ASME NUCLEAR CODES & STANDARDS

RELIABILITY AND INTEGRITY MANAGEMENT (RIM)

- REWRITE OF SECTION XI, DIVISION II, USING RISK INFORMED METHODOLOGY -

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BNCS Workshop

Prague, Czech Republic

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AGENDA

- Background History
  - Rewrite Criteria
- RIM (Reliability and Integrity Management)
  - SBC (System Based Code)
- Rewrite Status
- Conclusion

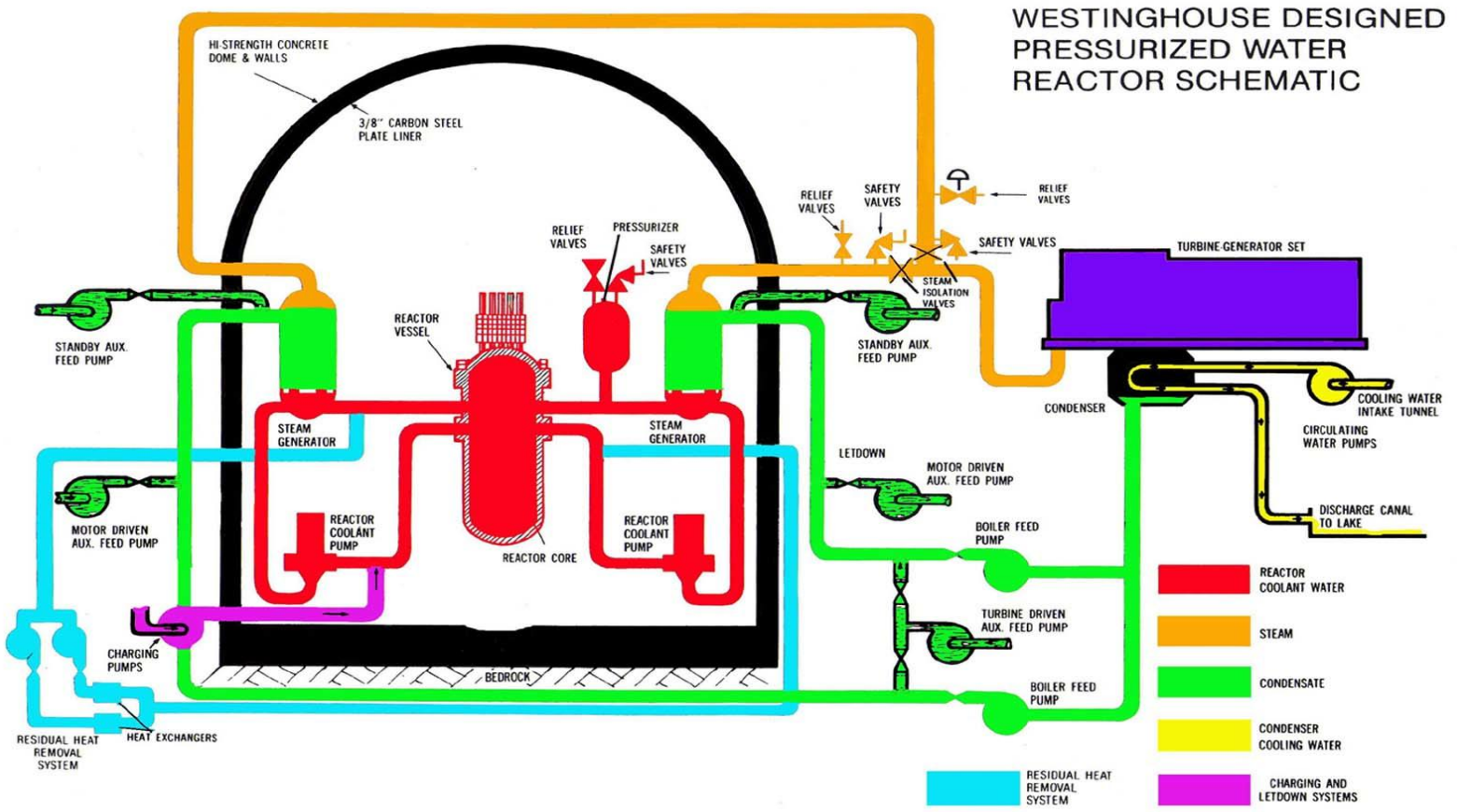
BACKGROUND & HISTORY

PHILOSOPHY OF SECTION XI

The philosophy of Section XI is to mandate a sufficient number of examinations and tests (selected deterministically)to provide assurance that the original safety that was designed and built into the plant is maintained throughout it's service life.

