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Our ref: LTR-NRC-06-59

October 24, 2006

Subject: LTR-NRC-06-59 NP-Attachment, "NRC/Westinghouse Meeting on LOCA Development Efforts" (Non-proprietary)

Enclosed is a copy of the presentation material used for the NRC/Westinghouse meeting on LOCA development efforts at Westinghouse on October 18, 2006.

Correspondence with respect to this letter should be addressed to James A. Gresham, Manager of Regulatory Compliance and Plant Licensing, Westinghouse Electric Company, P.O. Box 355, Pittsburgh, Pennsylvania 15230-0355.

Very truly yours,

J. A. Gresham, Manager
Regulatory Compliance and Plant Licensing

Enclosure

cc: J. H. Thompson, NRR
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LTR-NRC-06-59 NP-Attachment

NRC/Westinghouse Meeting on LOCA Development Efforts

October 18, 2006

Agenda

- Introduction and Purpose of the Meeting
- Update from Dec 2005 Meeting with NRC
  - –Status on code development
  - –Overview of the V&V matrix and current status
  - –Access to ROSA test data
  - –Status on pilot plant program
- Overview of Target Schedule for Submittal to the NRC
  - –Anticipated pre-submittal status meetings with the NRC
  - –Expected topical content for submittal
- Public Comments and Closing Remarks

12/05/05 Kick-off Meeting Objectives

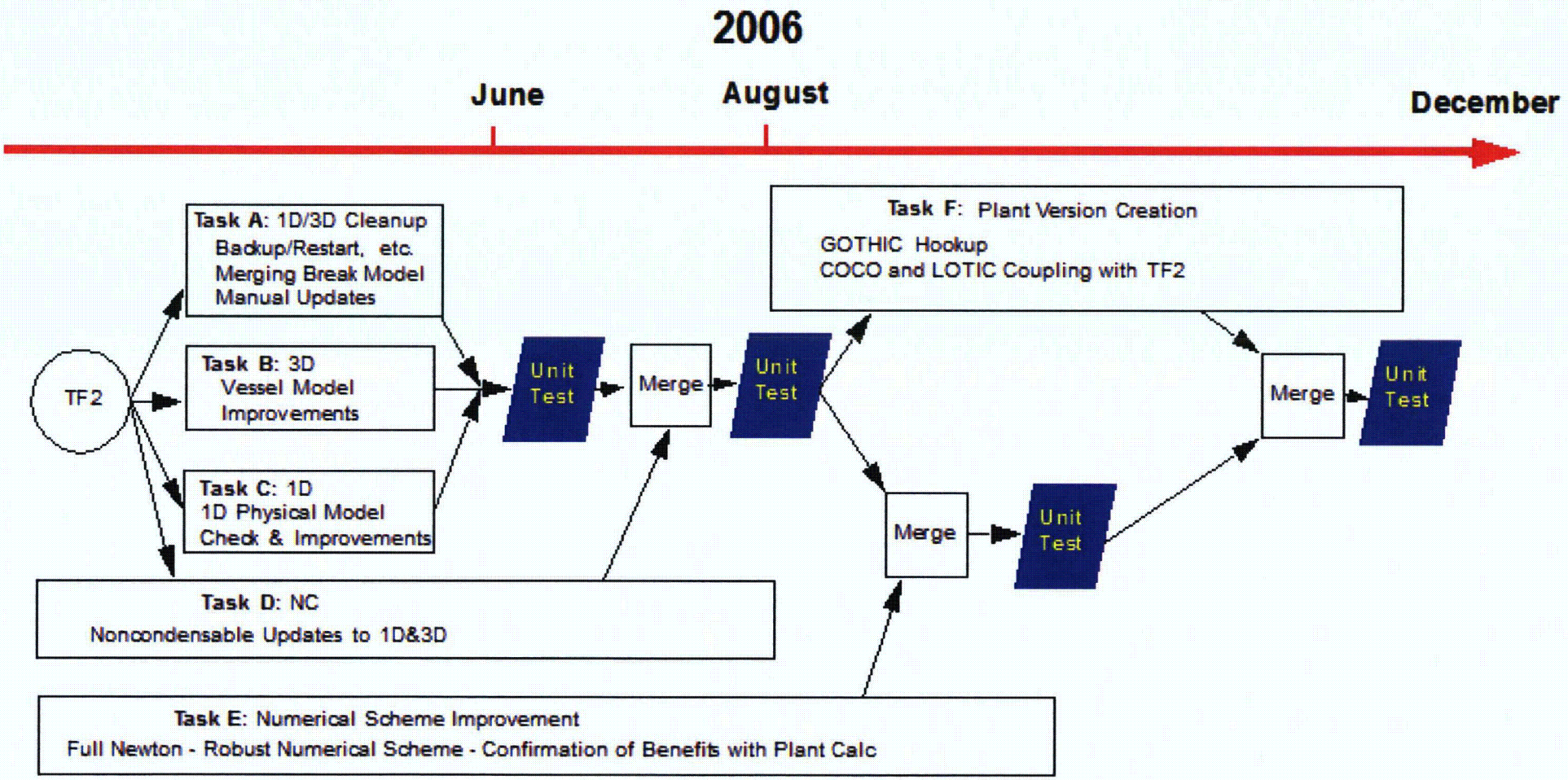
- Introduce NRC to Westinghouse Next Generation LOCA Technology
  - Drivers for Full Spectrum LOCA (FSLOCA)
  - PIRT development process
  - Code selection and improvements
  - Validation matrix
  - Uncertainty methodology
  - Schedule
- Obtain Informal Initial Feedback, as Appropriate

