

Recent Developments and Insights from
Application of ADS-IDAC Dynamic PRA Platform
(PSAM9 0344)

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Recent Developments and Insights from Application of ADS-IDAC Dynamic PRA Platform Presentation Outline

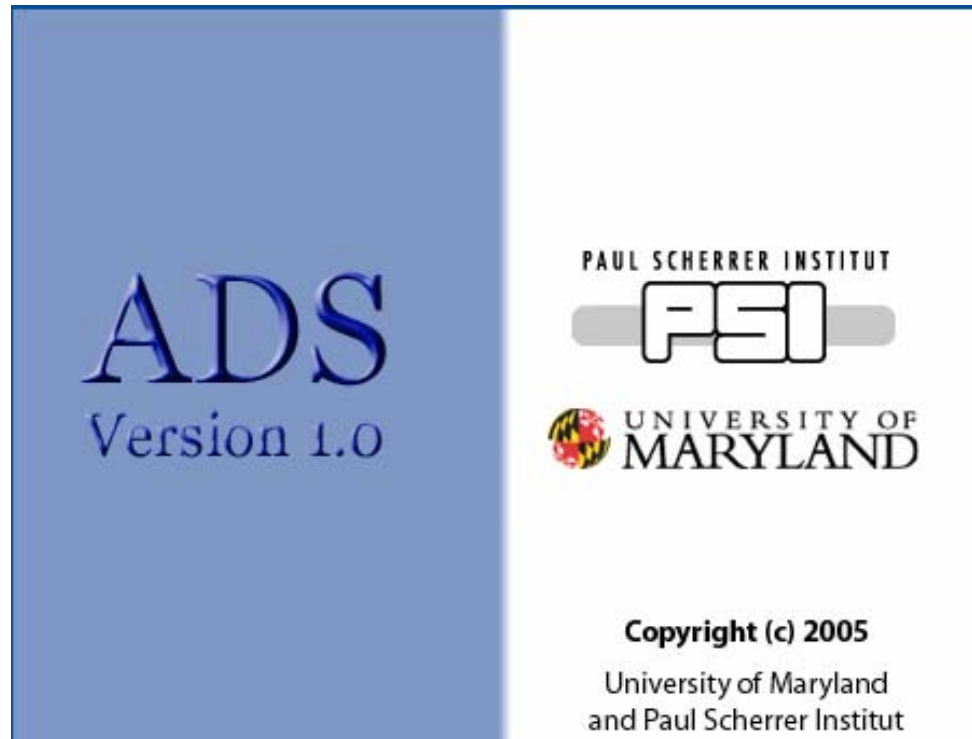
- Overview
- Current ADS state
- Simulation results
- Discussion

The views expressed are those of the authors and do not necessarily represent the views of the U.S. NRC and other organizations mentioned.

