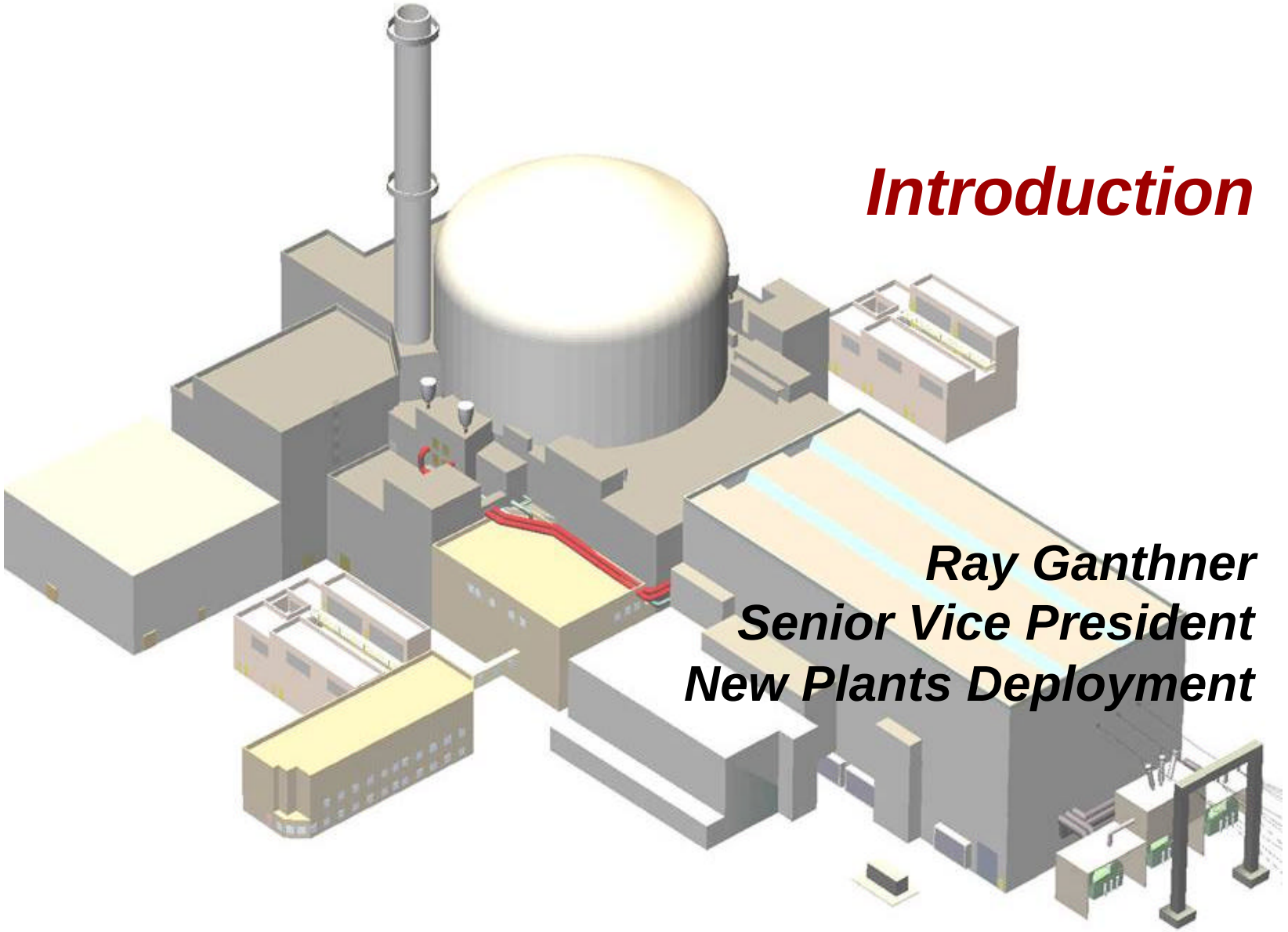
EPR Pre-Application Review Meeting: Design Process and Design Timeline for the U.S. EPR

Framatome ANP and the NRC
February 23, 2006

Introduction



Ray Ganthner
Senior Vice President
New Plants Deployment

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Meeting Objectives

- To provide an update on the status of the EPR
- To describe the overall design process and design schedule for the U.S. EPR
- To discuss the proposed approach for resolution of process and design issues in three specific areas:
  - Piping
  - Instrumentation and controls (I&C)
  - Human factors engineering (HFE)

Outline

- Overview of the Design Process and Design Timeline for the U.S. EPR (Sandra Sloan)
- Piping Design Process and Schedule (Tom Crom)
- I&C Design Process and Schedule (Vic Fregonese)
- Human Factors Engineering Design Process and Schedule (Vic Fregonese)
- Summary and Next Steps (Sandra Sloan)

Update on the Status of the EPR

- Constellation Energy awards contract to AREVA for technical support of COL application referencing the U.S. EPR
- U.S. design conversion progressing
  - 30 Systems Requirements Documents
  - 27 P&IDs
  - 10 System Design Descriptions
- International EPR licensing activities continue, including Finland and France
- Construction continues in Finland