Status on WCOBRA/TRAC-TF2 Code Development

Cesare Frepoli

October 18, 2006

Full Spectrum LOCA Code Development
WCOBRA/TRAC-TF2



Code Development Achieved Milestones

- Coupling with TRAC-PF1(replace TRAC-PD2)
- 3D Models Upgrades
- 1D Models Upgrades
- 3D Non-Condensable Transport in WCT-TF2
- First Version of WCT-TF2 Code and Input Manual was released
- Phase-1 V&V in progress

Code V&V Current Main Focus

- Revalidate Against LBLOCA SETs
- COSI
- TPFL and UPTF Loop Seal
- Preliminary Calculations With LOFT and ROSA
- Finalize Noding Strategy

Overview of V&V Matrix for FSLOCA

Kats Ohkawa
October 18, 2006

Purpose

- Process to establish V&V Matrix for FSLOCA
- List of SET for SBLOCA
- List of IET for SBLOCA
- Need for ROSA Test Data and Reports

Process to establish V&V Matrix for FSLOCA

- Element 1: PIRT
- Element 2: Identification of SETs & IETs
- Element 3: Model Development Plan/Implementation of Physical Models

V&V Plan for FSLOCA

- Selected LBLOCA V&V Subset from 1996/1999-CQD
- SET for SBLOCA
- IET for SBLOCA/IBLOCA

Application – Blowdown/Refill Period

Facility			Phenomena					
SET/IET	Test Feature	No. of Tests	Critical Flow	Break Res.	Fuel Rod	Heat Transfer	ECCS/Bypass	Condensation
ORNL	Upflow blowdown cooling, 17x17	3				X		
G-1	Downflow blowdown cooling, 15x15	6				X		
G-2	Downflow blowdown cooling, 17x17	4				X		
G-2 Refill	Refill, 17x17	7				X		
Marviken	Full Scale Critical Flow	16	X					

Application – Blowdown/Refill Period (cont.)