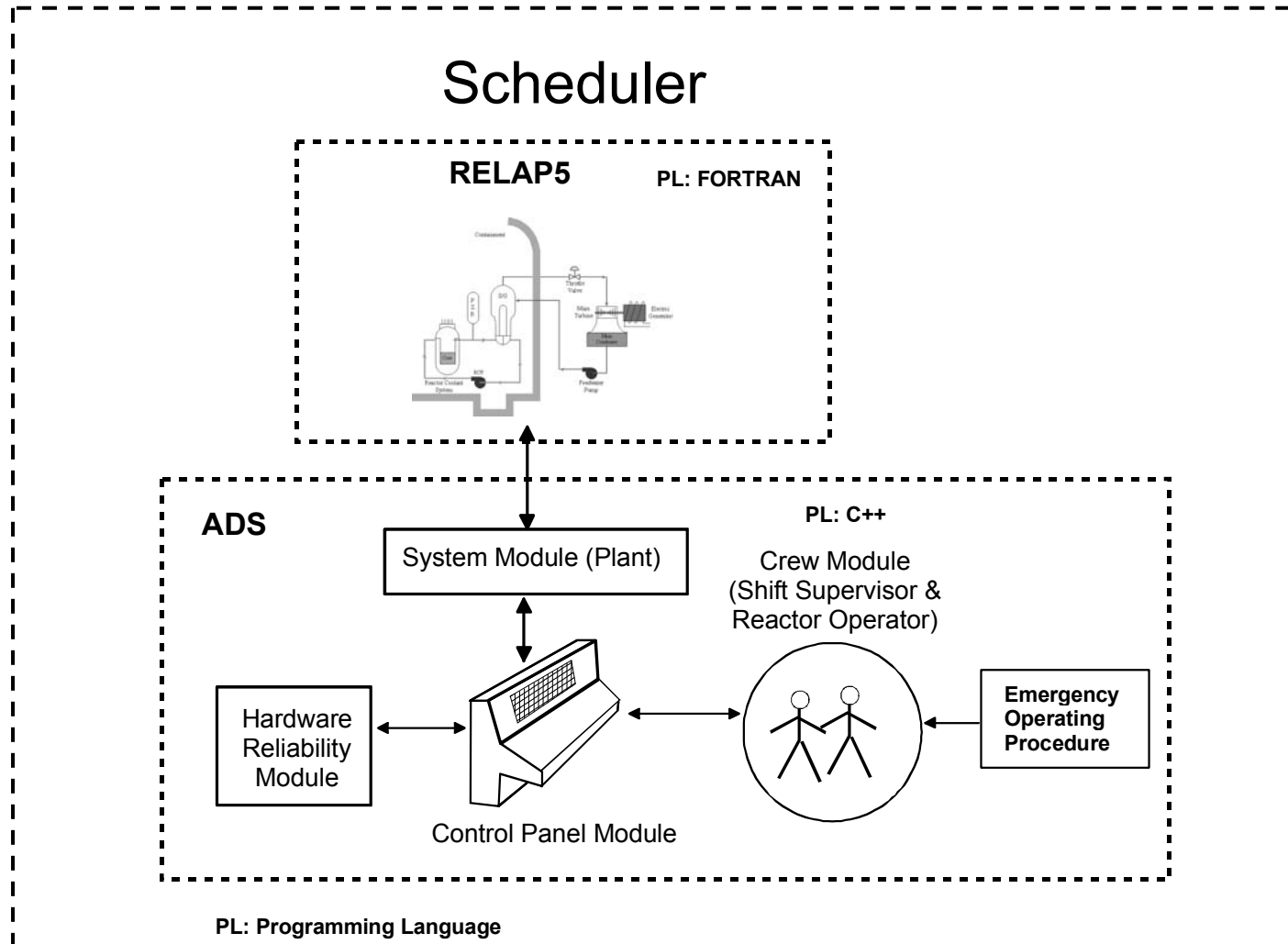
ADS-IDAC Overview

- Objective
 - Perform Dynamic PRA through rule-based, systematic computer simulation with focus on human effect on risk
- Approach
 - Model and simulate operator-operator and operator-plant interactions in a *probabilistic* computer simulation environment
 - Integration of five modules for simulation
 - System, Control Panel, Crew (include operating procedures), Hardware Reliability, and Scheduler
 - Risk scenarios are generated and presented in form of use of the discrete dynamic event tree (D-DET)
- History
 - Various versions have been developed over the past 15 years at the University of Maryland (ADS, ADSII, ADS-G2, ADS-RELAP, and ADS-IDAC)
 - Revisions leading to current version (10/2006) are made through a collaborative arrangement between University of Maryland and Paul Scherrer Institute, Switzerland

ADS Simulation Program



ADS-IDAC Modules



System Module Editing Screen

The screenshot displays the ADS (Advanced Design System) interface for editing system modules. The main window shows a list of modules with columns for Name, Card Number, and other parameters. Below the main window are several smaller panels for editing specific components:

Interactive Controls:

Name	Card Number
IC_801	801
IC_802	802
IC_803	803
IC_804	804
IC_805	805
IC_806	806
IC_807	807
IC_808	808
IC_809	809
IC_810	810
IC_811	811
IC_812	812

