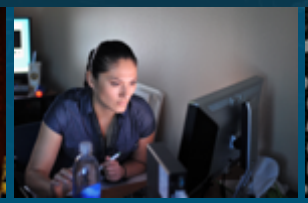
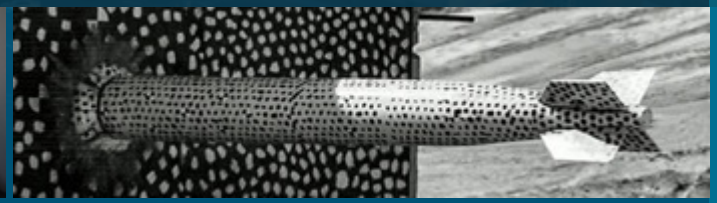
SAND2022-8114C

Sandia National Laboratories

MELCOR for HTGR, FHR, and MSR - Workshop Introduction





MELCOR Workshop June 13-17, 2022

PRESENTED BY

Brad Beeny

U.S. DEPARTMENT OF ENERGY | NNSA

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

MELCOR HTGR, FHR, and MSR Modeling/Development Introduction and Background

Overview

Development background

Modeling background

Workshop introduction

Background – Development

Development timeline for HTGRs and FHRs in MELCOR

- Prior to 2008
  - Few provisions for PMR/PBR (HTGR) and no provisions for FHR
  - Users adapted LWR models for PBRs
- 2008 – CSARP presentation outlines initial plans/efforts for HTGR
  - New COR package reactor types, components (reflector, RF), and conduction/convection models
  - Revisited/updated CVH/NCG capabilities (helium properties)
  - Beginnings of diffusional fission product release models, graphite oxidation model, and point kinetics mo
- 2009 to 2010 - Miscellaneous improvements and early draft of an evaluation model for HTGRs
- 2011 to 2017 - Limited development, some HTGR modeling activity from the code user base
- 2018 to present – Non-LWR modeling initiatives
  - Revamped/streamlined the diffusional fission product release model input processing (HTGR and FHR)
  - Revisited solution methods and strategies
  - Finalized evaluation model for HTGR and created one for FHR (similar to HTGR)
  - Added new models and capabilities (e.g. FLiBe EOS and MSM/GRTR), modified existing models and ca
  - Built on existing PBR-400 input model to ultimately perform a demonstration source term calculation (HT
  - Performed a demonstration source term calculation for FHR