Facility			Phenomena					
SET/IET	Test Feature	No. of Tests	Critical Flow	Break Res.	Fuel Rod	Heat Transfer	ECCS/Bypass	Condensation
W-SWM	1/3 Scale, Steam-Water Mixing	12						X
UPTF8	Full Scale, Steam-Water Mixing	7						X
CREARE	1/15, 1/5 Scale, ECCS Bypass	5					X	X
UPTF6	Full Scale, ECCS Bypass, Downcomer Cond.	5		X			X	X
LOFT	Sub Scale Critical Flow Nuclear Rods	4	X	X	X	X		X

Application – Refill/Reflood

Facility			Phenomena				
SET/IET	Test Feature/No Tests		Heat Transfer	Condensation.	N2 Injection	Fuel Rod	Ent/De-entmt
G2 Reflood	Forced reflood, cosine, 17x17, MVG	3	X				X
FLECHT LFR	Full Length Emergency Cooling Heat Transfer Tests, Forced reflood, cosine, 15x15	3	X				X
FLECHT SEASET	FLECHT-Separate Effects and System Effects Tests, Forced reflood, cosine, 17x17	5	X				X
FLECHT Skewed	Forced reflood, skewed power, 15x15	5	X				X
FEBA	Forced reflood, flat cosine, grid effect	4	X				X

Application – Refill/Reflood (cont.)

Facility			Phenomena					
SET/IET	Test Feature/No Tests		Heat Transfer	Condensation.	N2 Injection	Fuel Rod	Ent/De-entmt	UP Drain Dist
NRU	Forced reflood, skewed power shape, nuclear rods, cladding rupture	2	X			X	X	
Achilles	Gravity Reflood with N_2	1	X		X		X	
UPTF10	Full Scale UP Entrainment	1					X	
UPTF29B	Full Scale UP Entrainment	6					X	
UPTF25A	Full Scale DC Entrainment (superheated wall/saturated wall)	4		X			X	
UPTF20	Full Scale UP Entrainment with UPI	3					X	X

Application – Refill/Reflood (cont.)

Facility			Phenomena					
SET/IET	Test Feature/No Tests		Heat Transfer	Condensation	N2 Injection	Fuel Rod	Ent/De-entmt	UP Drain Dist
CCTF	Gravity Reflood, Core&UP Entrainment (1/21 scale)	5	X			X	X	
SCTF	Forced and Grav Reflood, Radial Power Effect, Core&UP Entrainmt (radial slice of a core)	5	X			X	X	
LOFT	Nuclear Core Scaled (1/48) PWR	4	X	X	X		X	
GECCFL	Subcooled CCFL at UCP	1		X			X	X
CCTF UPI Tests (72, 76)	Gravity Reflood, Core&UP Entrainment (1/21 scale) with UPI	2	X	X		X	X	X

Separate Effects Tests for SBLOCA

Small Break Process	Test	Comments
Break Flow	EPRI-NP-4556 +additional Marviken Dataset represents more than 1400 points from 40 geom., and 10 facilities, containing data from 13 to 2500 psia. The geom. ranges from $0 < L < 2300$mm, $0.464 < DH < 500$mm.	Available data appears to span PWR ranges of conditions for break area, upstream subcool-ing, flow quality. (V. Ilic, S. Banerjee and S. Behling, "A Qualified Database for the Critical Flow of Water", EPRI-NP-4556, May, 1986.)
Mixture Level	ORNL, W G-1 Loop, GE Blowdown	Data covers PWR expected range of pressure and bundle power.
Horizontal Flow Regimes	JAERI-TPTF Tests	Horizontal stratified regime transitions predicted according to Taitel-Dukler map.
Loop Seal Clearance	UPTF Loop Seal Tests	Data covers full scale geometry, provides infor-mation for range of Jg that covers PWRs.
Fuel Rod Models: Nuclear Rod Models Heat Transfer	Various sets of test data from LBLOCA, ORNL INEL Post-CHF Data	Fuel rod models were assessed and quantified for large break. Data representative of SBLOCA conditions.
Steam Generator Hydraulics	ROSA NC Tests	Prediction of flooding in SG tubes at PWR range of conditions.
Pump Performance	Pump Specific Data from LBLOCA	Empirical pump data; assessed for large break LOCA.
SI Condensation	COSI Tests	High pressure SI condensation.