Heat Structure:

Name	Card Number	Number of Mesh Points
HS_57001	5701001	8

Control Variable:

Name	Card Number	Unit (e.g., %, inch)
CV_999	999	Watt
CV_803	803	%
CV_856	856	%
CV_956	956	%
CV_903	903	%
CV_3345	3345	%
CV_3348	3348	%
CV_3448	3448	%
CV_3445	3445	%
CV_3123	3123	%
CV_3124	3124	%
CV_3163	3163	%

Other Panels:

- HV (High Voltage):** Lists HV modules like HV_550, HV_570, HV_101, etc., with their respective Card Numbers.
- HJ (Heat Junction):** Lists HJ modules like HJ_100, HJ_200, HJ_151, etc., with their respective Card Numbers.
- VT (Voltage Transformer):** Lists VT modules like VT_439, VT_416, VT_417, etc., with their respective Card Numbers.
- LT (Load Transformer):** Lists LT modules like LT_1651, LT_1652, LT_1653, etc., with their respective Card Numbers.

Result Viewing Screen

The screenshot shows the ADS software interface. The main window displays a sequence of events (PE_03 to PE_123) and a 'DET - Graphics' window showing a plot of a parameter over time. The plot shows a red line with data points, peaking around 870 and then decreasing. The 'DET - Graphics' window also includes a table of parameters and a list of intermediate events.

Intermediate Events

Name:	Time:	Node Probability:	Consequence Description:
ES_0	100.271	5.0E-4	"Sequence reached simulation truncation time"

