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MRP Reactor Internals Program Review

Dennis Weakland, *First Energy Corp., MRP Chairman*

Glenn Gardner, *Dominion, MRP RI Focus Group Chairman*

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June 21, 2007

NRC Headquarters

Agenda

Time	Item	Presenter
8:00 a.m.	Opening	NRC/NEI
8:05	Purpose and Objective of Meeting	Dennis Weakland, *First Energy Corp.*
8:15	Guidelines Context and Approach	Glenn Gardner, *Dominion*
8:45	Guidelines Outline and Contents	Glenn Gardner, *Dominion*
9:30	Break	
9:45	Inspection Standards Approach	Tom Alley, *Duke Energy*
10:45	Fleet Implementation	Glenn Gardner, *Dominion*
11:00	Discussion	All
11:45	Summary and Future Meetings	All
12:00	Adjourn	

Purpose and Objective of Meeting

Dennis Weakland

Purpose of Presentation

- *Request for SER of I&E Guidelines*
- *Guidelines Principles and Approach*
- *Outline of Guidelines and Contents*
- *Inspection Standards Approach*
- *Vision of Guidelines Implementation*

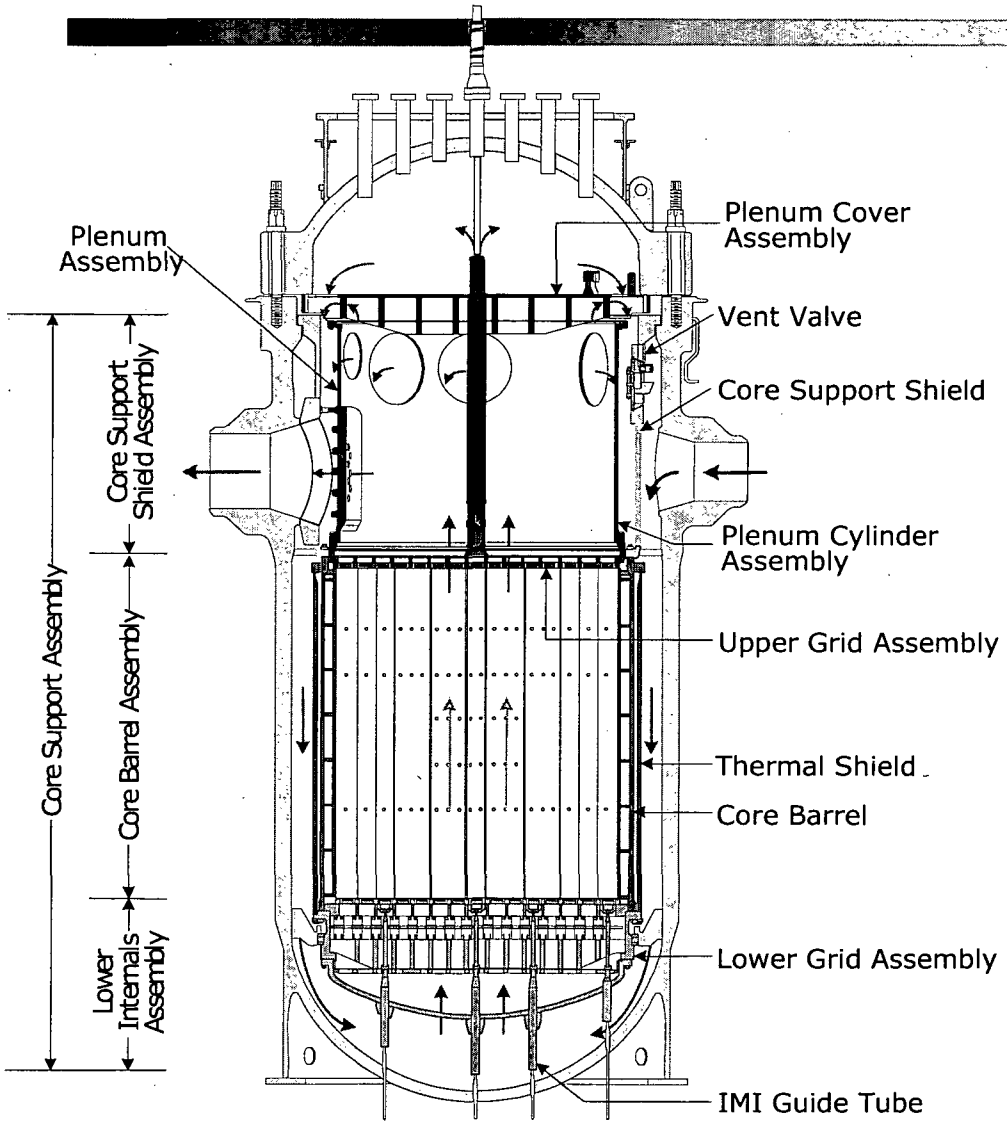
Request for SER on Guidelines

- In 2/23/07 meeting with NRC, suggestion that more NRC resources would be applied, and individual review efficiency would result
- An MRP decision to request SER was made and concurred by executives of PWR Materials Management Program (PMMP) on 4/23/07
- Guidelines will remain under NEI 03-08