Integral Effects Tests for SBLOCA

Small Break Process	Test	Comments
Break Flow, entrainment at Break	**LOFT L3-1, L3-5, L3-7** **ROSA: 10% CL (side), 5% CL (side), 2.5% CL (side), 2.5% CL (top), 2.5% CL (bottom), 0.5% CL (side)**	**Single and two-phase critical break flow measurements available. Orientation effect.**
Mixture Level	**ROSA: 10% CL, 5% CL, 2.5% CL, and 0.5% CL**	**Range of break sizes. Vessel inventories and system wide mass distributions.**
Steam Generator Hydraulics	**ROSA NC** **LOFT L3-7**	**Provides information on system wide phase separation, primary-secondary heat transfer.**
Loop Seal Clearance	**ROSA: 10% CL, 5% CL, 2.5% CL, 0.5% CL, and additional 5% CL with higher Core Bypass**	**Provides information on LSC phenomena.**
Fuel Rod Models: **Nuclear Rod Models:** **Heat Transfer:**	**LOFT (4 tests), ROSA SB-CLs**	**Nuclear rods.** **Clad heatup & PCTs.**
IBLOCAs	LOFT L5-1/L8-2	A 14in ACC line Break

ROSA vs SEMISCALE

- Scaling in ROSA vs SEMISCALE → 1/48 vs 1/1700
- S-LH-1 and S-LH-2 Liquid Hold-up Tests vs ROSA 5% Tests

		Bypass (% of Initial Core Flow)			
Test	POWER	HL-DC	DC-UH	V-Valve	Total
SB-CL-05	High	0.2	2.1	0	2.3
SB-CL-07	High	0	0.9	8.3 (t>60s)	9.2
SB-CL-06	Low	0.6	0.9	0	1.5
SB-CL-08, 18	High	0.2	0.3	0	0.5
SB-CL-10	Low	0	0.4	0	0.4
S-LH-1	Low	0	0.9	0	0.9
S-LH-2	Low	0	3.0	0	3.0
PWR	-	0.2→	0.3→	-	0.5 – 4.0

ROSA vs SEMISCALE

- SEMISCALE-NC Tests (5% and 1.5% Power)
- ST-NC-01/ST-SG-01 (5% Power), ST-NC-02/ST-SG-02 (2% Power)
- No oscillations seen in LSTF
- 141 vs 6 Tubes per SG
- Much Less Heat Loss in LSTF
- Lower Mass Inventory (56%) at End of NC

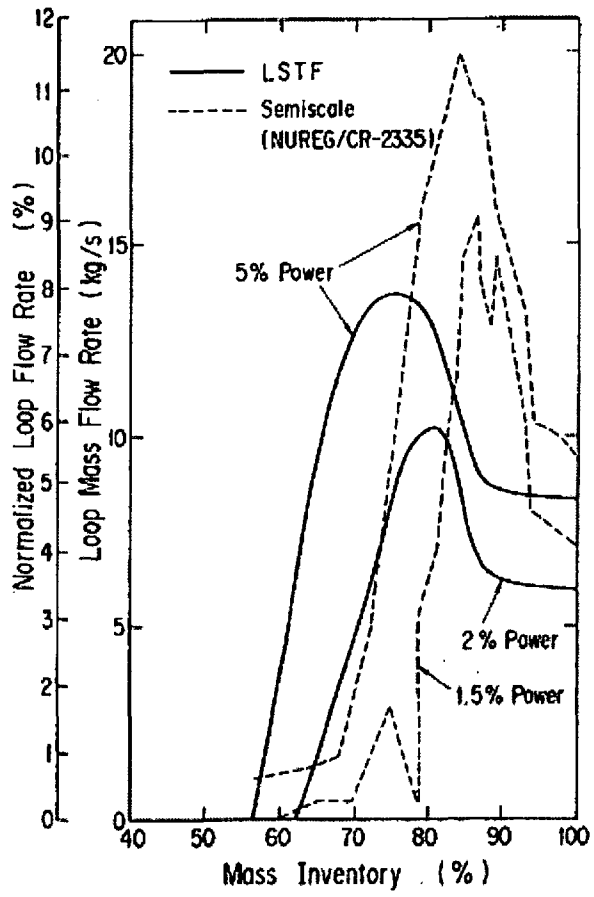


Fig. 13. Primary loop natural circulation flow rate, comparison of LSTF and Semiscale test results.