L.J. Chockie (1975)
Chair, Section XI

BACKGROUND & HISTORY



BACKGROUND & HISTORY

Section XI Program – Two Loop PWR

(SECTION XI CODE WRITTEN AFTER PLANT WAS BUILT)

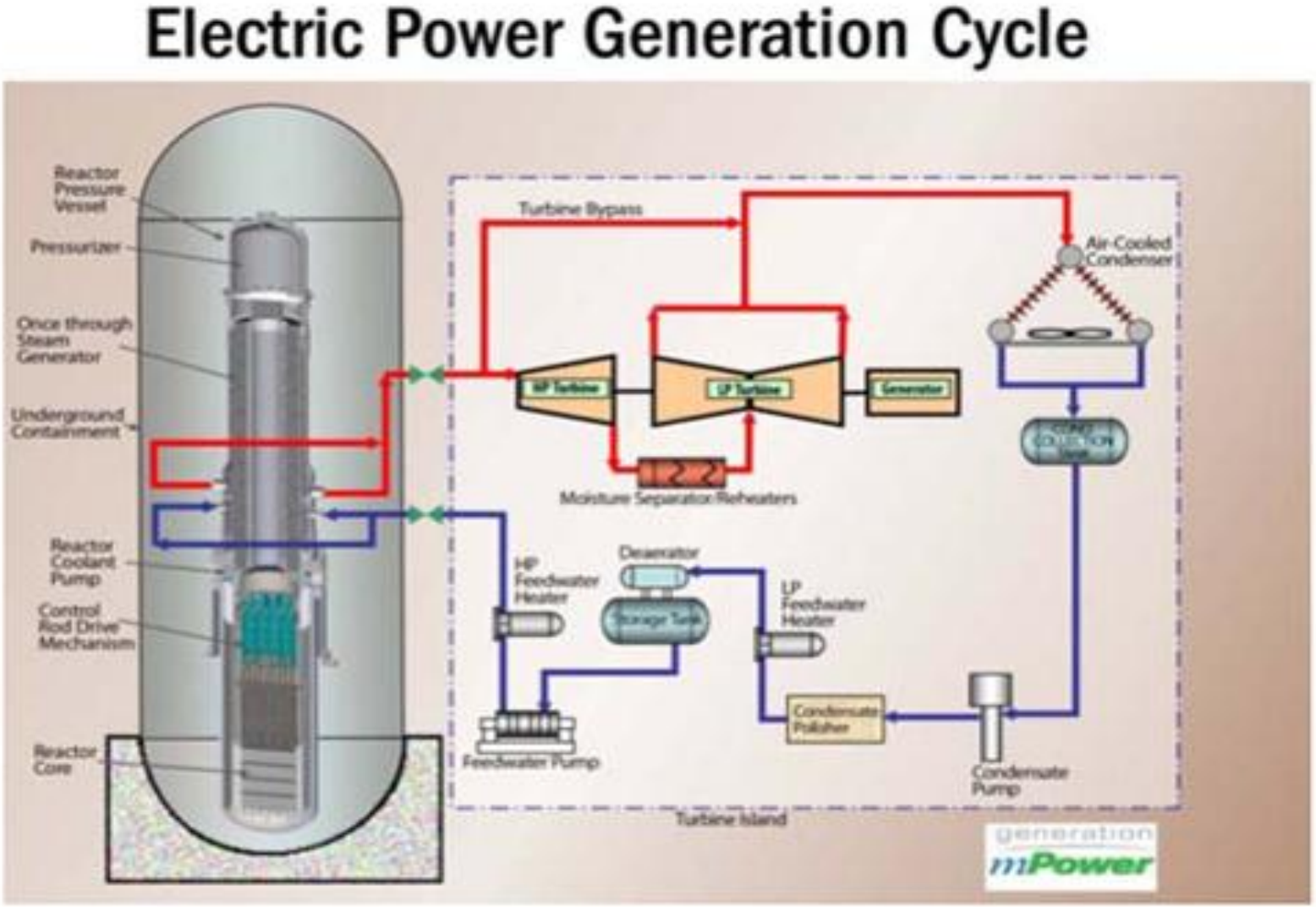
- Class 1 Exams Tests – 225

- Class 2 Exams & Tests – 450

- Class 3 Exams & Tests – 240

10 year Total - 915

BACKGROUND & HISTORY



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BACKGROUND & HISTORY

Section XI Program – Two Loop PWR

- Class 1 Categories
- BA Pressure Retaining Welds in Reactor Vessel
  BB Pressure Retaining Welds in Vessels Other Than Reactor Vessels
  BD Full Penetration Welded Nozzles in Vessels
  BF Pressure Retaining Dissimilar Metal Welds in Vessel Nozzles
  BG1 Pressure Retaining Bolting, Greater Than 2 in. (50 mm) in Diameter
  BG2 Pressure Retaining Bolting, 2 in. (50 mm) and Less in Diameter
  BJ* Pressure Retaining Welds in Piping

BACKGROUND & HISTORY

Section XI Program – Two Loop PWR

- Class 1 Categories (cont)
  - BK Welded Attachments for Vessels, Piping, Pumps, and Valves
  - BL2 Pump Casings BM2 Valve Bodies
  - BN1 Interior of Reactor Vessel
  - BN2 Welded Core Support Structures and Interior Attachments to Reactor Vessels