Guidelines Context and Approach

Glenn Gardner

Internals Functions and Design



- **Support the core**
- **Direct the cooling flow**
- **Maintain reactivity control**
- **Structural support for other functions**

Aging Mechanisms in PWR Internals

- Stress Corrosion Cracking (SCC)
- Irradiation Assisted SCC (IASCC)*
- Wear
- Fatigue
- Thermal Aging Embrittlement (TE)
- Irradiation Embrittlement (IE)*
- Irradiation-induced Stress Relaxation (IR)* and Creep (IC)*
- Void Swelling (VS)*

* Require neutron fluence

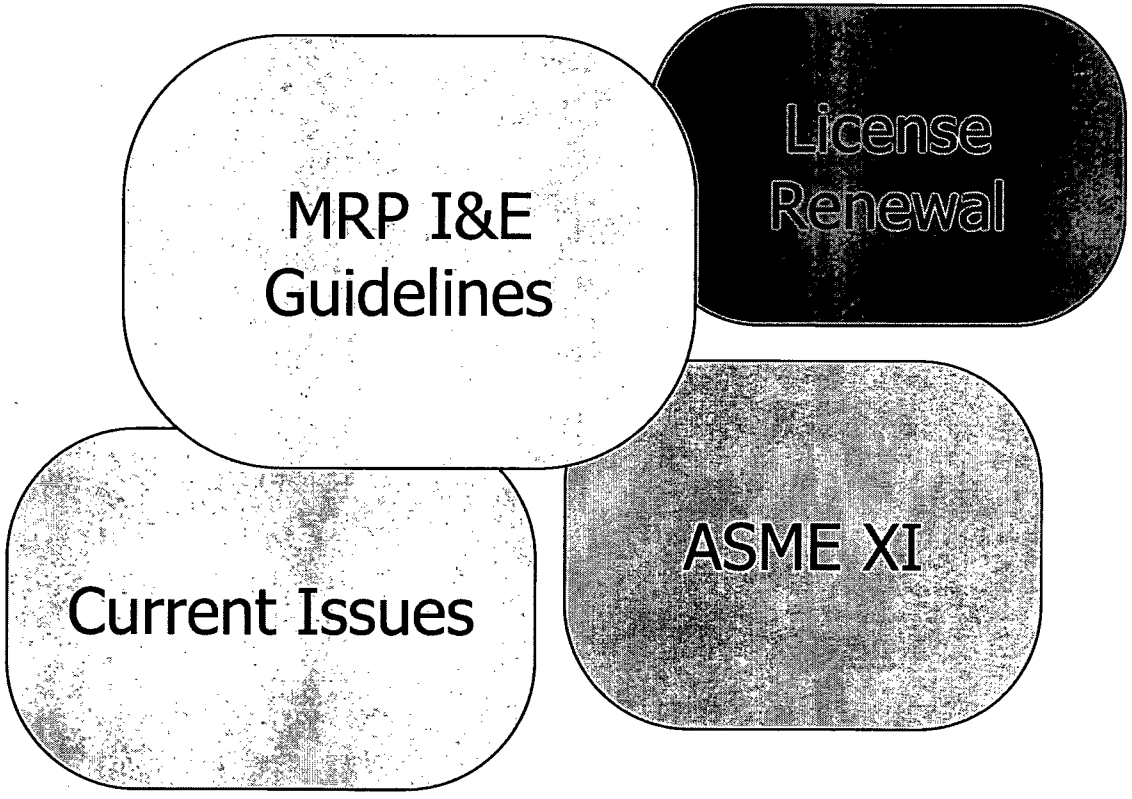
Aging Effects in PWR Internals

- Increased yield strength (beneficial)
- Reduced ductility
- Reduced fracture toughness
- Loss of preload

- Wear*
- Cracks*
- Distortion*
- Gaps*

* Potentially observable by NDE methods

Context of Guidelines



Guidelines applicable to all plants for both current and future terms

Current Issues / Operating Experience

- Flow induced vibration fatigue
- SCC of bolting and pins
- Wear
- IASCC of bolting

License Renewal Context

- Aging management reviews
- GALL Report
- Aging management programs
- Licensee commitments on reactor internals
- NRC approval of programs and inspection plans

MRP Approach to Aging and License Renewal - 1

- I&E guidelines for management of aging effects to maintain function
- *'Needed'* and '*mandatory'* elements to assure uniform implementation under NEI 03-08
- Guidelines have appendix describing how the 10 elements of an aging management program are implemented

MRP Approach to Aging and License Renewal - 2

- Guidelines have provisions for fleet-wide reporting and collective action
- MRP will develop a standard submittal for reactor internals inspection programs
- Guidelines are intended to provide the criteria and means to satisfy plant-specific commitments