Selected ROSA Simulations (shown with Underline) and Need for Data/Data Report - (Blue→ We have, Red→ We need)

ROSA-IV (LSTF) SYSTEM DESCRIPTION with CORE-I (JAERI-M84-237, 1985) ←

- SB-CL-01, -02, and -03 2.5% Side, Bottom, and Top Breaks (JAERI-memo 62-399, 1987)
- SB-CL-18 5% Side Break *(JAERI-M89-027, 1989)* (*ISP26)* is a repeat of SB-CL-08 0.5% Bypass
- SB-CL-09 10% Side Break (JAERI-memo 63-054, 1988)
- SB-CL-12 0.5% Side Break (JAERI-memo 63-026, 1988)
- SB-CL-07 5% *Side Break with 9.2% Core Bypass Flow (JAERI-M-???, 1990)*
- ST-NC/SG-01 5% *Power NC tests (JAERI-memo 62-434, 1987)*
- ST-NC/SG-02 2% *Power NC tests (JAERI-memo 63-040, JAERI-M88-215, 1988*)

Test Number → Availability of Data Tape, Report Number → Availability of Test Report

Status on Pilot Plant Program

Mitch Nissley

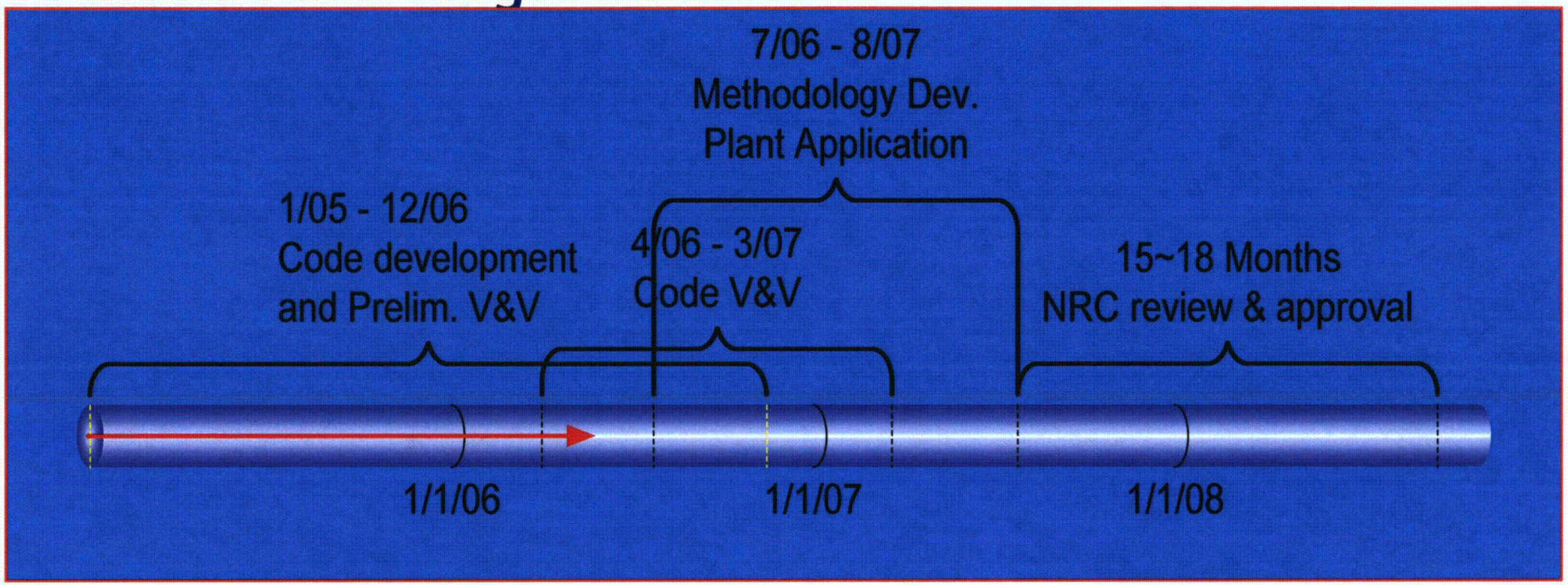
Overview Target Schedule for Submittal to the NRC