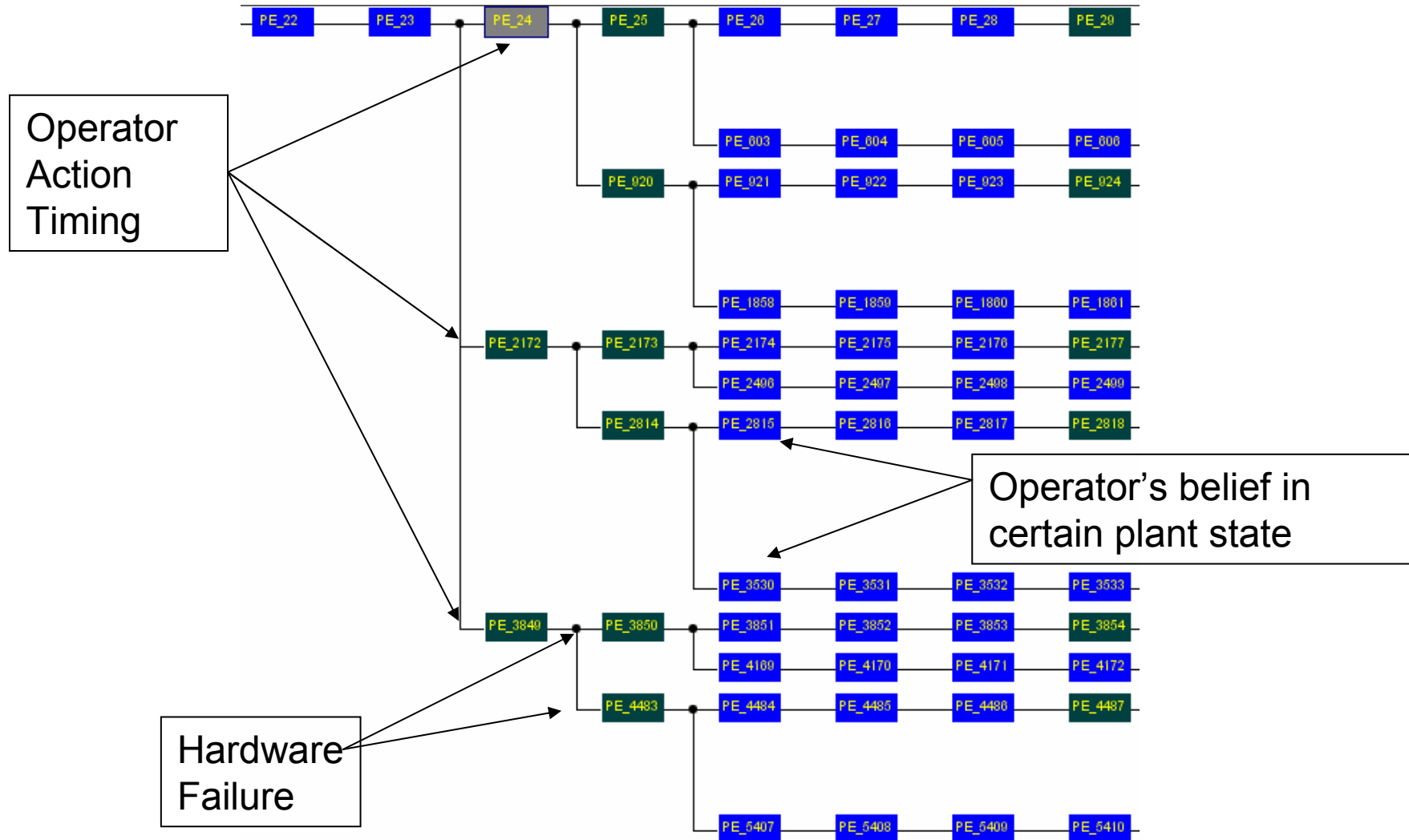
DET - Graphics

Graphic

Select Node: ES_0

Parameter	Unit	Select
LPI_Loop_C	lb/s	<input type="checkbox"/>
LPI_HDR_Pressure	lb/in ²	<input type="checkbox"/>
HPI_Loop_A	lb/s	<input type="checkbox"/>
HPI_Loop_B	lb/s	<input type="checkbox"/>
HPI_Loop_C	lb/s	<input type="checkbox"/>
HPI_HDR_Pressure	lb/in ²	<input type="checkbox"/>
ACC_A_Level	%	<input type="checkbox"/>
ACC_B_Level	%	<input type="checkbox"/>
ACC_C_Level	%	<input type="checkbox"/>
ACC_A_Pressure	lb/in ²	<input type="checkbox"/>
ACC_B_Pressure	lb/in ²	<input type="checkbox"/>
ACC_C_Pressure	lb/in ²	<input type="checkbox"/>
SG_A_NR_Level	%/100	<input type="checkbox"/>
SG_B_NR_Level	%/100	<input type="checkbox"/>
SG_C_NR_Level	%/100	<input type="checkbox"/>
SG_A_VWR_Level	%/100	<input type="checkbox"/>
SG_B_VWR_Level	%/100	<input type="checkbox"/>
SG_C_VWR_Level	%/100	<input type="checkbox"/>
SG_A_Pressure	lb/in ²	<input checked="" type="checkbox"/>
SG_B_Pressure	lb/in ²	<input type="checkbox"/>
SG_C_Pressure	lb/in ²	<input type="checkbox"/>