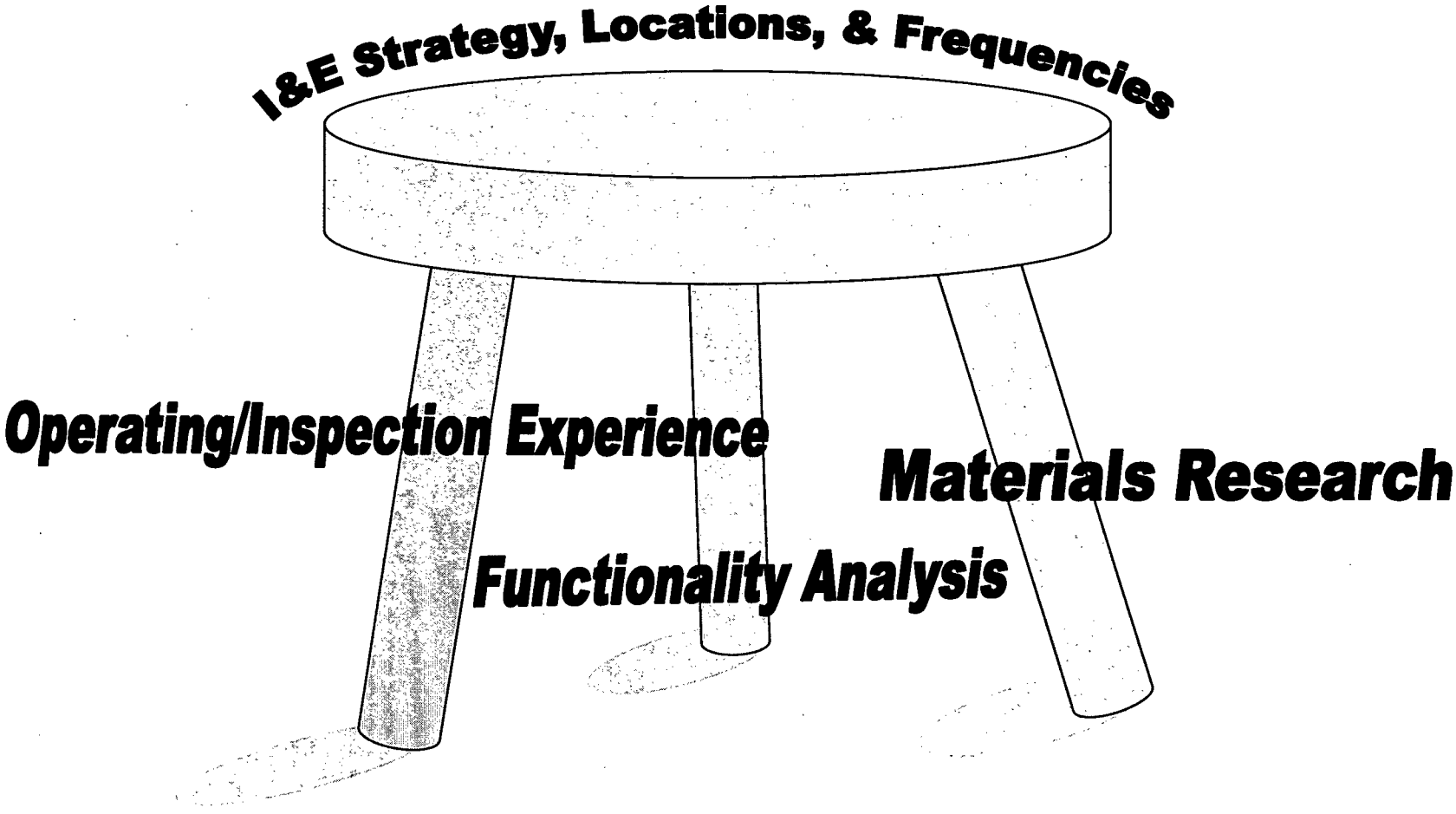
ASME XI Context

- ASME XI inspection rules apply only to removable core support structures
- IWB-2500 B-N-3 requires only VT-3
- ASME Code valuable reference for several examinations that go beyond VT-3
- Augmented internals inspections could be performed during an ASME vessel ISI or on a separate schedule as necessary

Principles of I&E Guidelines

- Maintain internals function and safety
- Long-term asset reliability and preservation
- Fleet-wide management of internals aging – effective information integration
- Consistent application in PWR fleet
- Periodic review and update of guidelines

Technical Bases for Guidelines



Aging Management Approach

- Use functionality analysis and operating/inspection experience to help guide timing and extent of inspections
- Leverage prior experience
- Monitor operating parameters
- Rely on existing ASME XI programs to the extent practicable

Collection/Assessment of Industry Experience

- Good aging management programs require continuing assessment of operating experience
- Since only outlier examples of degradation are expected initially, need to share individual experience with rest of fleet
- Best to have uniform MRP assessment of experience and its implications

- Results in periodic update of the Guidelines

Guidelines Outline and Contents

Glenn Gardner

I&E Guidelines Outline

1 – Executive Summary

2 – Introduction

3 – Component Categorization

4 – Inspection Strategies

5 – Inspection Acceptance Criteria

6 – Load Conditions for Evaluation

7 – Evaluation Methodology

8 – Summary of Requirements

9 – References

Appendix A – Aging Management Program Attributes

Section 2 – Introduction

- Includes a brief summary of past work (MRP-189, 190 & 191) including initial screening Categories A, B, C