Olkiluoto 3: January 2006

Construction of the winter shelter

Olkiluoto 3: January 2006

Inside the winter shelter

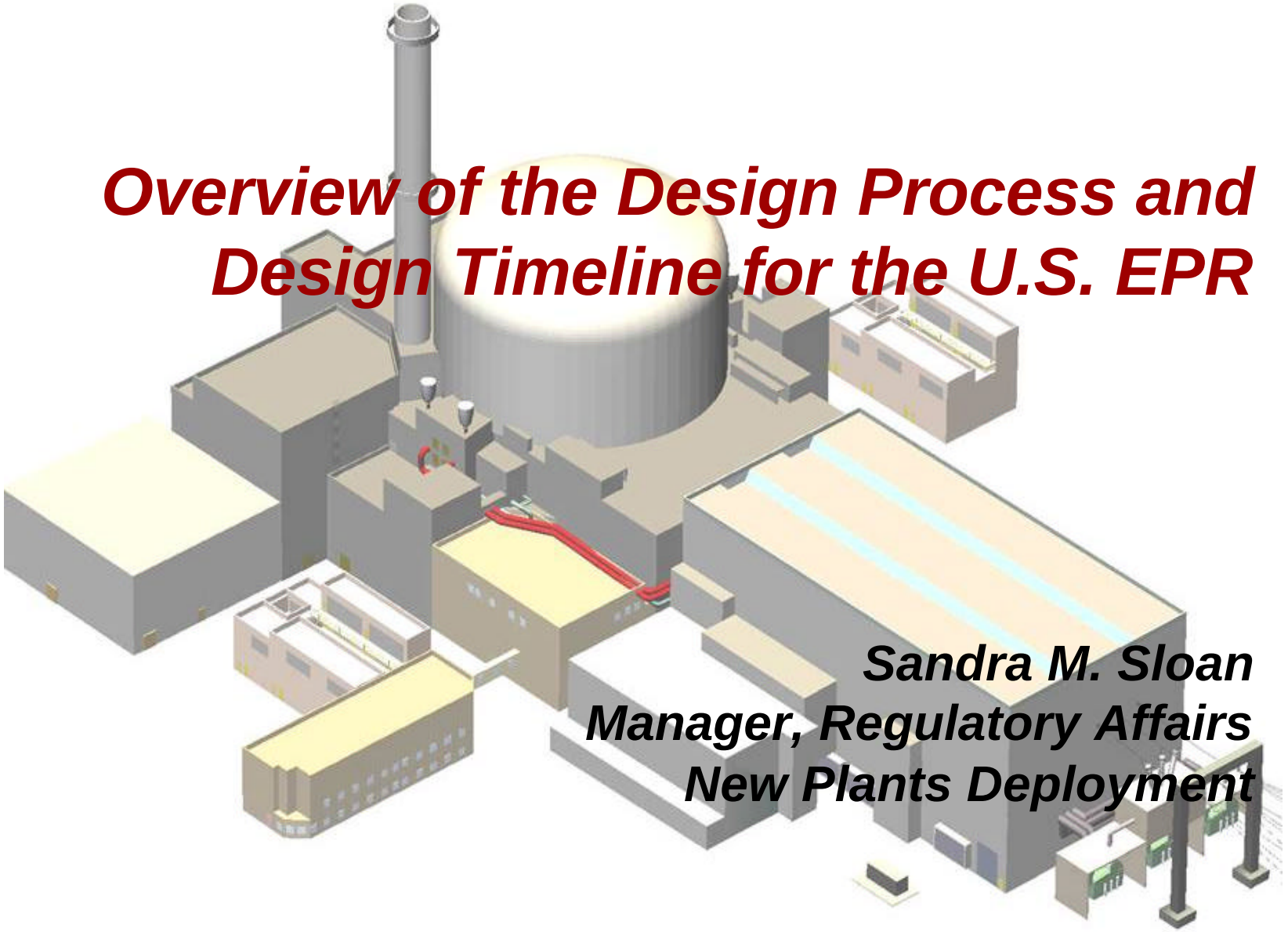
Olkiluoto 3: February 2006

Panoramic view of site showing winter shelter

February 2006

OL3 I&C cabinet #1

Overview of the Design Process and Design Timeline for the U.S. EPR

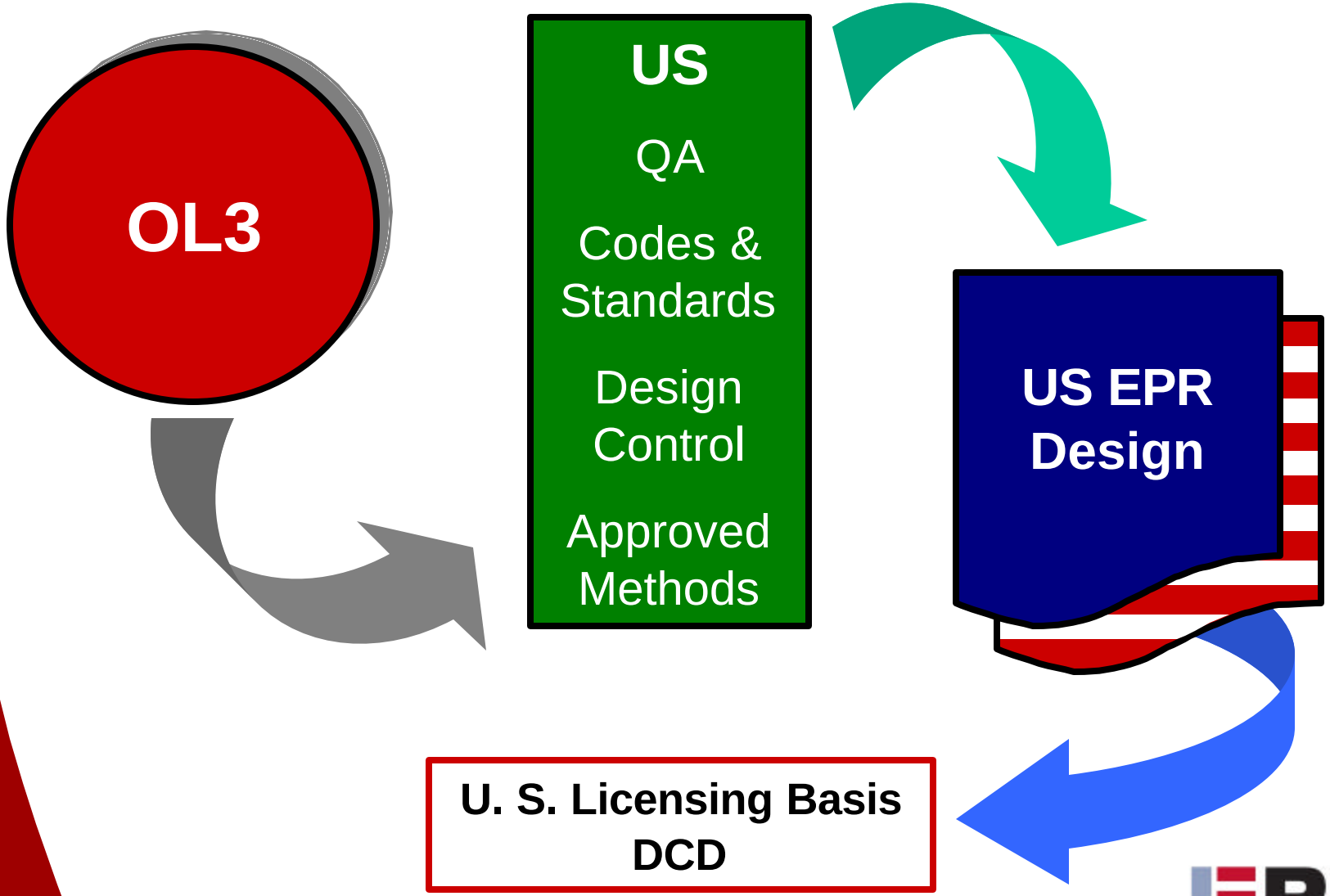


Sandra M. Sloan
Manager, Regulatory Affairs
New Plants Deployment

U.S. EPR Design Process Fundamentals

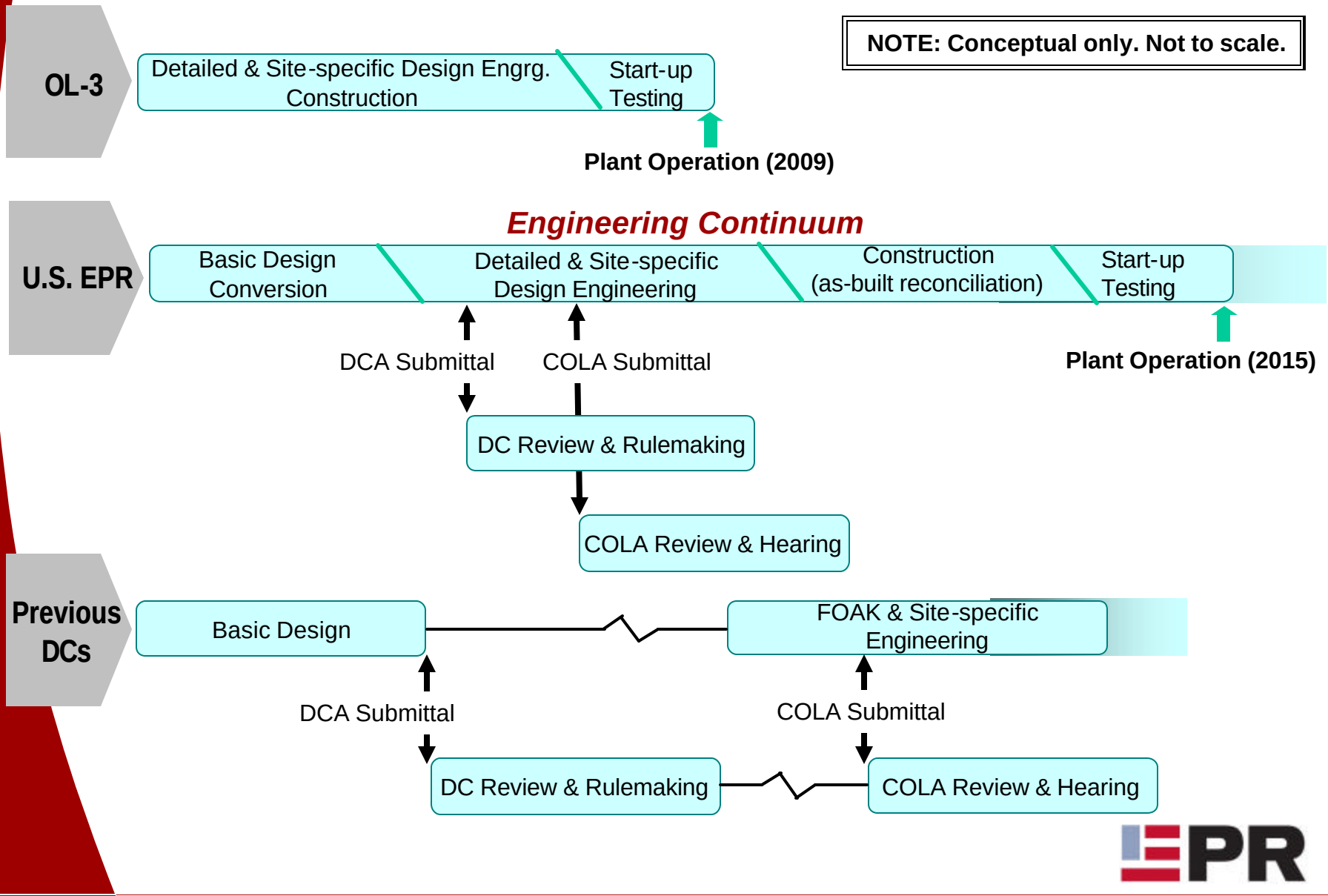
- The "reference plant" for the U.S. EPR design is Olkiluoto-3 (OL3)