A Sample DDET



ADS-IDAC for HRA

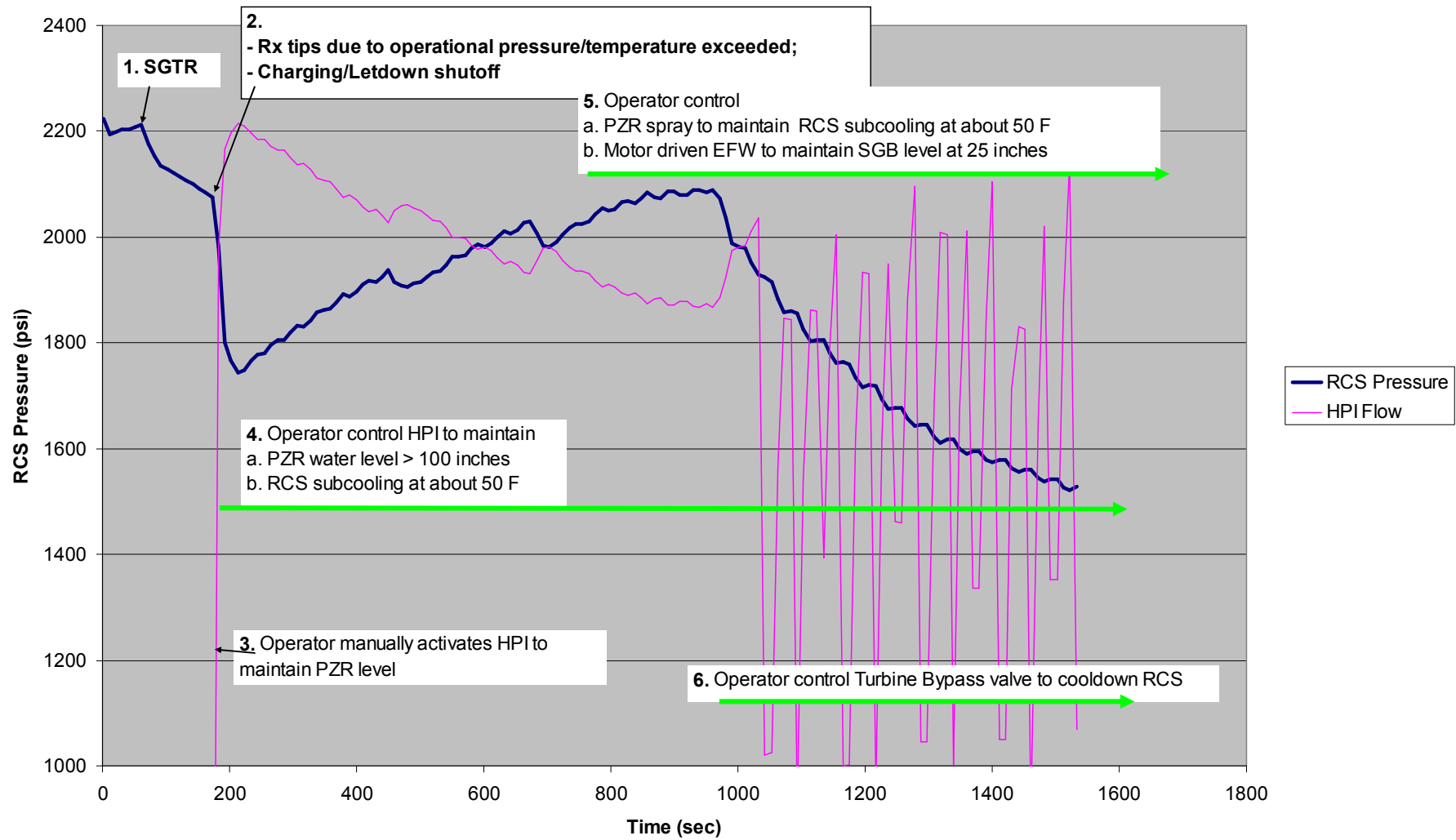
- Rich in contextual information for modeling crew behavior
- Two-operator crew
 - Decision Maker (SRO) & Action Taker (RO)
- Currently simulated crew behavior
 - Follow procedure literally
 - Key symptom-response behavior
- Probabilistically modeled crew response
 - Symptom-response behavior
 - Action time
- Separate simulation engine from input data
 - Manipulating scenarios without no changes in source code