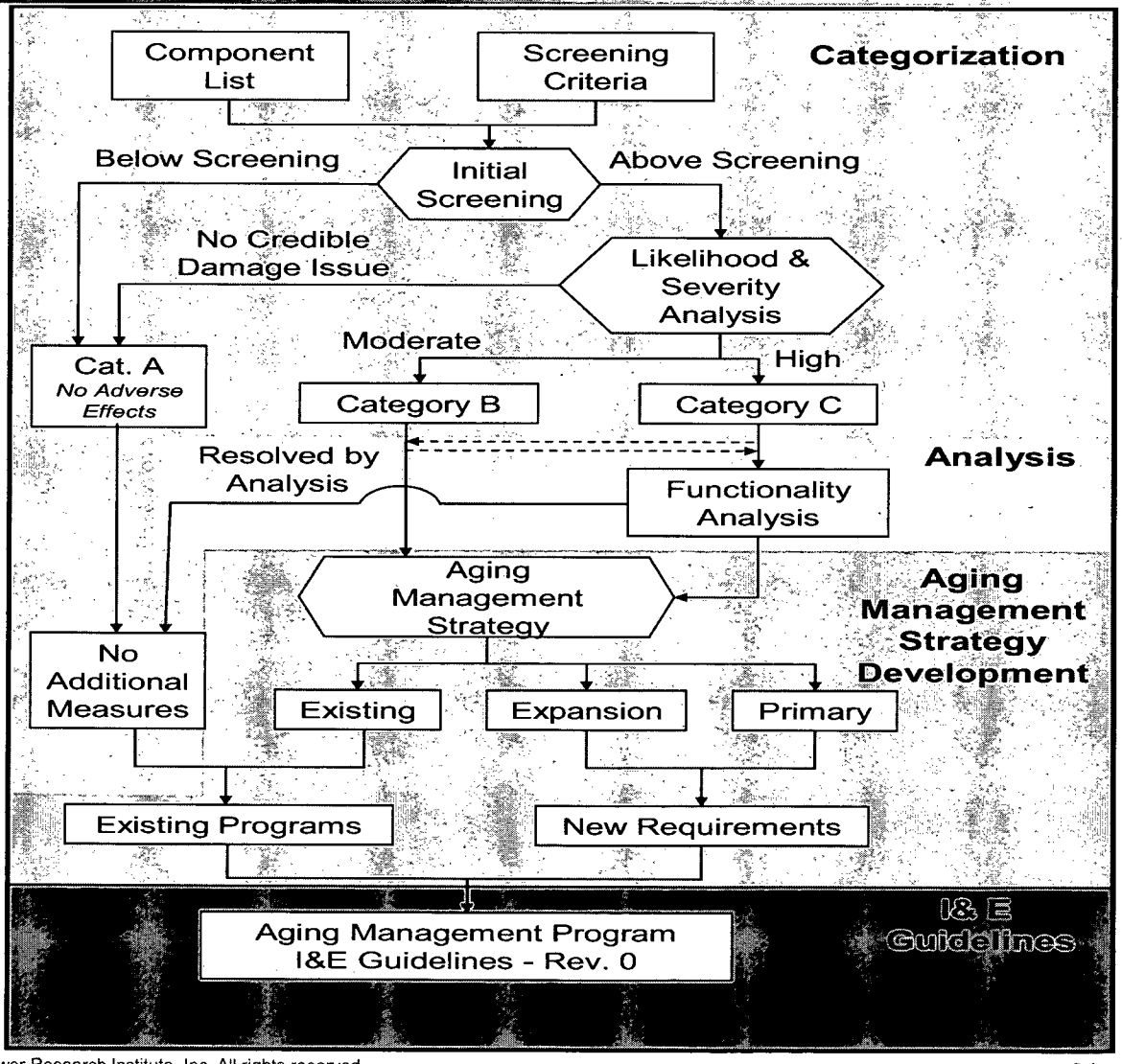
- Introduces the concept of Functional Categories
  - Concept going forward for the B and C components

- Summarizes Industry Materials Initiative Implementation requirements

Section 3 – Categorization

- Summarizes:
  - Common design characteristics of the PWR fleet
  - Screening criteria
  - Category definitions
  - Components functional categories

Draft Flow Chart



Section 4 – Inspection Strategies

- Describes the overall aging management strategy
- Describes the various examination methods:
  - Existing ASME Code Section XI visual examinations (VT-3)
  - Other visual, surface, and volumetric examination methods
  - Other aging management program elements such as monitoring and trending
  - Integrated industry program
- Provides component-specific tables of Primary and Expansion components for each NSSS vendor with examination requirements and cross references to acceptance criteria, functionality results, figures, etc.

