reliability. The full range of PRA topics is presented in abbreviated form with the goal of introducing the regulatory staffs to the basic concepts and terminology of PRA as applied to the inspection process. The course uses actual plant PRAs and IPEs and stresses the uses and applications of these publications in planning audits and inspections and evaluating plant safety issues.

- **P-111: PRA Technology and Regulatory Perspectives**

  This course addresses the special needs of regional inspectors, resident inspectors, and other technical personnel who require knowledge of PRA issues and insights to better evaluate the effects of design, testing, maintenance, and operating strategies on system reliability. The course will concentrate on the use of PRA results in inspection planning, monitoring licensee performance, and reviewing licensee risk-based submittals.

- **P-300: Accident Progression Analysis**

  This course deals with the portion of probabilistic risk assessment typically referred to as Level 2 analysis. The course will address accident phenomenology under post-core damage conditions and will discuss development of PRA models for this severe accident regime. The emphasis of the course is on the important modeling issues and how they are dealt with, rather than how to use specific modeling software.

- **P-301: Accident Consequence Analysis**

  This course deals with the portion of PRA typically referred to as Level 3 analysis. The course addresses environmental transport of radio nuclides and the estimation of offsite consequences from core damage accidents. The emphasis of the course is on important modeling issues and how they are dealt with, rather than how to use specific modeling software. This course covers important modeling issues and how these issues are dealt with. Hands-on modeling examples using the MACCS (MELCOR Accident Consequence Code System) software code are covered in the course.

- **P-302: Risk Assessment in Event Evaluation**

  This four-day course covers the use of PRA techniques to assess the risk significance of initiating events and condition assessments that occur at operating reactors. The course addresses the use of simplified PRA models to estimate conditional damage probability

using the Graphical Evaluation Module (GEM) of the SAPHIRE suite of programs. In addition, common cause and non-recovery probabilities will also be addressed. The course includes conventional workshops and GEM program workshops.

- **R-800: Perspectives on Reactor Safety**

  This is an advanced course that provides a detailed perspective of important reactor safety concepts with emphasis on topics important to reactor risk. It is recommended that enrollees have a basic to intermediate knowledge of reactors and reactor support systems. Five major areas are covered. (1) Historical Overview: design for safety; defense in depth strategy; emergency core cooling system (ECCS) rulemaking; and severe accident and safety goal policy. (2) Accident Sequences: safety risk concepts and terminology; accident sequence development; important accident sequences; and IPE and IPEEE programs. (3) Accident Progression in the Reactor Vessel: fission product inventory and decay heat; and core melt progression. (4) Accident Progression in the Containment: containment phenomena; reactor cavity and vessel breach phenomena; and hydrogen and combustion events. (5) Radiological Releases and Consequences: radionuclide groups; environmental transport; protective action guidelines; and emergency response. Discussions also focus on plant events, accident management principles, and historical perspectives.

- **E-110: Power Plant Engineering**

  The course provides an understanding of the practical aspects of nuclear power plant operation. Emphasis is placed on the use and operation of various types of equipment rather than design. When topics such as physics, chemistry and heat transfer are discussed, their relationship to basic reactor operation and the nuclear plant cycle are stressed. Course topics include: basic plant cycles, reactor physics, heat transfer and thermal hydraulics, process chemistry, print reading, basic electrical, generators, motors, electrical distribution equipment, piping, turbines, diesel generators, process instrumentation, controllers, nuclear instrumentation and radiation protection.

- **H-100: Site Access**

  The course provides a general understanding of radiation types, quantities, units, biological effects, protection standards and guides, dose limits, posting requirements, exposure control, “as low as reasonably achievable” (ALARA) practices, monitoring instruments and dosimeters, bioassay, contamination protection, industrial safety, and emergencies. It also provides a generic understanding of industrial safety practices, physical protection programs and responses to radiological emergencies. The course also includes an exercise in which each student will be expected to don protective clothing, perform simple tasks and remove protective clothing. A grade of at least 80% is required for passing.

5 Template for MACCS Analyst Training Journal

Note: This table is only a template and should be adjusted to reflect the activities needed to develop the individual employee's technical expertise.

Name: _____

Activity	Title	Time Spent on Activity	Date Completed	Trainee Initials	Branch Chief or Designee Initials	Notes
Individual Study Activities						
ISA-1	Severe Accident Consequence Assessment Overview					
ISA-2	History of Severe Accident Regulation and Research					
ISA-3	Severe Accident Phenomena					
ISA-4	Severe Accident Progression in PWRs and BWRs					
ISA-5	Severe Accident Source Terms					
ISA-6	Atmospheric Transport and Dispersion					
ISA-7	Health Effects and Risk					
ISA-8	Economic Modeling					
ISA-9	Large Release Frequency and Large Early Release Frequency					
ISA-10	Accident Management Programs					
ISA-11	Severe Accident Mitigation Alternatives					
ISA-12	Modeling Emergency Planning					
ISA-13	Risk Communication					
ISA-14	NRC Reference Sources					
On-the-Job Training (as appropriate)						
	ACRS meeting					
	Demonstrate Competency in MACCS					
	Temporary assignment in model development or review					
	Rotation to another branch or region					