Event Description

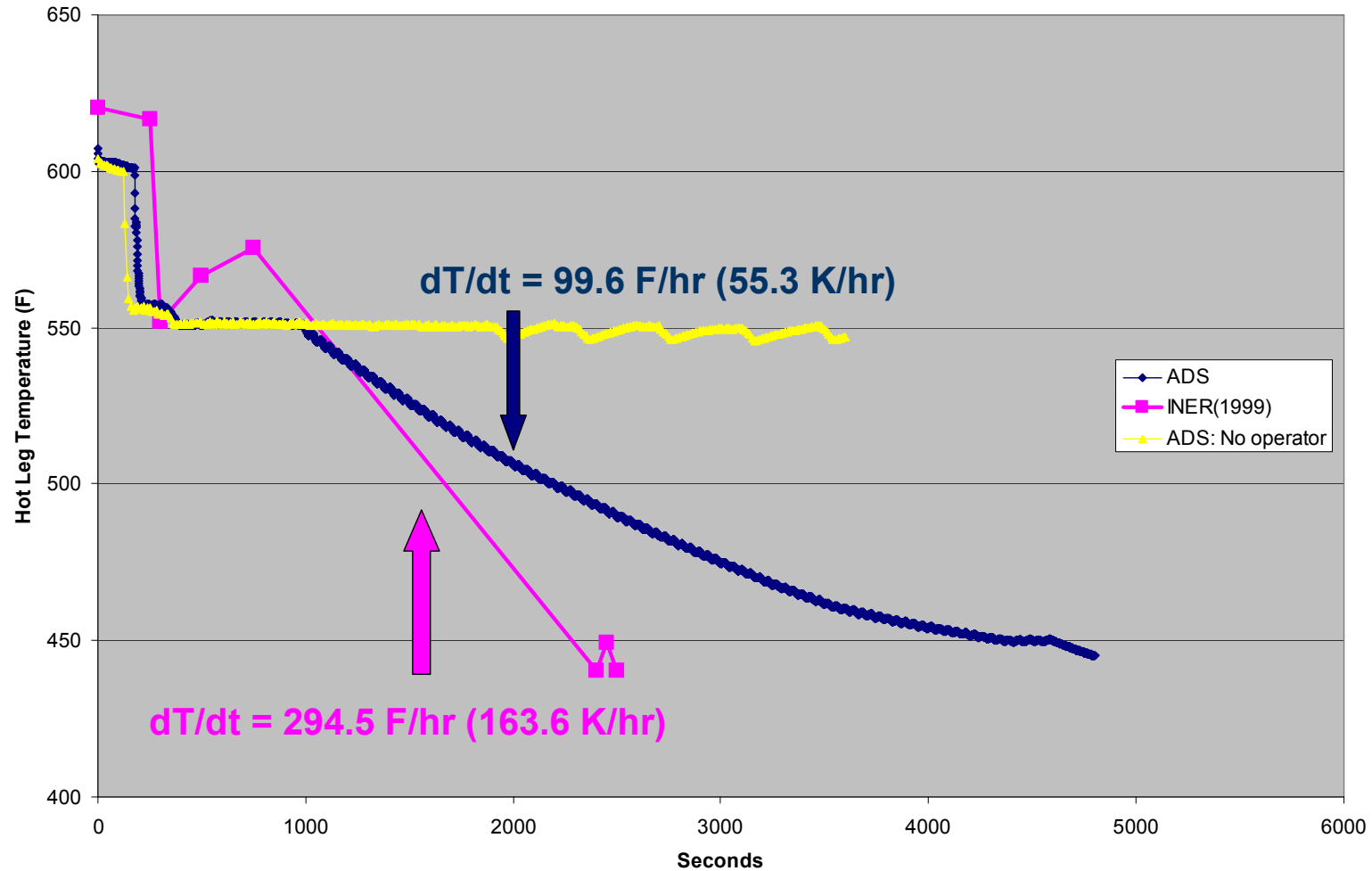
- A 2 cm in diameter SGTR
- Hardware failures when demanded:
 - HPI fails on demand
 - All other plant systems functioned as designed

“Nominal” System-Crew Responses

(Operator Activates HPI)