Cesare Frepoli and Robert Kemper

October 18, 2006

Full Spectrum LOCA Development

Schedule and Target Milestones



- Physical Model Code Version (August 2006)
- FSLOCA Updates Code Version (October 2006)
- Plant Code Version (December 2006)
- Complete Validation (March 2007)
- Pilot Plant Analysis Complete (June 2007)
- Submit Topical Report to NRC (August 2007)

W/NRC Anticipated Meetings

- First Kick-off Meeting to Introduce NRC to Concept was Held in December 2005
- Today (October 18th 2006) : Review V&V plan with NRC
- At Least Two Additional Status Meetings with NRC Expected Prior to Submittal
- Early Kick-off Meeting with ACRS Is Desired
- Open, Frequent Dialog with NRC Before and During Review is Encouraged

Purpose of Additional Pre-Submittal NRC Meetings

- Goal is to Update Staff, Obtain Feedback at Key Points in Program, e.g.,
  - Completion of major code development milestones
  - Completion of major code validation studies
  - Decision time on major uncertainty elements
  - Meaningful pilot plant results available

ACRS Kick-off Meeting

- Envision 1½ Day Meeting with T/H Sub-committee
- Focus on:
  - Integrated PIRT
  - Key code model revisions
  - Major V&V results
  - Uncertainty methodology overview
  - Sample PWR results
- Focus and Content to be established with the NRC

Submittal Currently Expected to be All-Inclusive

- Integrated Phenomena Identification and Ranking Table (PIRT) for Small, Intermediate and Large Breaks
- Complete Code Description
  - Model equations, basis, how coded
- Validation Results for Separate and Integral Effects Tests
- Uncertainty Methodology
- Sample PWR Analysis with Pilot Plant(s)

Submittal Content

- Regulatory Guide 1.203 (EMDAP) is followed
- Volume 1 (Steps 1-->12):
  - –EM Development Roadmap
  - –PIRT, EM requirements and assessment base
  - –Complete Code Description
  - – Model equations, basis, how coded
- Volume 2 (Steps 13-->19)
  - –Validation Results for Separate and Integral Effects Tests
  - –Assessment of biases and uncertainties

Submittal Content (cont...)

- Volume 3 (Step 20):
  - –PWR Uncertainties and Sensitivities
- Volume 4:
  - –Uncertainty methodology, technical basis
  - –ASTRUM-FS process flowchart
  - –Demonstration PWR analysis (pilot plant(s))
  - –Methodology summary

Alternate Option for Submittal

- Have Discussed Concept of Phased Submittals with NRC
  - Schedule for "all inclusive" submittal is aggressive
    - Need to have a high quality & complete submittal
  - Phased submittal concept was not rejected by the NRC on Dec. 2005 Meeting. Further insights?
- Prior Experience Indicates that the Review will be Sequential
  - PIRT, code physical models, validation (Volumes 1 and 2)
  - Development of uncertainty methodology (Volumes 3 and 4)
  - Demonstration analysis (Volumes 3 and 4)

    => Logical basis for phased submittals

Summary

Westinghouse FSLOCA Development Addresses Industry Needs

- Regulatory changes (LB redefinition, increased scrutiny of Appendix K methods, potential for ANL/CEA negative impacts)
- US/utility strategic objectives
  - EPU reduces need for more natural gas, oil consumption
  - $/MWe increase from EPU attractive for utilities

Request That Periodic Program Updates be Continued

- Westinghouse to advise NRC of evolution of code, methods
- Any informal feedback beneficial