Section 5 – Acceptance Criteria

- Provides component specific acceptance criteria for the inspection requirements for
  - Visual (VT-3) examinations,
  - Visual (VT-1) examinations,
  - Ultrasonic volumetric (UT) examinations of bolts
  - Eddy Current Testing (ET) for surface examinations

- Describes the requirements for determining reexamination intervals based on analysis

Section 6 – Load Conditions for Evaluation

Describes:

- Typical expected and unexpected loads that must be applied to internals component locations for any flaws exceeding acceptance criteria
- Typical corresponding loading combinations
- General requirements for stress analysis methods used for flaw evaluations
- Plant specific loading must be considered

Section 7 – Evaluation Methodology

- Describes various methodologies for evaluating flaws:
  - Limit load capacity demonstration
  - LEFM or EPFM assessment, depending on applicability

- Provides bases for:
  - Flaw depth in the absence of flaw depth sizing
  - Flaw growth during operation until the next examination
  - Considerations for uninspectable regions
  - Flaw proximity/combination
  - Allowable flaw size determination
  - Fracture toughness limits for evaluation methods

Section 8 – Summary of Requirements

- Summarizes NEI 03-08 needed and mandatory requirements for implementing the guidelines:
  - Formal PWR Reactor Internals Program
  - Inspection and other aging management
  - Acceptance criteria and evaluation of results
  - Reporting of results to MRP

Appendix A – Aging Management Program Attributes

- Discusses how the program meets the 10 attributes defined in the GALL
- Expected to serve as roadmap for NRC review of guidelines
- Other appendices may also be needed to document the bases for our requirements

Inspection Standards Approach

Tom Alley

Topics

- Objective
- Strategy
- Technical Justifications
- Inspection Standards Organization
- Draft Schedule

Objectives

- Provide reliable inspection techniques for components designated in the I&E Guidelines for Vessel Internals
  - Develop program in parallel with I&E Guidelines development
  - Participate in development of I&E Guidelines
  - Coordinate activities of Inspection ITG and Internals FG

Strategy

- Use existing techniques when possible
  - ET of Flux thimble tubes
  - UT of Baffle Former bolts
  - UT of Core Barrel bolts
  - Section XI VT examinations

- Document Inspection Standards in report organized similar to BWRVIP-03

- NDE techniques to meet ASME Section V, Article 14, Low rigor

Technical Justifications Requirements

- Meet ASME Section V, Article 14
  - Applicable degradation mechanism to be detected
  - Explain physics of inspection
  - Scope and limitations of procedure
  - Calibration
  - Essential variables
  - Determination of critical flaw to detect
  - Flaw detectability
  - Description of experiments & demonstrations
  - Field experiences and confirmed results

Implementation of TJs

- Must be approved by NDE Level III
- Reviewed and accepted by Owner (Inspection ITG)
- Applicable Authorized Inspection Agency
  - Consider 'global' review by ANIIs
  - Reduce individual site reviews
- 3rd party (EPRI)
  - EPRI to publish report similar to BWRVIP-03
  - Document TJs that have been accepted
  - Document demonstrations, if applicable
  - Reference vendor procedure qualification records and/or technical justifications

Strategy for Inspection Standards

- Evaluation of potential NDE techniques
  - Review vendor procedure qualification records and/or technical justifications (TJ)
    - If acceptable document in Inspection Standards report
  - If procedure qualification necessary then:
    - Develop qualification program protocol based on I&E Guidelines inputs
    - Fabricate qualification blocks
    - Qualify procedure by demonstration
  - Develop NDE techniques and equipment, if necessary and qualify procedure
- Document process

Inspection Standards

- Publish living document similar to BWRVIP-03
  - NDE program for Primary and Expansion components
  - Update as necessary

- For each component
  - Code exam, demonstration requirements and/or summary of TJ
  - Document essential variables from demonstrations
  - Document results - reliability or capability of NDE or TJ

Bolting Demonstration Status

- Reviewed EPRI reports and vendor procedure qualification records and/or technical justifications (baffle-former)
  - Satisfied that records are acceptable
  - Need to summarize them and incorporate into Inspection Standards
  - Need to review other bolting UT techniques for incorporation
- Core Barrel Bolts
  - Cooperating with Duke to design mockups
  - Fabricating to EPRI QA program
  - Plan to fabricate bolts with flaws
  - Conduct demonstrations

Visual Examinations

- Provide recommendations concerning scanning speed, lighting, field of view, etc.
- Document technical justifications for use of
  - VT-1
  - VT-3
- Evaluate accessibility of components
- Will consider BWRVIP lessons learned

Examples of Potential Inspections

- Core support to core barrel bolts (UT)
- Lower Grid assembly to core barrel bolts (UT)
- Baffle to former bolts or screws (UT)
- Flow distributor to lower grid shell forging bolts (UT)
- Fuel alignment pins of the lower support (UT)
- Thimble tube (ET)