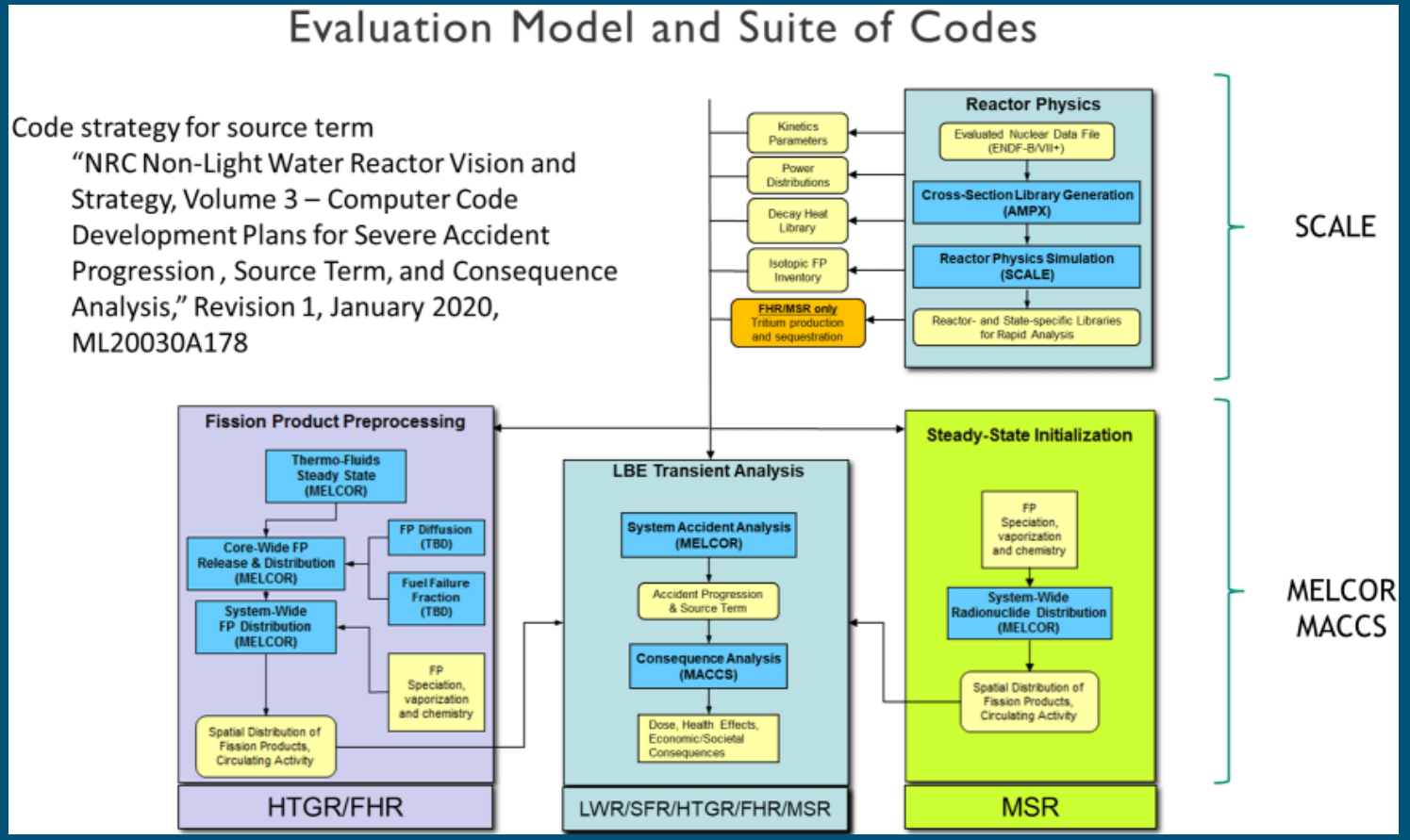
Background – Modeling

User base exercised MELCOR HTGR models in various stages of maturity, both PMR and PBR

- Domestically, e.g. Texas A&M and PBR/PMR thermal hydraulics modeling
- Internationally, both European (PSI for HTR-PM, Nubiki for Allegro) and Asian users

SNL in-house modeling:

- MELCOR testing
  - Input models for verification/validation
  - Input models for quality assurance
- Demonstration
  - USNRC HTGR/FHR evaluation model
  - End-to-end source term calculation(s)
- Simultaneous with development



Workshop Introduction

Conventional MELCOR workshop format focused largely on two topics:
- Core package (COR) thermal hydraulics modeling for HTGRs and FHRs (largely similar in nature)
- Radionuclide transport (fission product release) modeling from fuel for HTGRs and FHRs – largely configured in COR

Two sections per topic to discuss theory and practice in turn

Incorporate “best practice” recommendations that reflect, e.g.:
- HTGR modeling presented at EMUG of 2021
- HTGR workshop delivered at AMUG of 2021
- NURETH-19 SNL presentations on HTGR, FHR, and MSR related topics
- EMUG and AMUG of 2022
- US NRC source term demonstration calculation methodologies (HTGR and FHR)
  - Public presentations readily available
  - US NRC working to make input models readily available to MELCOR user base

Incorporate input model exercises
- Text file editing method exclusively (SNAP largely unavailable for non-LWR)
- Output and post-processing (MELGEN/MELCOR text, plot variables and control function arguments, HTML)

Workshop Introduction

MELCOR Workshop Days 4 Agenda: HTGR/FHR	
Day 4, Session 3 (Afternoon session 1) COR Thermal Hydraulics Theory • Components and Materials • Conduction • Convection • Oxidation • Point Kinetics	~ 2 hr

Day 4, Session 4 (Afternoon session 2)
COR Thermal Hydraulics Input/Exercises
• Exercise – PBR Nodalization
  • User input structures
  • Follow-along input exercise
• Exercise – PBR Point Kinetics
  • User input structures
  • Follow-along input exercise
  • Output
	~ 1.5 hr

Workshop Introduction

MELCOR Workshop Day 5 Agenda: HTGR/FHR	
Day 5, Session 1 (Morning Session 1) COR Diffusional FP Release Theory • Fuel element representation • Finite volume diffusion • Fuel element temperature profiles • Analytic release model • Solution methodology • DCH/RN1 mapping • Class release scaling	~ 2 hr

Day 5, Session 2 (Morning Session 2)
COR Diffusional FP Release Input/Exercises
• Exercise – FP release model
  • User input structures
  • Follow-along input exercise
• Exercise – Run sequence & VCFs
  • User input structures
  • Follow-along input exercise
  • Output
	~ 1 hr

Workshop Introduction

MELCOR Workshop Day 5 Agenda: MSR	
Day 5, Session 3 (Afternoon Session 1) MSR Thermal Hydraulics Theory/Practice • FLiBe as a working fluid • Fluid core configuration • Fluid fuel point reactor kinetics • Exercise – Zero Power Pump Coast	~ 2 hr

Day 5, Session 4 (Afternoon Session 2)
MSR FP Release Theory/Practice
• GRTR
• DCH/RN1 input considerations
  • Class and form mapping
  • Form-wise mass initialization
  • Form-wise source specification
	~ 1 hr