- Systematic process is being applied to prepare the reference plant design for U.S. deployment
  - Complete conversion to U.S. design codes & standards
  - Compliance with NRC regulations and QA requirements
  - Use NRC-approved computer codes and methods for safety and fuel analyses
- With OL3 as major input, the U.S. EPR is proceeding through the normal phases of design, engineering, procurement, and construction

EPR Design Conversion



Design Process Timeline

NOTE: Conceptual only. Not to scale.



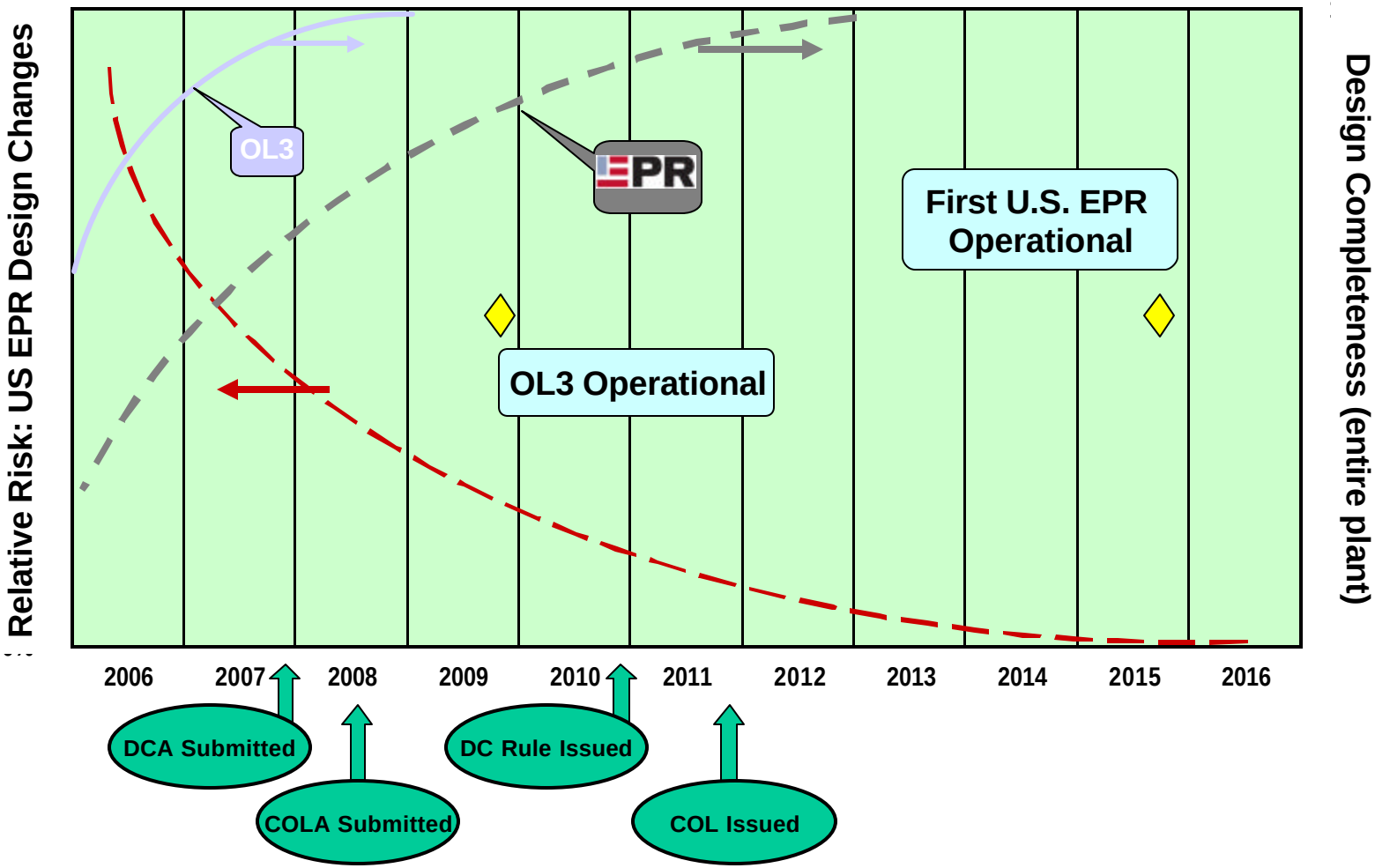
Previous Uses of Design Acceptance Criteria (DAC)