Activity	Title	Time Spent on Activity	Date Completed	Trainee Initials	Branch Chief or Designee Initials	Notes
Formal Training (as appropriate)						
P-105	PRA Basics for Regulatory Applications					
P-111	PRA Technology and Regulatory Perspectives					
P-300	Accident Progression Analysis					
P-301	Accident Consequence Analysis					
P-302	Risk Assessment in Event Evaluation					
R-800	Perspectives on Reactor Safety					
E-110	Power Plant Engineering					
H-100	Site Access					

6 Bibliography

Bixler, N., et al., NUREG/CR-6525, Rev. 1, "SECPOP2000: Sector Population, Land Fraction, and Economic Estimation Program," ML032310279, Sandia National Laboratories, Albuquerque, NM, August 2003.

Fuller, E., "History of Severe Accident Regulation and the Role of Research," ML101370748, U.S. Nuclear Regulatory Commission, May 2010.

Fuller, E., "Level 3 PRA Seminar," ML11217A204, U.S. Nuclear Regulatory Commission, July 2011.

Fuller, E., "Severe Accident Phenomena," ML101610775, U.S. Nuclear Regulatory Commission, June 2010.

Fuller, E., "Severe Accident Progression in PWRs and BWRs," ML101460614, U.S. Nuclear Regulatory Commission, May 2010.

Jow, H., et al., NUREG/CR-4691, Vol. 2, "MELCOR Accident Consequence Code System (MACCS) Model Description," ML063560409, Sandia National Laboratories, Albuquerque, NM, February 1990.

Limerick Ecology Action, Inc. v. United States Nuclear Regulatory Commission, 869 F .2d 719, United States Court of Appeals, Third Circuit, February 1989.

Nuclear Energy Institute, NEI 91-04, Rev. 1, "Severe Accident Issue Closure Guidelines," ML072850981, Washington, DC, December 1994.

Palla, R., "Perspectives on Severe Accident Mitigation Alternatives for US Plant License Renewal," ML101370753, U.S. Nuclear Regulatory Commission, April 2010.

Palla, R., "The US Accident Management Program," ML101530624, U.S. Nuclear Regulatory Commission, June 2010.

Pratt, W., et al., NUREG/CR-6595, Rev. 1, "An Approach for Estimating the Frequencies of Various Containment Failure Modes and Bypass Events," ML043240040, Brookhaven National Laboratory, Upton, NY, October 2004.

Till, J., Meyer, H., NUREG/CR-3332, "Radiological Assessment, A Textbook on Environmental Dose Analysis," ML091770419, U.S. Nuclear Regulatory Commission, Washington, DC, September 1983.

U.S. Code of Federal Regulations, 10 CFR 50.47, "Emergency Plans"

U.S. Nuclear Regulatory Commission, "Policy Statement on Severe Reactor Accidents Regarding Future Designs and Existing Plants," *Federal Register*, 50 FR 32138, ML003711521, August 1985.

U.S. Nuclear Regulatory Commission, "BWR Mark I and Mark II Filtered Containment Venting System (FCVS) Issue," ML12137A008, Washington, DC, May 2012.

U.S. Nuclear Regulatory Commission, NUREG-75/014 (WASH-1400), "Reactor Safety Study, An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants," ML083570090, Washington, DC, October 1975.

U.S. Nuclear Regulatory Commission, NUREG-1150, Vol. 1, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants," ML120960691, Washington, DC, December 1990.

U.S. Nuclear Regulatory Commission, NUREG-1860, “Feasibility Study for a Risk-Informed and Performance-Based Regulatory Structure for Future Plant Licensing, Volumes 1 and 2,” ML080440170, ML080440215, Washington, DC, December 2007.

U.S. Nuclear Regulatory Commission, NUREG-2122, “Glossary of Risk-Related Terms in Support of Risk-Informed Decisionmaking,” ML13311A353, Washington, DC, November 2013.

U.S. Nuclear Regulatory Commission, NUREG-2161, “Consequence Study of a Beyond-Design-Basis Earthquake Affecting the Spent Fuel Pool for a U.S. Mark I Boiling Water Reactor,” ML14255A365, Washington, DC, September 2014.

U.S. Nuclear Regulatory Commission, NUREG/BR-0058, Rev. 4, “Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission,” ML042820192, Washington, DC, September 2004.

U.S. Nuclear Regulatory Commission, NUREG/BR-0184, “Regulatory Analysis Technical Evaluation Handbook,” ML050190193, Washington, DC, January 1997.

U.S. Nuclear Regulatory Commission, NUREG/BR-0308, “Effective Risk Communication: The Nuclear Regulatory Commission’s Guidelines for External Risk Communication,” ML040690412, Washington, DC, January 2004.