Fine Modeling in Operator Response

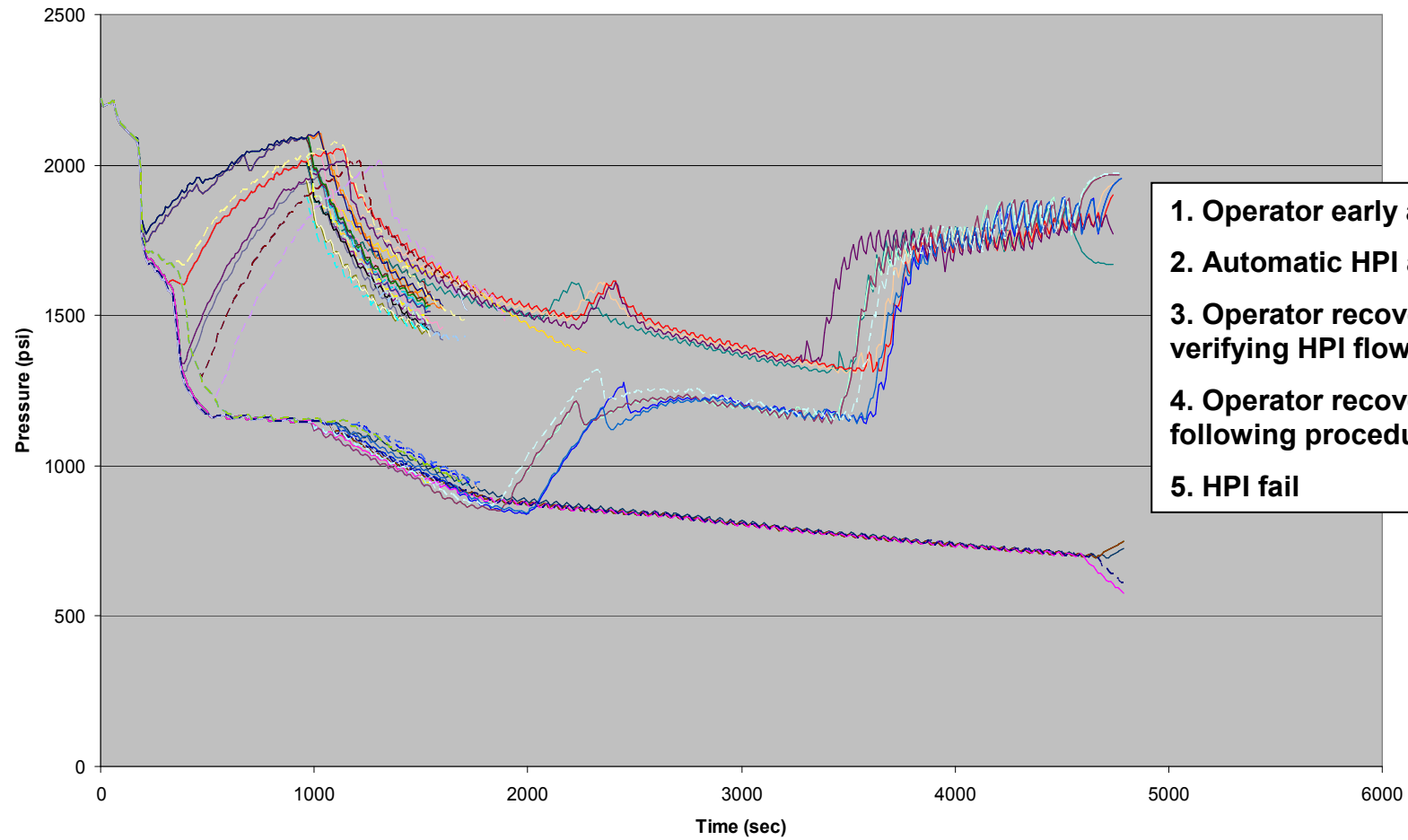


Scenario Variations

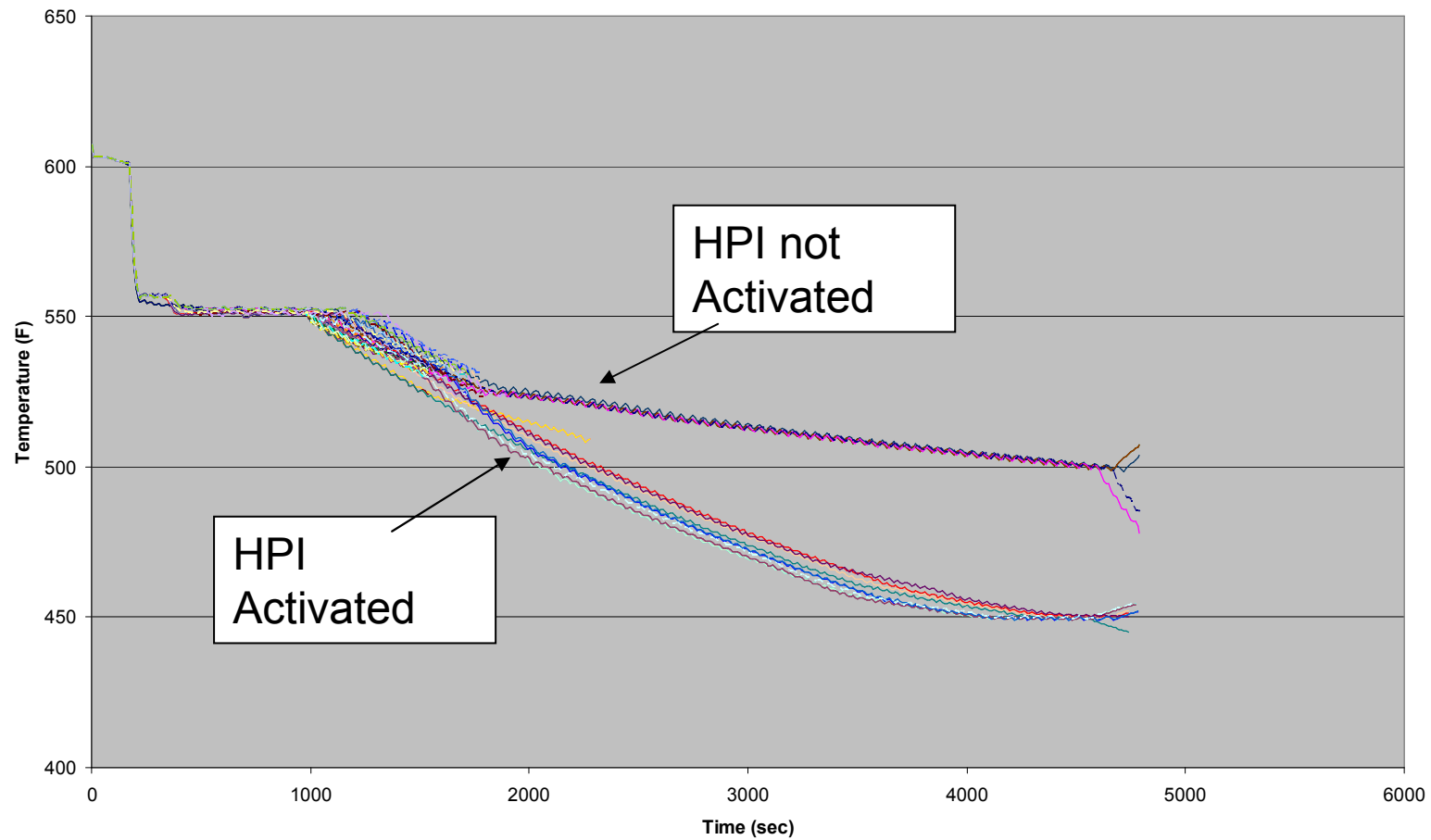
Summary of Simulation Results

- 74 sequences are generated
- 41,892 Pivotal Event (PE) generated
- Simulation time 10 Hr 48 Min in a 3G PC

RCS Pressure Variation



Hot Leg A Temperature Variation



Discussion

- HRA oriented simulation
- Potential of ADS-IDAC for studying new control room designs
 - Computer-based procedures
 - Faster procedure following pace
 - Affect team communication/situation awareness
 - Priorities assigned to automatic control functions
 - Alarm processing system
 - Prioritize, screen, and group alarms
- Distributed computation ADS has been developed

Example of Operational Goal Conflict