- Typically applied in areas of rapidly changing technology or design areas for which as-built or as-procured information is not available at the time of DCD submittal
- Consist of analysis methods, performance tests, and inspections, in lieu of design detail (design development process)
- Relationship of DAC and ITAAC
  - DAC are used to verify that a system was designed in accordance with the agreed-upon design process
  - ITAAC are used to verify that the system is built and will operate in accordance with the requirements

U.S. EPR Design Process and Verification Approach

- The goal is to set a high threshold for DAC in the U.S. EPR design certification
- FANP proposes to address process and design issues for the U.S. EPR during the design certification review
- The U.S. EPR is uniquely positioned for this approach
  - First-of-a-kind engineering for reference plant (OL3) will be completed prior to submittal of the DCA
  - Detailed engineering for U.S. EPR will continue uninterrupted as basic design is completed

Completeness and Finality of Design



The maturity of the reference plant design gives confidence in the completeness and finality of the U.S. EPR.

Proposed Strategy for Resolution of Process and Design Issues

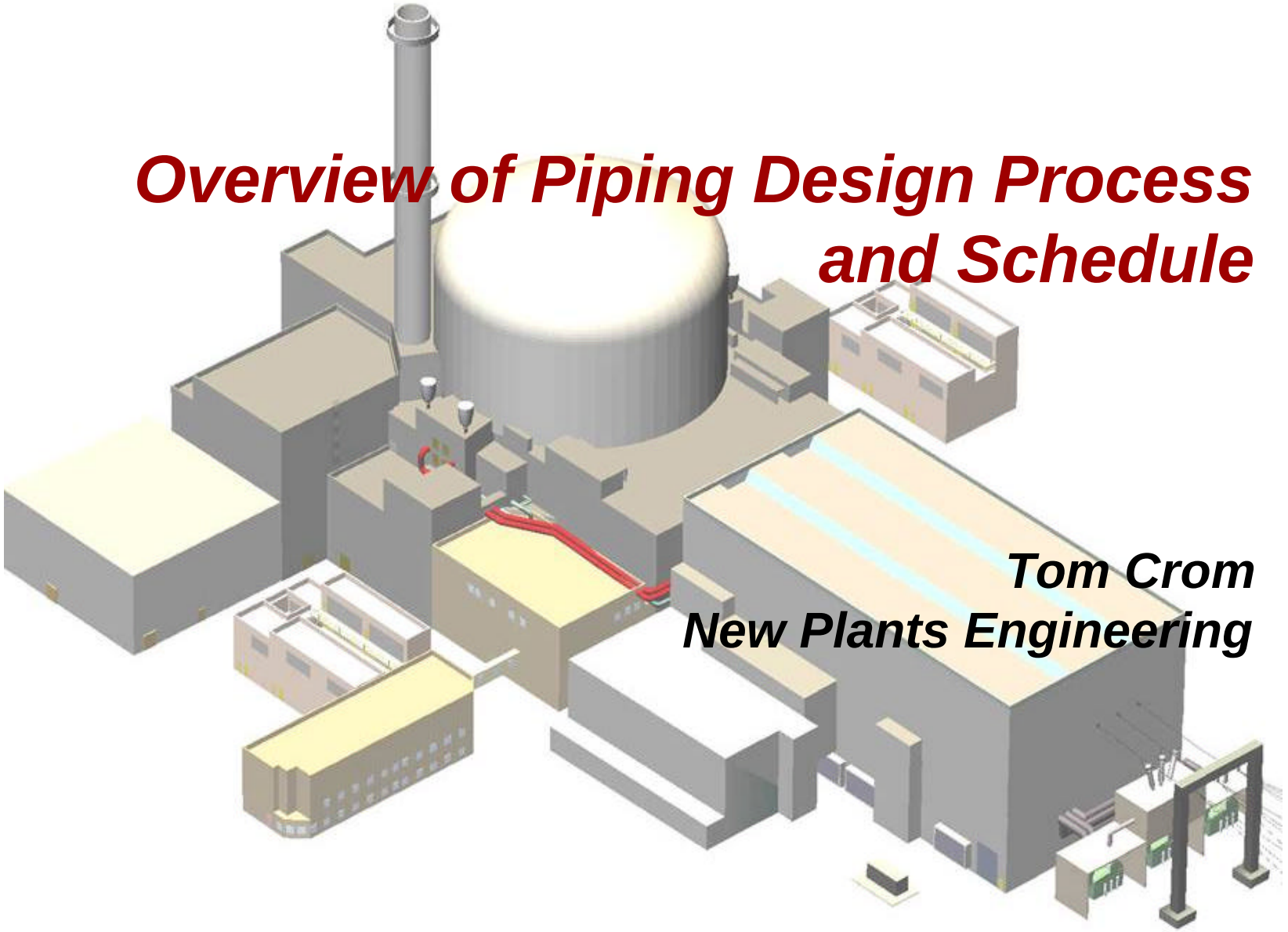
- Early submittal of design process descriptions for piping, I&C, and human factors (3Q CY 2006)
  - Request NRC approval by 1Q CY 2007
- Define level of design completion and detail required to close out design issues during the DC review (2Q CY 2007)
- Submittal of DC application in December 2007 (without DAC)
- NRC verification of design process elements and implementation (CY 2009)
- Translate remaining design verification activities to ITAAC or DAC (prior to FDA) for final version of DCD

This process would be applied for detailed piping analysis, I&C design, and human factors engineering.