  - BN3 Removable Core Support Structures
  - BO Pressure Retaining Welds in Control Rod Drive and Instrument Nozzle Housings
  - BP All Pressure Retaining Components
  - BQ Steam Generator Tubing

BACKGROUND & HISTORY

Section XI Program – LWR SMR

- Class 1 Exam & Tests - < 100

  Major reduction in BJ Welds

  Reduction in BF Welds

  Reduction in Vessel Nozzles

  No CRDM Nozzles

- Question – Are the current deterministic requirements good enough for LWR SMR?

BACKGROUND & HISTORY

- May 2012 – Meeting with mPower
  - Issues

1. S/G tube sampling
2. Interval length
3. Use the Non-LWR PRA Standard
4. Current Division 1 (deterministic) may not provide adequate safety
5. Feedback to Design Phase to ensure reliability to meet operation & examination

BACKGROUND & HISTORY

- **Rewrite Criteria**
  - INTERNATIONALIZATION QUESTIONS
    - Limit use to only plants designed to Section III rules
    - Materials - Section II
    - NDE Performance Based qualifications (for procedure and personnel)
    - Quality assurance programs
    - Design to inspect - assume a variety of construction codes
    - Remove Regulatory Requirements

RIM (RELIABILITY AND INTEGRITY MANAGEMENT)