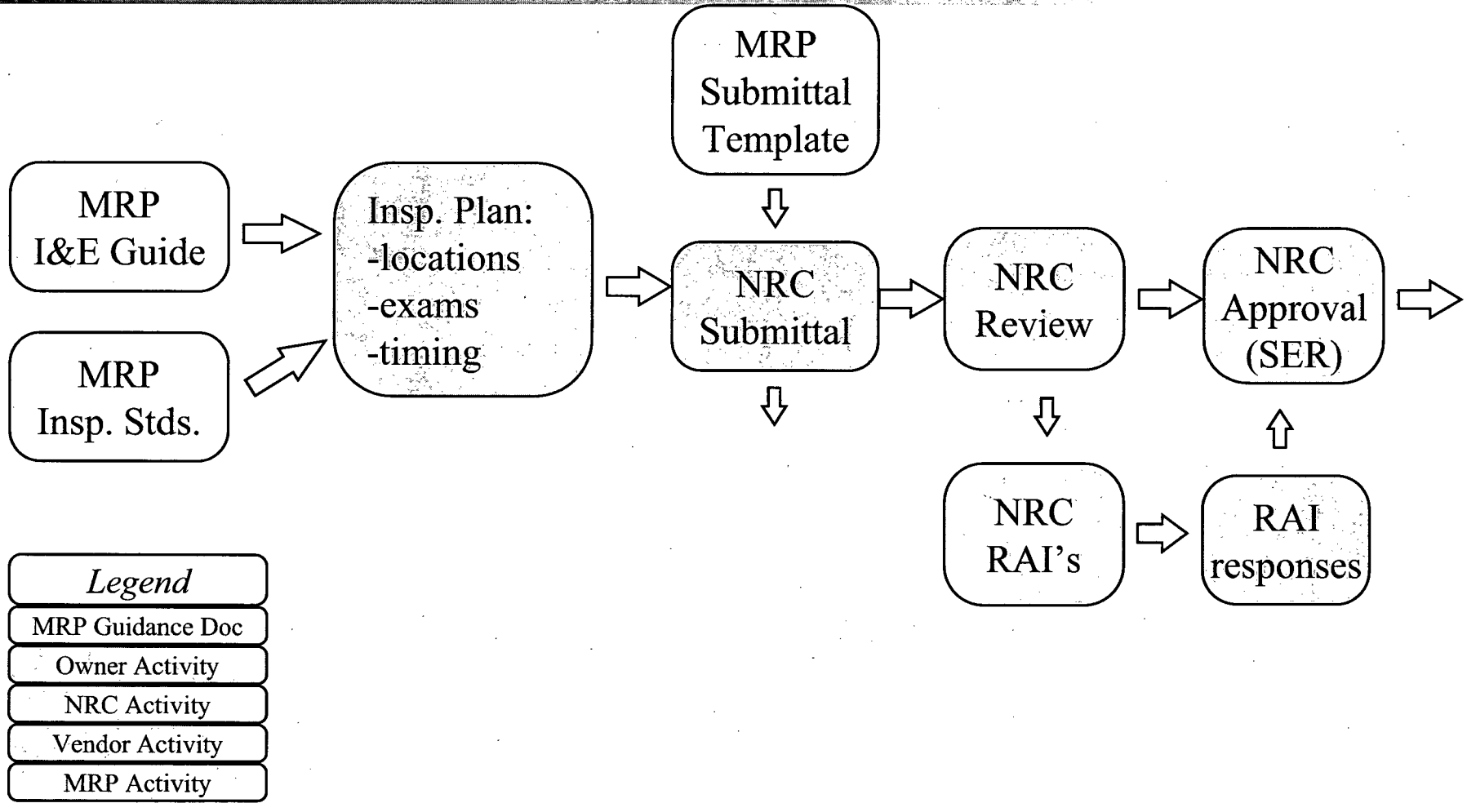
Draft Schedule

Review Baffle Bolt UT	March – April 2007
Develop Core Barrel UT qualification program	April – September 2007
Draft Inspection Standards	December 2007
Complete activities for other components	September 2007- October 2008
Complete Inspection Standards	December 2008