Key Process Elements

- Early agreement on design process requirements
- Early agreement on level of design completion and detail required to close out design issues during the DC review
- DCD content (December 2007 submittal)
  - Tier 1 contains ITAAC (no DAC)
  - Tier 2 descriptions consistent with previous DCDs
- Resolution of design process elements and implementation during the DC review
  - Submittal of topical reports on design process/procedures
  - NRC review of activities and documentation related to detailed design
- Any remaining design verification and reconciliation activities incorporated into ITAAC if possible, otherwise limited DAC, in final version of DCD

Overview of Piping Design Process and Schedule

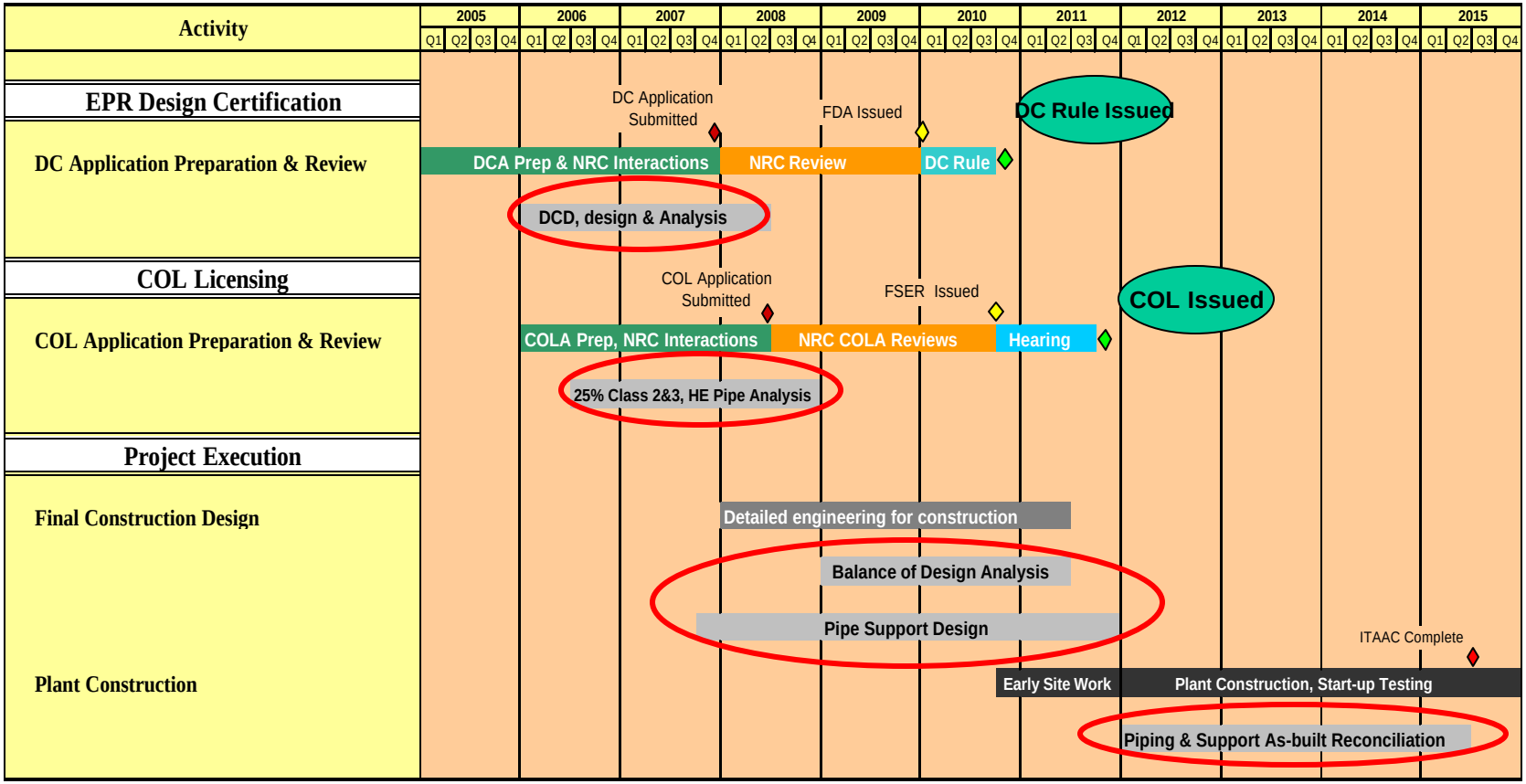


Tom Crom
New Plants Engineering

Topics

- Timeline for Piping Design and Analysis
- DCD Piping Information
- Documentation Available at DCA Submittal
- Piping Design and Analysis at COLA Submittal
- Piping Analysis Post-COLA Submittal
- Relationship of U.S. EPR Piping Design to OL3

Timeline for Piping Design and Analysis



DCD Piping Information

- **Tier 1: Inspection, Testing, Analysis and Acceptance Criteria (ITAAC)**
  - **Piping classes 1, 2 & 3 comply with requirements of ASME Section III Code including fatigue analysis**
  - **Structures, systems and components required for safe shutdown are protected from the dynamic and environmental effects of postulated pipe breaks**
  - **As-built piping is reconciled with the design configuration/analysis**
- **Tier 2:**
  - **Address requirements in SRP 3.6, 3.7, 3.9 & 5.2 related to piping**

Documentation Available at DCA Submittal

- Included in DCD (Tier 2)
  - Piping stress analysis criteria
    - Classifications versus codes/standards requirements
  - Piping support/restraint design requirements
  - Piping analysis procedures
    - Analysis methods
    - Modeling techniques
    - Piping analysis computer codes
  - Summary of leak-before-break (LBB) methodology and scope
- LBB analysis (reactor coolant system (RCS), surge line, and main steam line)
- Class 1 primary stress analysis of the RCS main coolant loop and surge line
- Class 2&3 piping analysis for one train of main steam, feedwater, emergency feedwater, safety injection, component cooling and steam generator blowdown

Piping Design & Analysis Status at COLA Submittal

- Class 1 piping analysis ongoing
- Class 2 & 3 piping
  - 20% - 25% of piping (≥ 2”) will be qualified per code requirements
  - Support/restraint designs completed
  - Break locations identified with initial whip/jet restraints located and designed

Piping Analysis Post-COLA Submittal

- **Class 1 piping**
  - **RCS piping (including surge line)**
    - **Transient and fatigue analysis**
    - **Stratification analysis (surge line)**
  - **Attached piping and supports**
    - **Structural, stress and fatigue analysis**
    - **Stress analysis of supports**
  - **LBB topical reports completed and submitted for separate NRC review for ITAAC closure**
- **Class 2 & 3 piping and supports**
  - **Remainder of design and analysis will be completed to support construction schedule**

Reference Plant (OL3) Status at DCA Submittal

- **Piping specification complete**
- **Piping design & layout complete**
  - **U.S. EPR piping design starts with OL3 design layout**
- **Piping analysis complete**
  - **U.S. EPR analysis performed to similar code requirements and seismic input as that of OL3**