SYSTEM BASED CODE

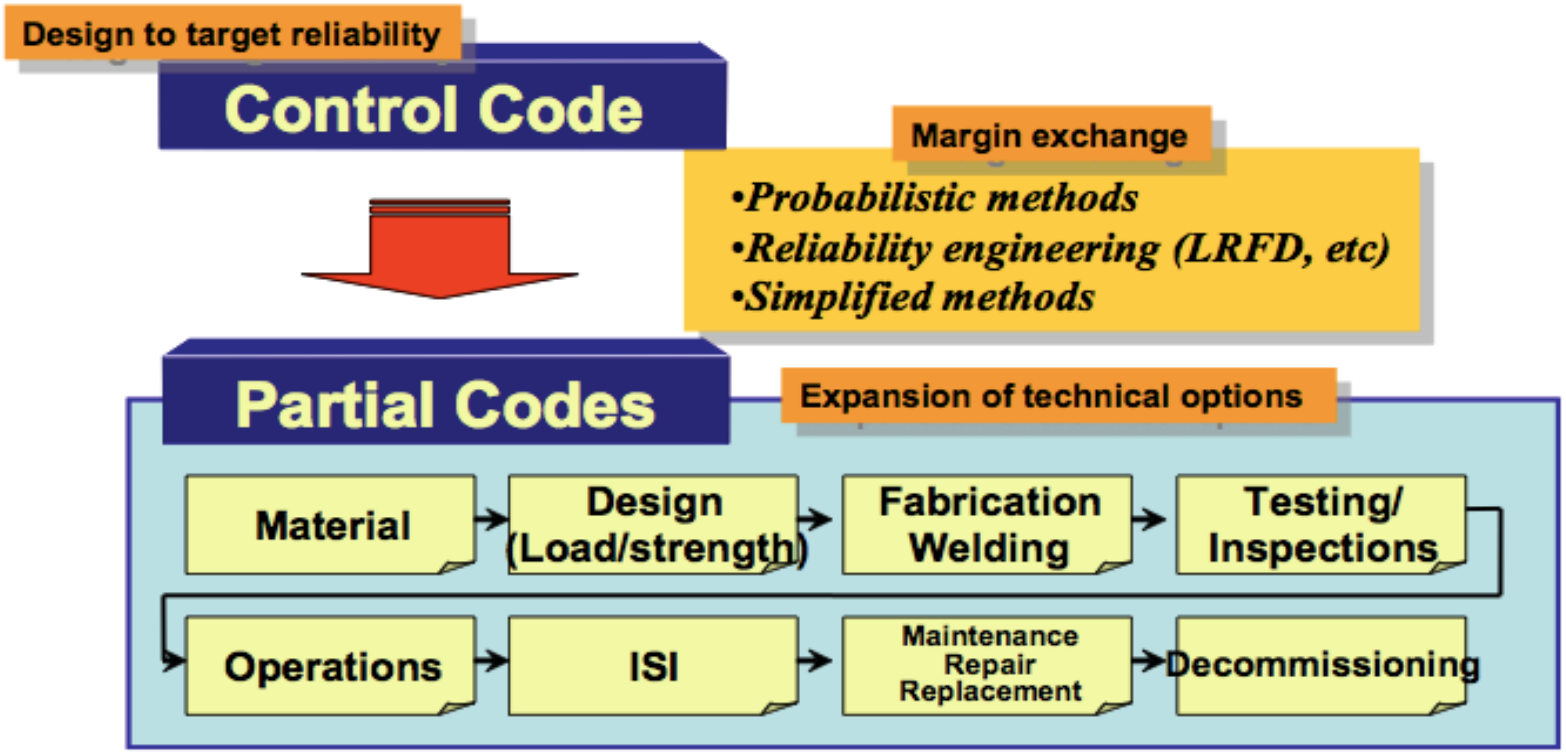
2004 – The idea was introduced by JSME

The key concepts are

- Designing to clearly defined target reliabilities for SSCs
- Life-cycle margin optimization, and
- Expansion of technical options as well as combinations of technical options beyond the current codes and standards.

RIM (RELIABILITY AND INTEGRITY MANAGEMENT)

SYSTEM BASED CODE



Partial codes encompass technical options available in current codes

Fig. 2.2.2 Structure of System Based Code

RIM (RELIABILITY AND INTEGRITY MANAGEMENT)