Fleet Implementation

Glenn Gardner

Implementation of I&E Guidelines - Preliminary



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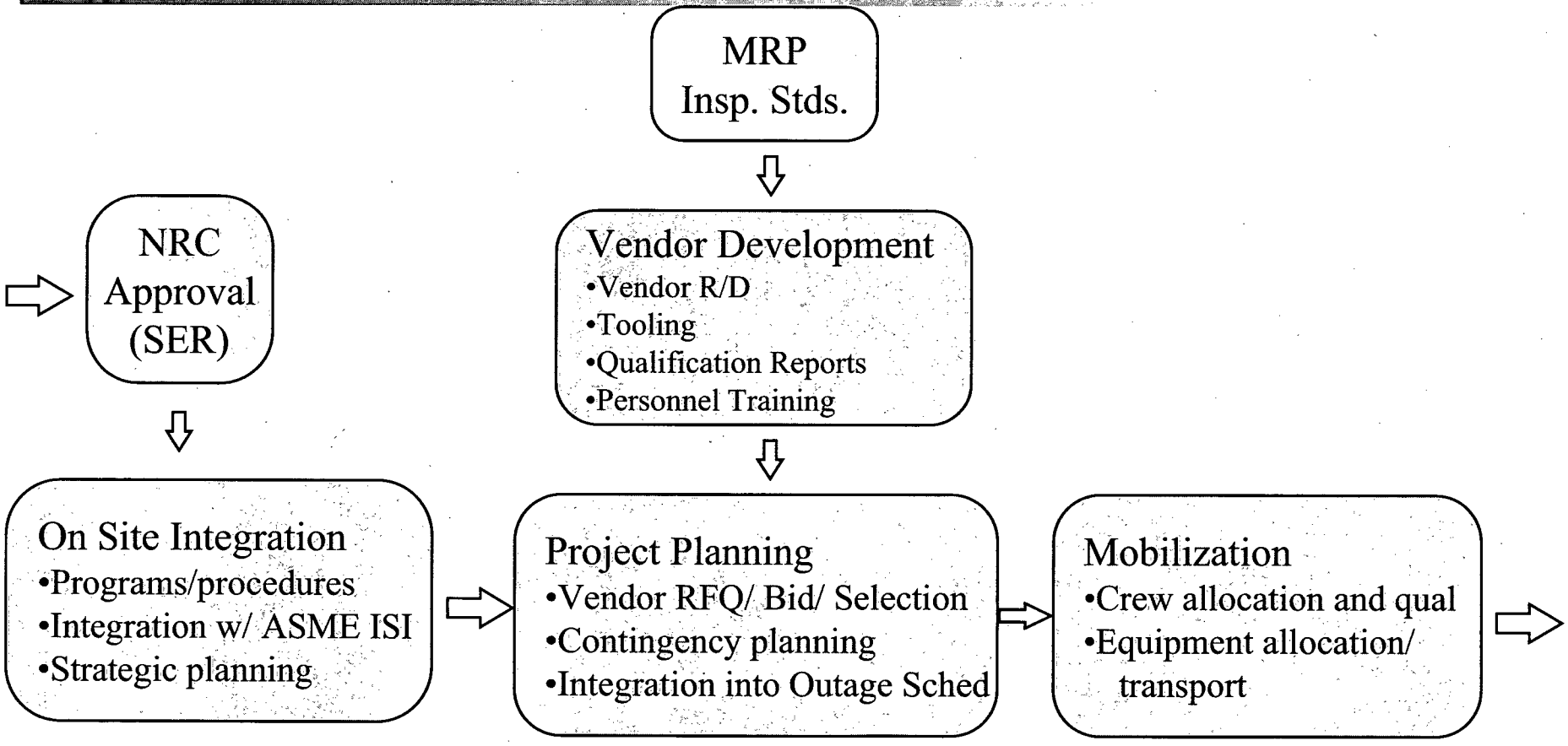