OL3 vs. U.S. EPR
Piping Analysis - Codes

- **OL3 (RCC-M) vs U.S. EPR (ASME III)**
  - **Class 1 – RCC-M requirements similar to ASME III**
    - **RCC-M allowables are same as ASME III, upset conditions are treated as normal conditions**
    - **RCC-M simplified elasto-plastic fatigue calculations are different from ASME**
  - **Class 2 & 3 – RCC-M equivalent to ASME III – 1980, no addenda**
    - **Stress equations nearly identical for all load cases**
    - **RCC-M allowables are more conservative for design, upset and faulted conditions**

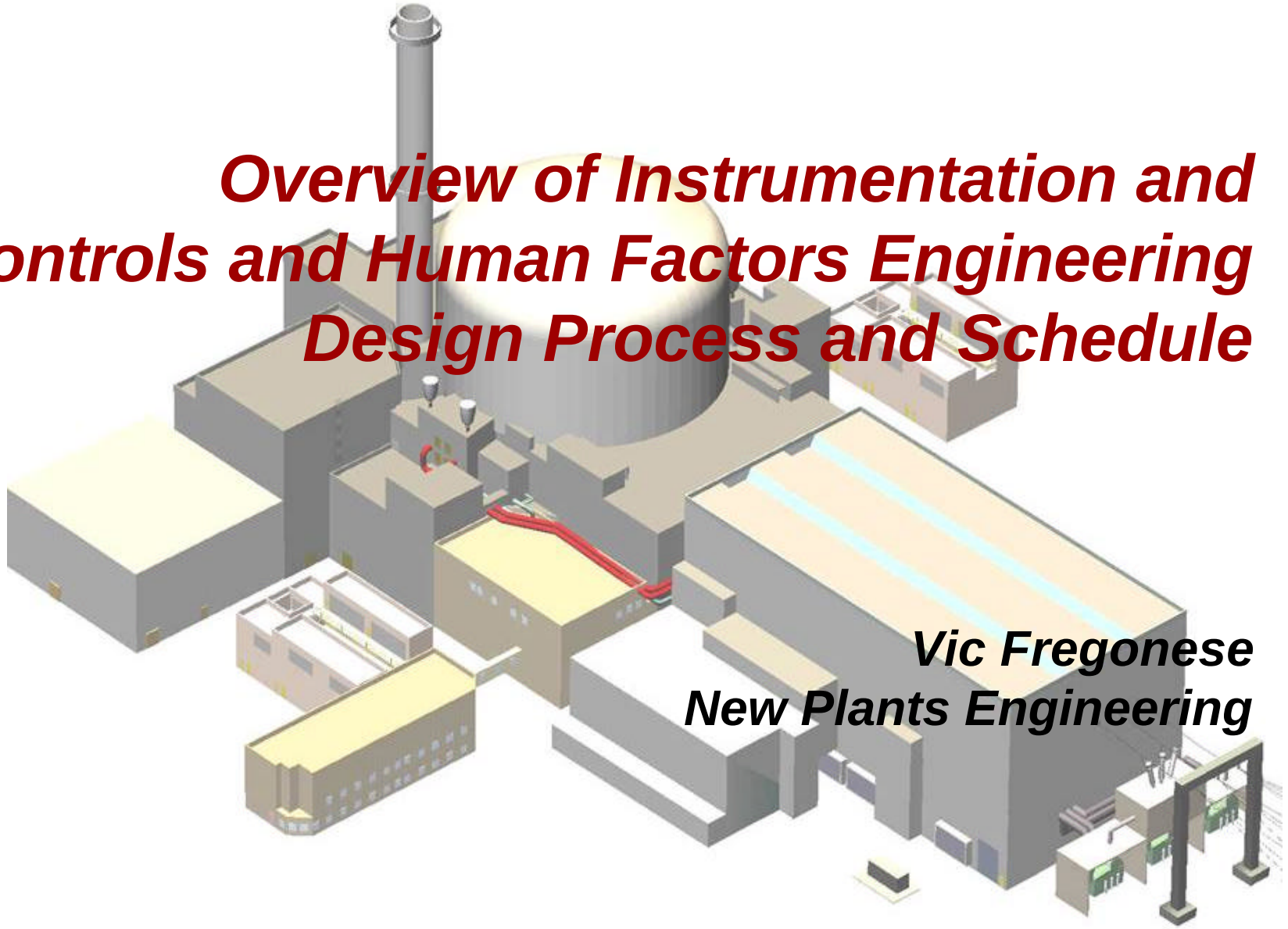
U.S. EPR will meet ASME III and 10 CFR 50.55a.

OL3 vs. U.S. EPR
Piping Analysis - Seismic

- OL3 piping analyzed to envelope spectra developed from peak ground accelerations of 0.1g rock and 0.25g EUR
- U.S. EPR piping analyzed to spectra developed from peak ground accelerations of 0.3g EUR
- U.S. EPR model for development of floor spectra benchmarked against OL3 model
- U.S. EPR layout, support/restraint location & type and piping analysis results are not expected to be significantly different from those of OL3

Similarity of code and seismic requirements for OL3 provides confidence in U.S. EPR design.

Overview of Instrumentation and Controls and Human Factors Engineering Design Process and Schedule