SYSTEM BASED CODE

(2) life-cycle margin optimization, and

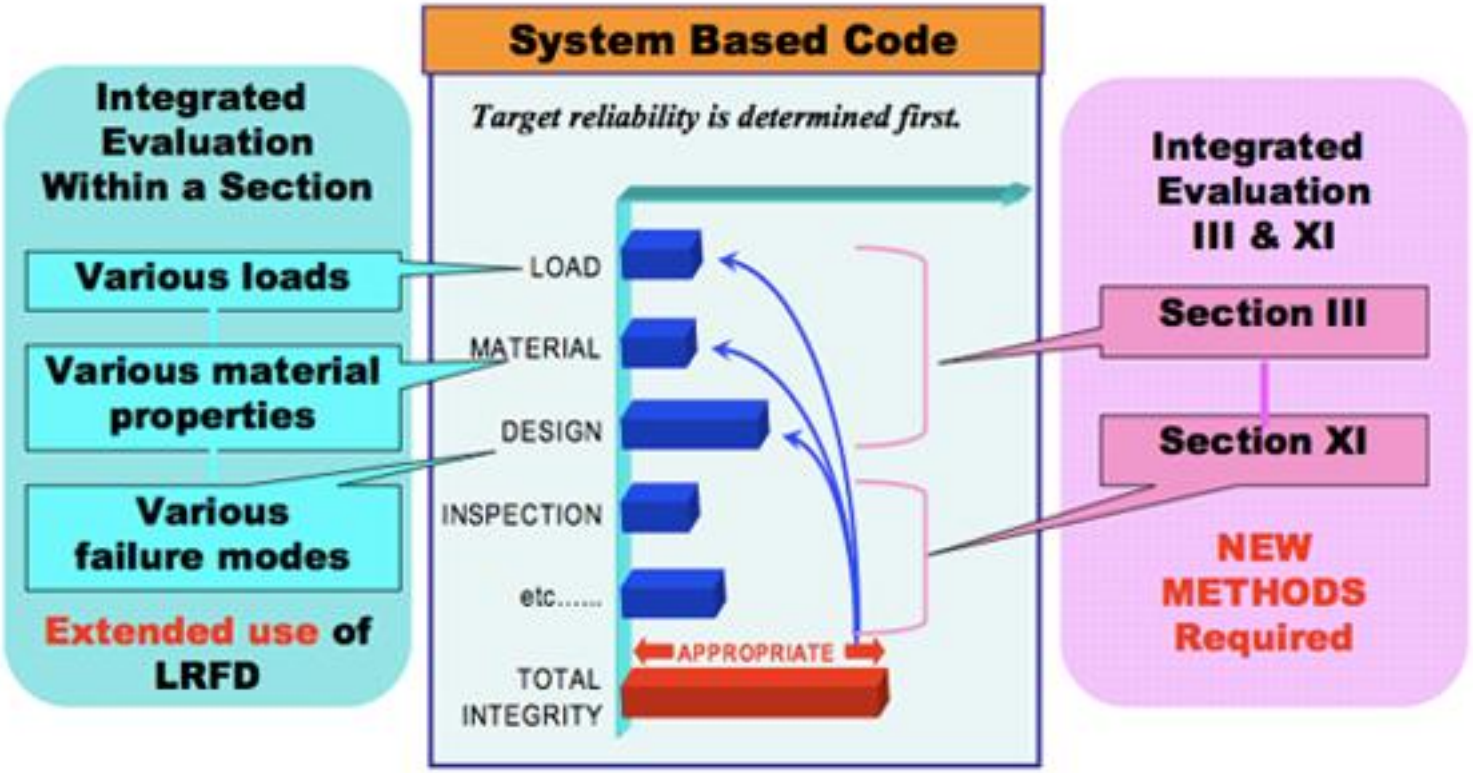


Fig. 2.2.3 Two major technologies to materialize the System Based Code Concept

RIM (RELIABILITY AND INTEGRITY MANAGEMENT)

SYSTEM BASED CODE

(3) **expansion of technical options as well as combinations of technical options beyond the current codes and standards.**

Focus of RIM Program, Section XI, Division 2

RIM (RELIABILITY AND INTEGRITY MANAGEMENT)

SYSTEM BASED CODE

Need for new PRA Standard

2006 – The Working Group Non-LWR PRA Standard created, including;

