

Modeling boiling water reactor main steam isolation valve leakage using MELCOR

Presented at the
21st Annual Regulatory Information Conference
March 10-12, 2009

M. Salay, M. Blumberg
US Nuclear Regulatory Commission
Washington, DC

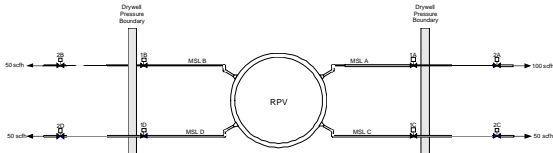
R. Gauntt
Sandia National Laboratories
Albuquerque, NM

Purpose

- Evaluate whether the main steam isolation valve (MSIV) leakage methodology in RG 1.183, Rev 0 is appropriately conservative.
- Provide a technical basis for appropriate revisions to Regulatory Guide (RG) 1.183.

2

Background MSIV configuration



3

Background

- Main Steam Lines (MSLs) in a BWR penetrate containment providing a dose release pathway.
- MSLs contain two quick closing MSIVs used to isolate reactor pressure vessel (RPV), as necessary
- MSIVs are not leak tight
- Limits on the MSIV leakage are established and incorporated into the plant design
- Over the past 15 years, plants have justified increased MSIV leakage limits using existing dose methodologies, including RG 1.183.

4

Background

- Leakage limits are based upon low probability/risk accidents (core melt) and defined by limits provided in regulation - 10 CFR 50.67
- Regulatory Guide 1.183, Rev 0
 - Provides an acceptable method to meet 10 CFR 50.67
 - MSIV leakage can be important component of the method
 - Uses a containment source term for evaluating MSIV leakage - NUREG-1465 (Alternative Source Term)
- *Why we did this reassessment?*
 - *Regulatory guide has not been updated since issuance in 2000*
 - *Nine years of experience implementing RG has shown this release path to be a potentially significant contributor to dose consequences.*
 - *Concerns regarding whether the current methodologies are appropriately conservative.*

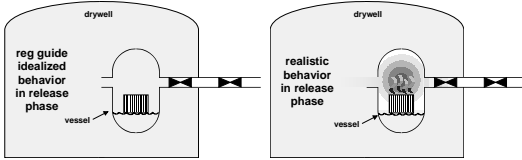
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Use of MELCOR

- MELCOR used to assess RG 1.183 methods typically used in the determination of allowable MSIV leakage rates
 - MELCOR provides a "state of the art" integrated assessment
 - Current MSIV leakage rate methods assessed:
 - adequacy of drywell fission product environment as surrogate for the steam dome
 - main steam line aerosol removal coefficients
 - MSIV leakage flow rates
 - the effect of sprays on the steam dome fission product concentration
 - Full plant design basis accident for Mark-I and Mark-III containments used to establish source
 - Steam line (inside containment) and recirculation line break
 - With and without containment sprays
 - Reduced model containing only steam dome and steam lines used for uncertainty analysis
 - Faster running
 - Uses full model steam dome fission product inventory and fluid conditions as boundary conditions

6

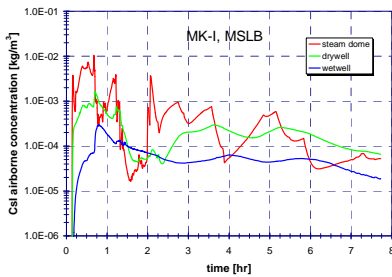
RG 1.183 vs. Realistic Model



- RG 1.183 currently assumes uniform fission product (f.p.) in drywell
- MSIV leak source in RG 1.183 currently assumed to be drywell

7

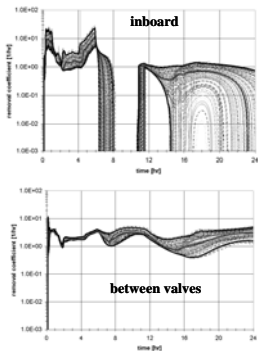
RPV (Steam Dome) vs. Containment (Drywell) fission product concentration



- Steam dome (SD) concentration exceeds drywell (DW) concentration for significant time periods
- RG 1.183 currently assumes SD and DW concentrations are equal
- Relation developed between SD and DW fission product concentrations
- No reflood for this figure

8

Main steam aerosol removal



- Aerosol removal rates highly dependent on aerosol size
 - removal alters size distribution
- Characterized by removal coefficient, A , assuming that the deposition rate is $-m_{aerosol}^2$
- Revaporization observed from inboard main steam line
- Main steam line aerosol removal rates lower than if determined using only containment aerosol size distribution

9

Summary

- **MELCOR was used to study design basis MSIV leakage calculations**
 - Provides a technical basis for potential modifications to regulatory guidance for MSIV leakage (RG 1.183)
 - MELCOR was used to generate main steam line removal coefficients for use with a dose assessment computer code
- **Recommendations made on (among others):**
 - source
 - aerosol removal rates
 - crediting of containment sprays
 - flow calculation methodology
- **NRR is currently evaluating potential changes to RG 1.183 based on the SNL findings**
 - Any proposed changes will be provided in a draft guide for stakeholder comment

10