Vic Fregonese
New Plants Engineering

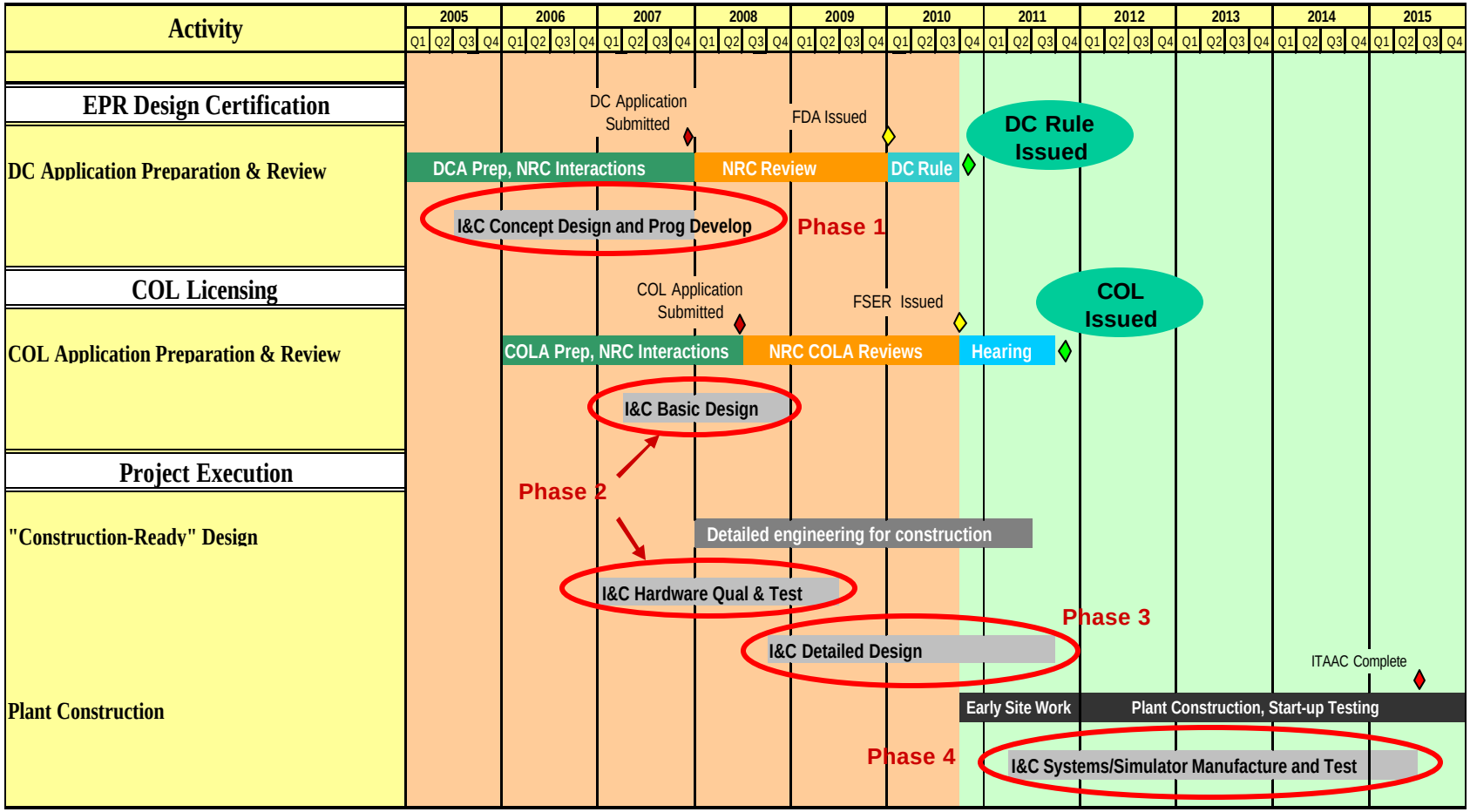
Topics

- I&C Design – Phased Approach
- Timeline for I&C Design
- Documentation Available at DCA Submittal
- Documentation Available at COLA Submittal
- Documentation Available During Construction Phase

Phased Approach to Design

- **Design process comprises four phases:**
  - **Phase 1 – Conceptual Design**
  - **Phase 2 – Basic Design**
  - **Phase 3 – Detailed Design**
  - **Phase 4 – Manufacturing/Testing/Installation**

Timeline for I&C Design



Documentation Available at DCA Submittal

- DCD
  - Tier 2 Chapter 7
  - Specific COL applicant responsibilities will be identified
  - ITAAC will be defined
- Design completion to the level of system requirements, functional and system-level design
- Topical reports submitted as required for focus areas
  - Program areas addressed for software development, equipment qualification/dedication, and setpoint methodology

Documentation Available at COLA Submittal

- Plant specific design differences from the referenced topical reports or Tier 2 documentation
- I&C design documentation consistent with Phase 2 and Phase 3 design activities

Documentation Available During Construction Phase

- I&C design documentation consistent with Phase 3 and Phase 4 design activities
- Installation documentation associated with I&C systems
- Plant simulator documentation
- O&M documentation

Human Factors Engineering

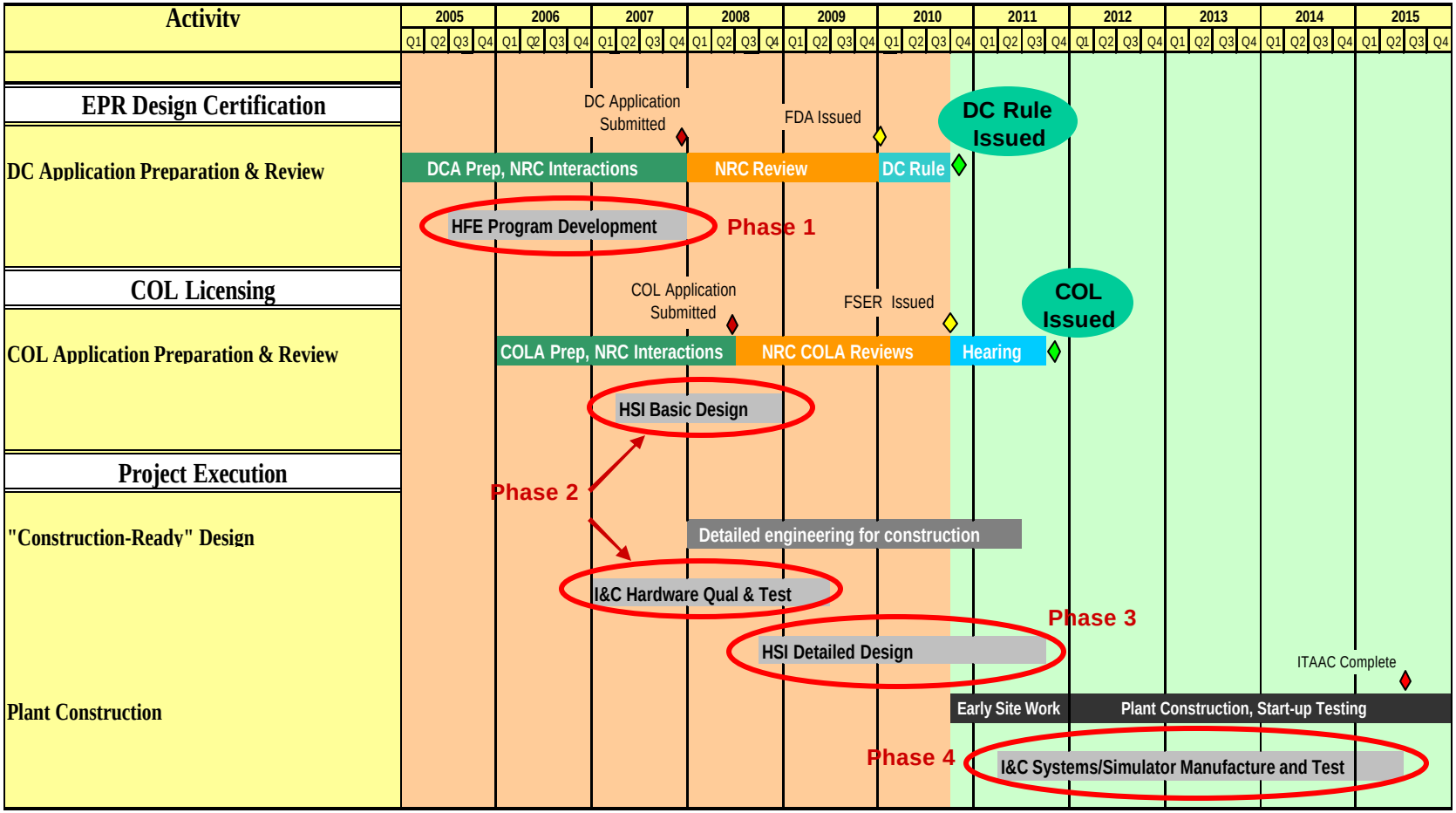
Topics

- HFE Design – Phased Approach
- HFE Design Timeline and Process
- Documentation Available at DCA Submittal
- Documentation Available at COLA Submittal
- Documentation Available During Construction Phase