Design Element

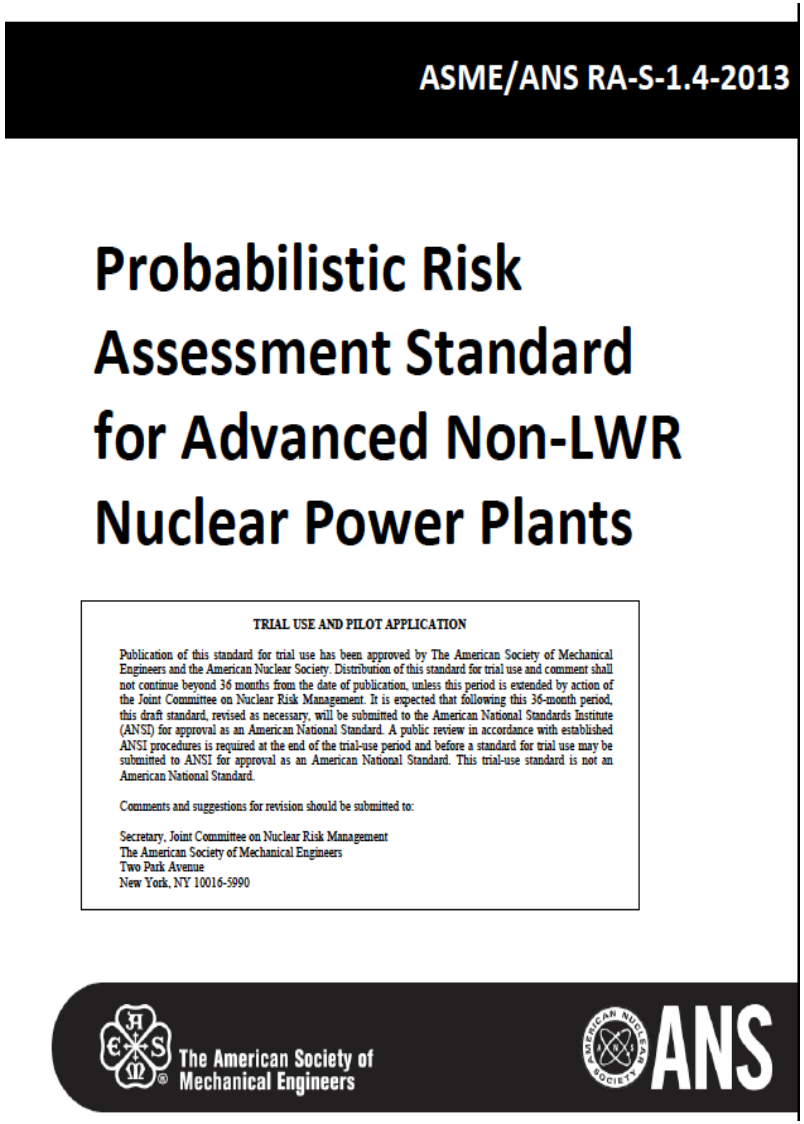
Level 1, 2, and 3 Elements

Multi-units

ISI & NDE Methods

2013 – **Non-LWR PRA Standard**, Approved for Trial-Use

RIM (RELIABILITY AND INTEGRITY MANAGEMENT)

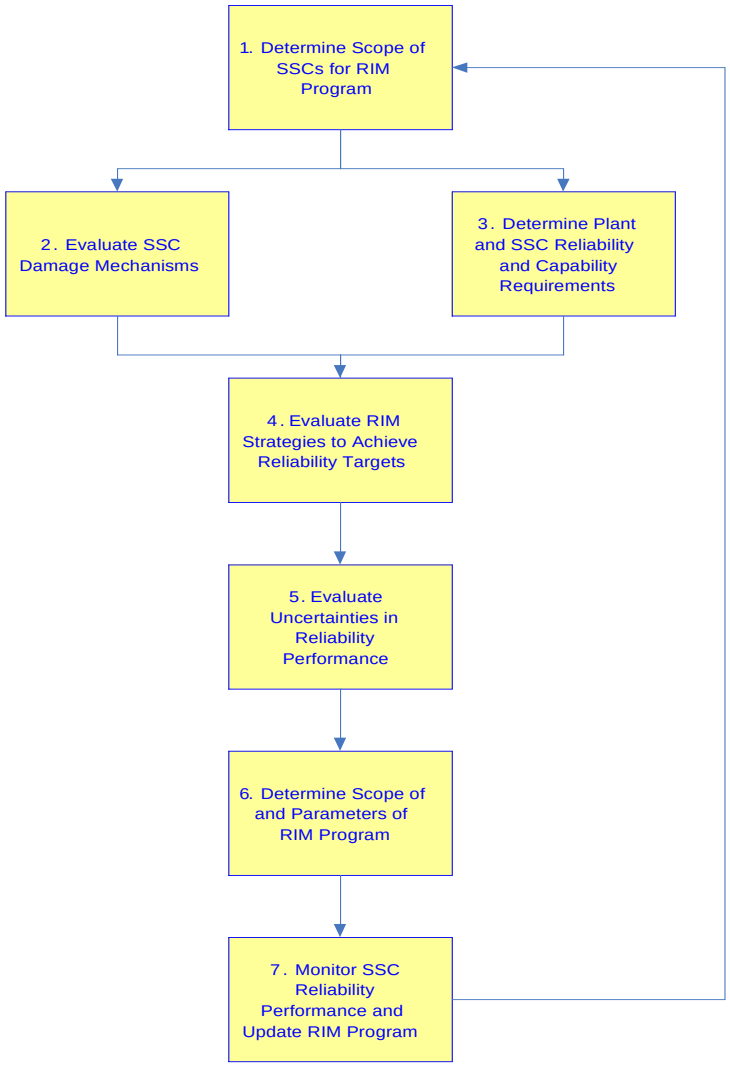


RIM (Reliability and Integrity Management)