U.S. Nuclear Regulatory Commission, NUREG/BR-0318, “Effective Risk Communication: Guidelines for Internal Risk Communication,” ML050960339, Washington, DC, December 2004.

U.S. Nuclear Regulatory Commission, NUREG/BR-0359, Rev. 1, “Modeling Potential Reactor Accident Consequences,” ML12347A049, Washington DC, December 2012.

U.S. Nuclear Regulatory Commission, NUREG/CR-6042, Rev. 2, “Perspectives on Reactor Safety,” ML021080026, Washington, DC, March 2002.

U.S. Nuclear Regulatory Commission, NUREG/CR-7154, Vol. 1, “Risk Informing Emergency Preparedness Oversight: Evaluation of Emergency Action Levels – A Pilot Study of Peach Bottom, Surry and Sequoyah,” ML13031A500, Washington, DC, January 2013.

U.S. Nuclear Regulatory Commission, NUREG/CR-7160, “Emergency Preparedness Significance Quantification Process: Proof of Concept,” ML13164A285, Washington, DC, June 2013.

U.S. Nuclear Regulatory Commission, RG 1.174, Rev. 1, “An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis,” ML023240437, Washington, DC, November 2002.

U.S. Nuclear Regulatory Commission, SECY-89-102, “Implementation of the Safety Goals,” Washington, DC, March 1989.

U.S. Nuclear Regulatory Commission, SRM SECY-89-102, “Staff Requirements Memorandum Regarding the Implementation of the Safety Goals,” ML051660712, Washington, DC, June 1990.

U.S. Nuclear Regulatory Commission, SECY-90-016, “Evolutionary Light Water Reactor (LWR) Certification Issues and Their Relationship to Current Regulatory Requirements,” ML003707849, Washington, DC, January 1990.

U.S. Nuclear Regulatory Commission, SRM SECY-90-016, “Staff Requirements Memorandum – Evolutionary Light Water Reactor (LWR) Certification Issues and Their Relationship to Current Regulatory Requirements,” ML003707885, Washington, DC, June 1990.

U.S. Nuclear Regulatory Commission, SECY-93-087, “Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs,” ML003708021, Washington, DC, April 1993.

U.S. Nuclear Regulatory Commission, SRM SECY-93-087, “Staff Requirements Memorandum – Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs,” ML003708056, Washington, DC, July 1993.

U.S. Nuclear Regulatory Commission, SECY-93-138, “Recommendation on Large Release Definition,” ML082880044, Washington, DC, May 1993.

U.S. Nuclear Regulatory Commission, SRM SECY-93-138, “Staff Requirements Memorandum – Recommendation on Large Release Definition,” ML12297A782, Washington, DC, June 1993.

U.S. Nuclear Regulatory Commission, SECY-00-0077, “Modifications to the Reactor Safety Goal Policy Statement,” ML003684288, Washington, DC, March 2000.

U.S. Nuclear Regulatory Commission, SRM SECY-00-0077, “Staff Requirements Memorandum – Modifications to the Reactor Safety Goal Policy Statement,” ML003727206, Washington, DC, June 2000.

U.S. Nuclear Regulatory Commission, SECY-12-0110, “Consideration of Economic Consequences within the U.S. Nuclear Regulatory Commission’s Regulatory Framework,” ML12173A478, Washington, DC, August 2012.

U.S. Nuclear Regulatory Commission, SECY-13-0029, “History of the Use and Consideration of the Large Release Frequency Metric by the U.S. Nuclear Regulatory Commission,” ML13022A207, Washington, DC, March 2013.

U.S. Nuclear Regulatory Commission, SECY-15-0085, “Evaluation of the Containment Protection and Release Reduction for Mark I and Mark II Boiling Water Reactors Rulemaking Activities (10 CFR 50) (RIN-3150-AJ26),” ML15005A079, Washington, DC, June 2015.

APPENDIX A

Sample Certification Memorandum

MEMORANDUM FOR: **{Name}**
Accident Analysis Branch
Division of Systems Analysis
Office of Nuclear Regulatory Research

FROM: **{Name}**, Branch Chief
Accident Analysis Branch
Division of Systems Analysis
Office of Nuclear Regulatory Research

SUBJECT: CERTIFICATION AS A MACCS ANALYST

Based on my review of your professional background, work experience, education, and successful completion of the MACCS Analyst Training and Qualification Plan, I have determined that you are qualified to perform technical review and project management activities in the areas of consequence analysis work.

Your formal education includes a Bachelor of **{….. and graduate degrees if appropriate}**. In addition, you have completed numerous training courses at the NRC including **{….. and….}**. Additionally, you have kept your site access training up to date.

Thus, through my evaluation of your NRC employment history, educational background and successful completion of the MACCS Analyst Training and Qualification Plan, I have concluded that you have the necessary skills and experience to perform assigned technical review and project management tasks related to consequence analysis work. Therefore, you are hereby certified as a qualified MACCS Analyst to perform technical reviews, project management activities, research studies, confirmatory analyses, and licensing applications for activities related to consequence analysis.