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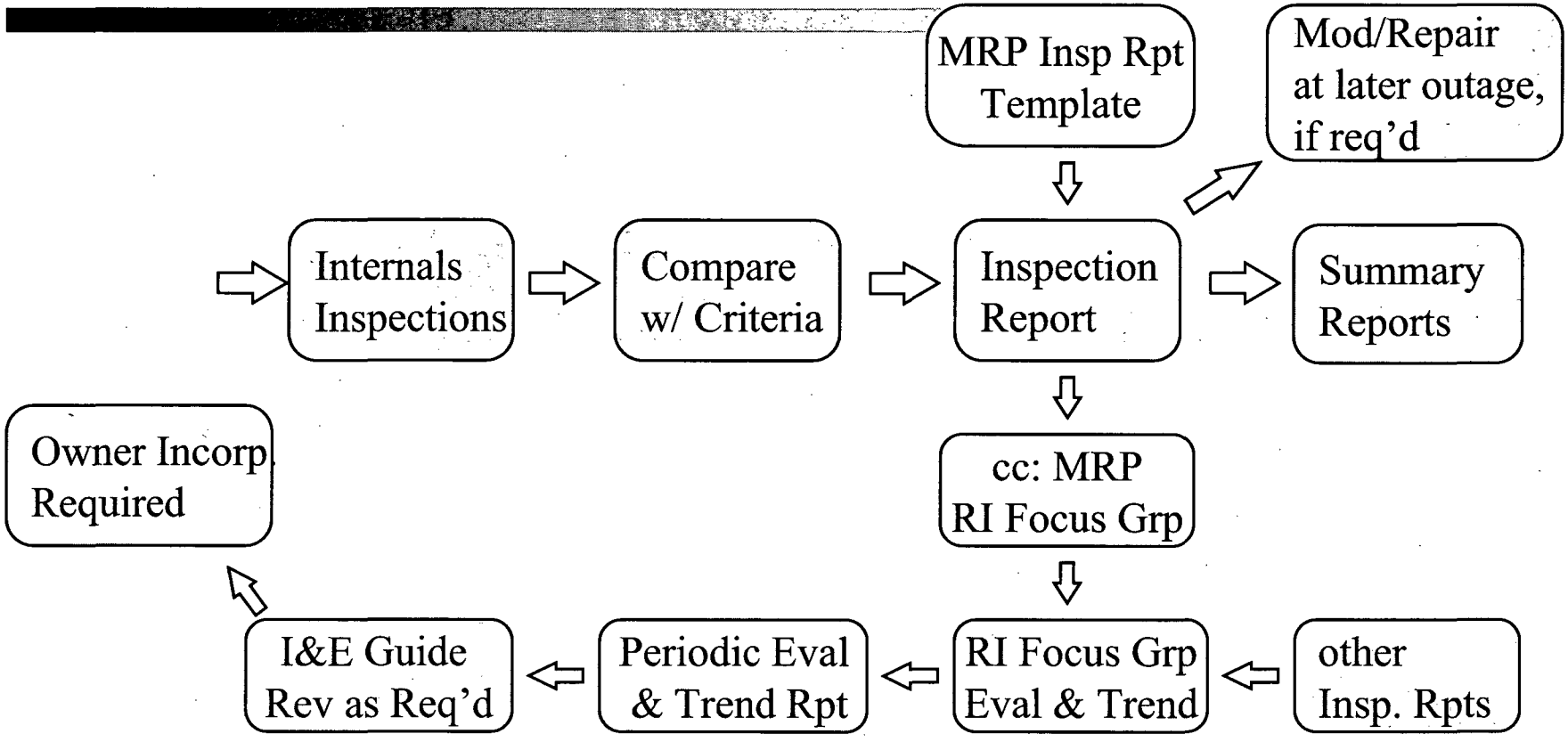
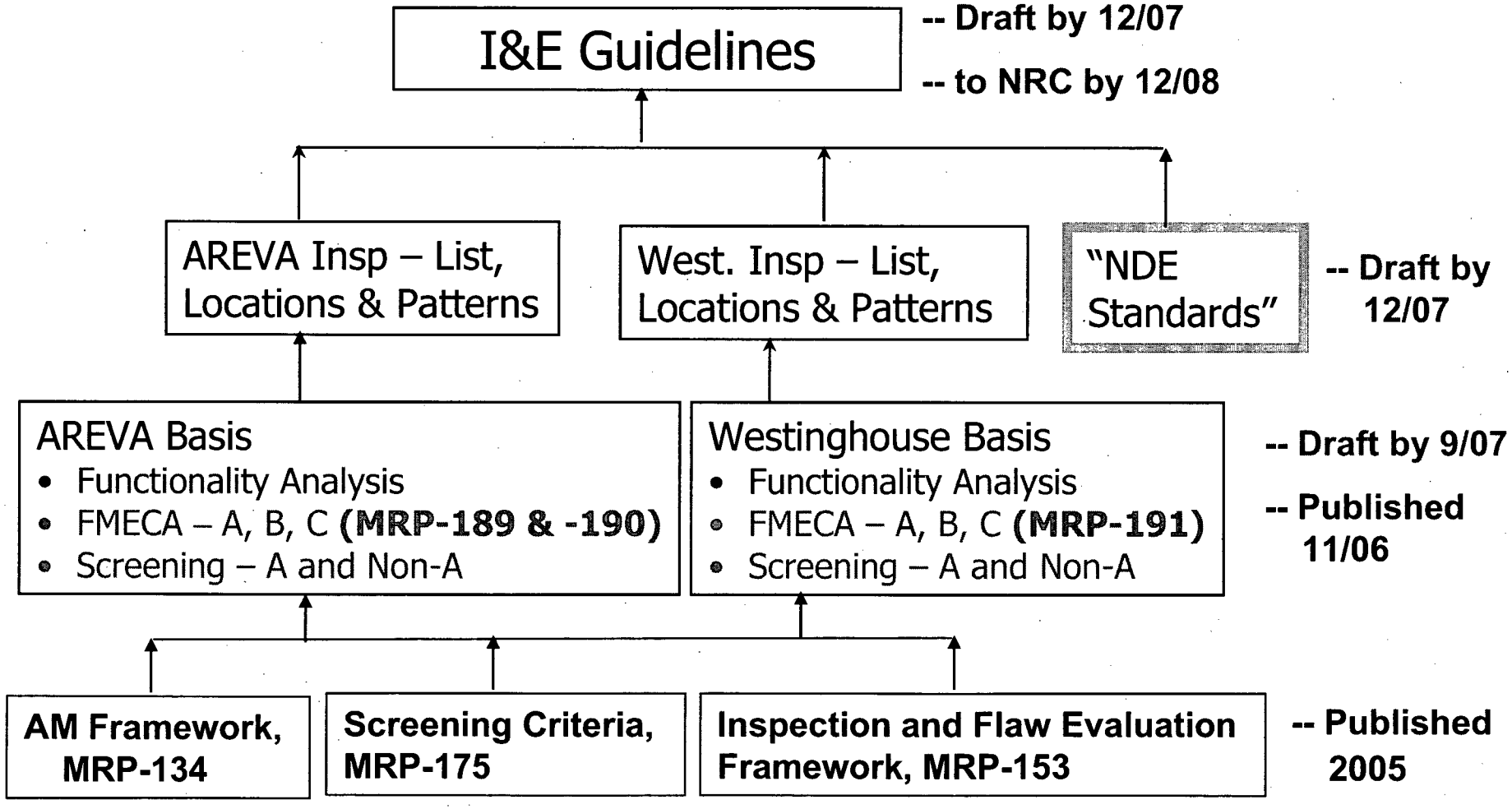


Discussion

Summary and Future Meetings

I&E Guidelines Schedule and Milestones



Future NRC/RI-FG Meeting Plan

- November 2007
  - Functionality Analysis Results
  - Inspection Strategy
  - I&E Guidelines Including Inspection Methods and Qualification
  - I&E Guidelines Support of License Renewal Commitment
- 2008
  - Standard Aging Management Program Submittal

Thank you!