- **Reliability and Integrity Management (RIM)**:

  Those aspects of the plant design process that are applied to provide an appropriate level of reliability of SSCs and a continuing assurance over the life of the plant that such reliability is maintained. These include design features important to reliability performance such as design margins, selection of materials, testing and monitoring, provisions for maintenance, repair and replacement, pressure and leak testing, and In-service Inspection (ISI).

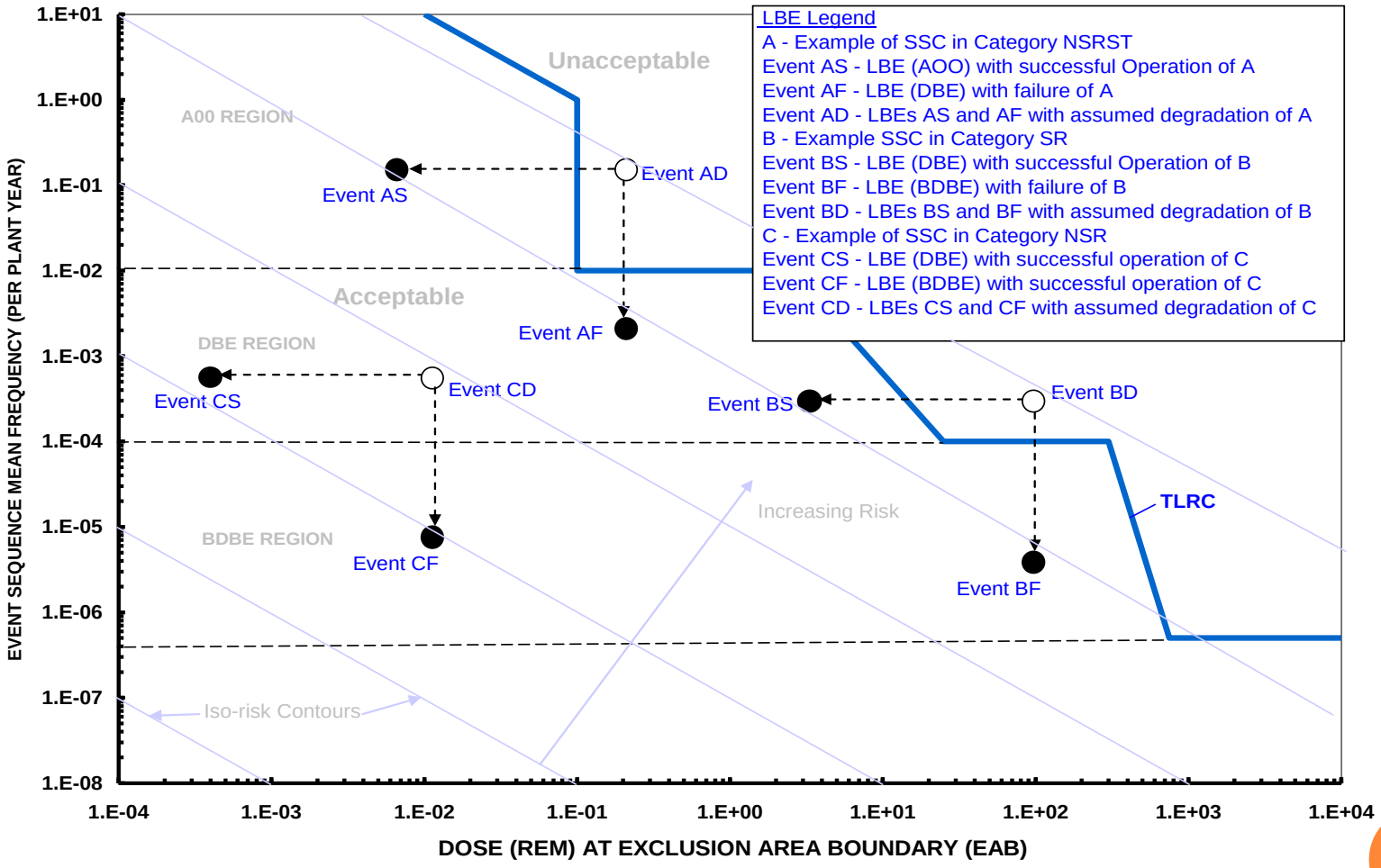
RIM (RELIABILITY AND INTEGRITY MANAGEMENT)