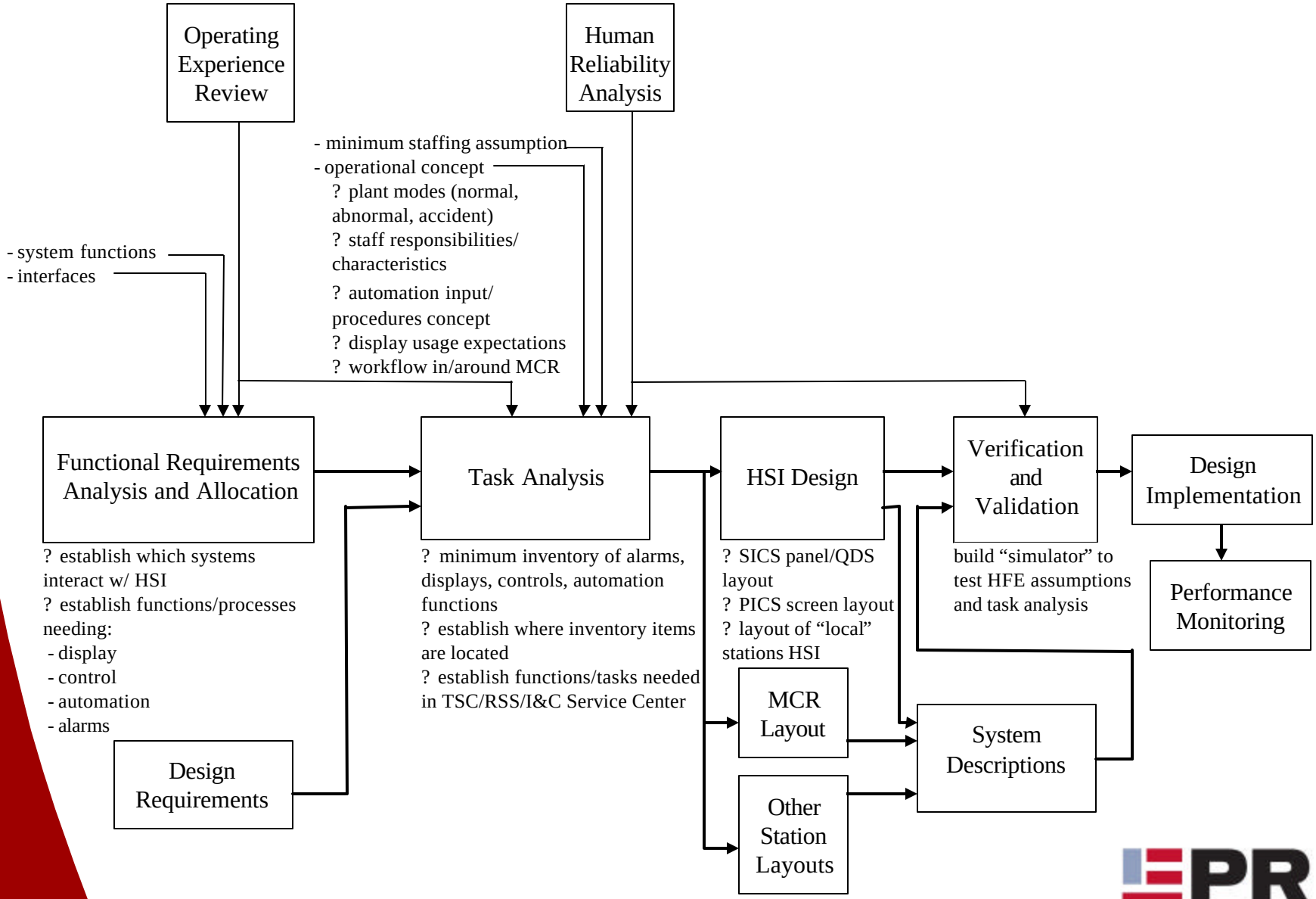
Phased Approach to Design

- **Design process comprises four phases:**
  - **Phase 1 – Conceptual Design**
  - **Phase 2 – Basic Design**
  - **Phase 3 – Detailed Design**
  - **Phase 4 – Manufacturing/Testing/Installation**

Timeline for HFE Design



Overview of HFE Design Process



Documentation Available at DCA Submittal

- DCD
  - Chapter 18
  - Description of COL applicant responsibilities
  - ITAAC will be defined
- Design completion to the level of system requirements, functional and system-level design
- Topical reports submitted as required for focus areas

Documentation Available at COLA Submittal

- COL applications will reference the following topical reports submitted in two phases:
  - Phase 1 – 1st quarter 2007
    - U.S. EPR Human Factors Report
  - Phase 2 – 1st quarter 2008
    - U.S. EPR Procedure Development
    - U.S. EPR Verification and Validation
- Design documentation consistent with Phase 2 and Phase 3 activities

Documentation Available During Construction Phase

- HFE design documentation consistent with Phase 3 and Phase 4 design activities
- Installation documentation associated with HSI
- Plant simulator documentation
- O&M documentation

Summary and Next Steps

Sandra M. Sloan
Manager, Regulatory Affairs
New Plants Deployment

Summary

- FANP's goal is a high threshold for DAC in the U.S. EPR design certification
- The maturity of the reference plant design gives confidence in the completeness and finality of the U.S. EPR
- Ongoing design work during the DC review period provides the opportunity to close "DAC"-type items prior to FDA
- An approach is proposed to address process and design issues during the DC review and incorporate remaining design requirements as ITAAC or DAC in final version of DCD
- FANP will provide sufficient information in the DCA and supporting documentation to allow the staff to make the necessary findings with regard to safety

Continuity of the U.S. EPR design process will allow ongoing NRC inspection during the DC review, reducing the need for DAC.

Next Steps

- **Discussion and agreement on:**
  - **Timing of submittal of design process descriptions**
  - **Level of design completion and detail required to close out design issues during the DC review**
  - **Requirements and process for incorporating remaining DAC into DCD**
- **Letter from FANP to NRC outlining the agreed-upon approach for the U.S. EPR design certification in the areas of piping, I&C, and human factors engineering**
- **Next meeting**
  - **March 2006, Overview of U.S. EPR Compliance Evaluation**