RIM (Reliability and Integrity Management)

- Step 1 Determine Scope of SSCs for RIM Program
- Step 2 Evaluate SSC Damage Mechanisms
- Step 3 Determine Plant and SSC Level Reliability and Capability Requirements
- Step 4 Evaluate RIM Strategies to Achieve Reliability Targets
- Step 5 Evaluate Uncertainties in Reliability Performance
- Step 6 Determine Scope and Parameters of RIM Program
- Step 7 Monitor SSC Reliability Performance and Update RIM Program

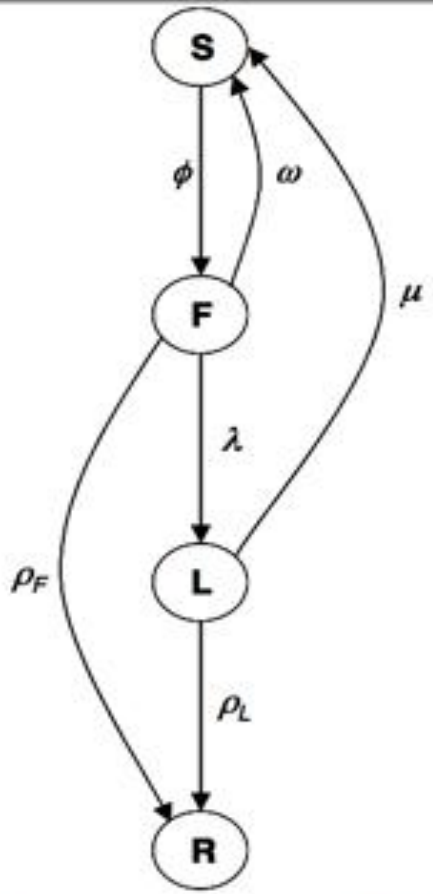
RIM (Reliability and Integrity Management)



RIM (Reliability and Integrity Management)

P B M R

MARKOV MODEL FOR EVALUATING INSPECTION STRATEGIES



Pipe Element States

S – success, no detectable damage
F – detectable flaw
L – detectable leak
R - rupture

State Transition Rates

ϕ – flaw occurrence rate
λ – leak failure rate
ρ_F – rupture failure rate given flaw
ρ_L – rupture failure rate given leak
ω – repair rate via ISI exams
μ – repair rate via leak detection

REWRITE STATUS

RIM Format

- RIM-1000 SCOPE AND RESPONSIBILITY
- RIM-2000 RIM PROGRAM
- RIM-3000 EVALUATION & STANDARDS
- RIM-4000 REPAIR/REPLACEMENTS
- RIM-5000 SYSTEM PRESSURE TESTS
- RIM-6000 RECORDS
- RIM-9000 GLOSSARY

REWRITE STATUS

RIM Format

APPENDICISES

1.Plant Type

- Water
- Gas
- Metal
- Salt

2.Mandatory

- Appendix I – TBD
- Appendix II – United States Administrative Requirements for Nuclear Plants Using the RIM Program

REWRITE STATUS

RIM Format

- Appendix III – Owner's Reports for RIM Program Activities
- Appendix IV – Qualification Program for NDE Personnel
- Appendix V – Catalog of NDE Examination Requirements and Areas of Interest
- Appendix VI – Decision Flow Charts

Conclusion

- NON-LWR PRA STANDARD (2013)
- PILOT RIM PROJECT COMPLETED
- NRC COMMENTS RESOLUTION
- PUBLISH RIM IN 2015 CODE EDITION