

Updating a PWR Simulator in Python

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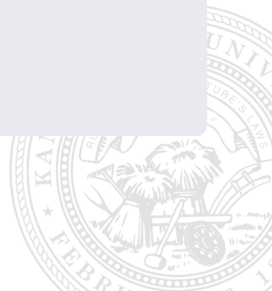
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Outline

Presentation Outline

- Introduction and Background
 - Motivation and Goals
 - Original Fortran
- Physical Models
- Graphical User Interface
- Conclusion



Introduction and Background

Motivation

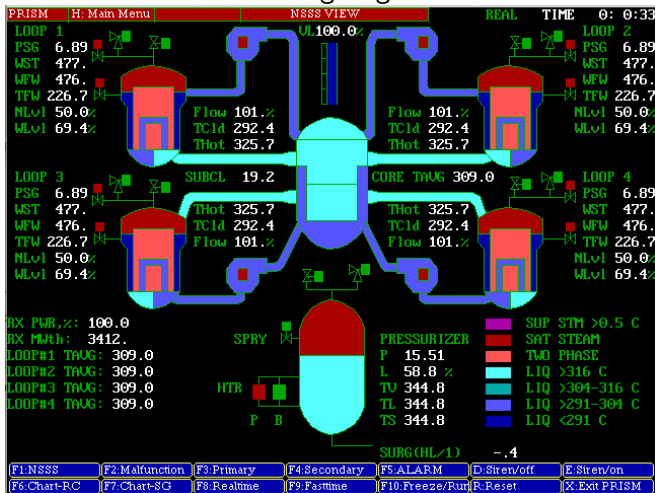
- PRISM only works on DOS
- PRISM is useful for teaching tool
- Python and Kivy are cross platform and modern languages

Goals

- Translate Physical models from Fortran 77 to Python
- Recreate GUI using Kivy Library
- Validate the results against original PRISM
- Support cross-platform versions of program

Original Fortran

Screenshot of the Landing Page for DOS based GUI



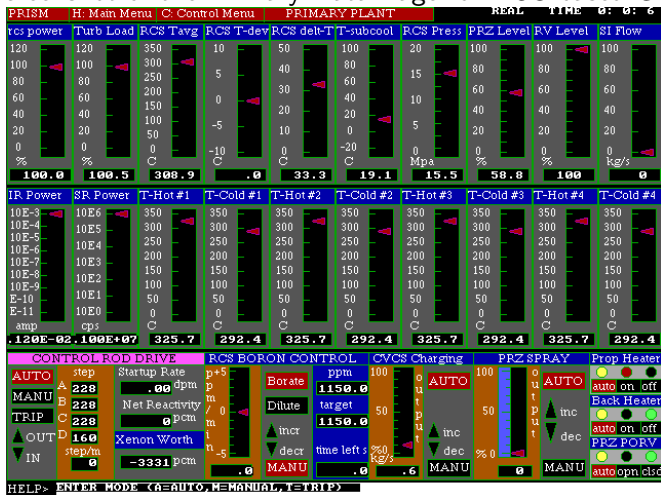
Original Fortran

Screenshot of the Malfunction for DOS based GUI

MALFUNCTION MENU				Current Time	0: 0: 4
No.	MALFUNCTION	Status (s)	No.	MALFUNCTION	Status (s)
1.	Reactor Trip	InActv	13.	Turbine Trip Fail	InActv
2.	Turbine Trip	InActv	14.	Main Steam Iso. Fail	InActv
3.	Auto SCRAM Fail	InActv	15.	Aux. FW Fail to Start	InActv
4.	Loss of Offsite Power	InActv	16.	Prz Safety Fail Open	InActv
5.	Main FW Isolation	InActv		% Valve Open:	.0
6.	Prz PORVs Fail Closed	InActv	17.	Reactivity Accident	InActv
7.	Turbine Load Rejection	InActv		Step Change (pcm):	.0
	% of load rejected:	.0			
	LOOP #1		2	3	4
8.	Steam Line Isolation	InActv	InActv	InActv	InActv
9.	Small-Break in Cold Leg	InActv	InActv	InActv	InActv
	Break Diameter (cm)	.0000	.0000	.0000	.0000
10.	SG Tube Rupture	InActv	InActv	InActv	InActv
	No. Tubes Ruptured	0	0	0	0
11.	SteamLine Break bf. MSIV	InActv	InActv	InActv	InActv
	Break Fraction (%)	.0	.0	.0	.0
12.	FeedwaterLine Break	InActv	InActv	InActv	InActv
	Break Fraction (%)	.0	.0	.0	.0
Enter 0 to Exit Malfunction Menu					
Please Enter Malfunction No.(0-17): _					

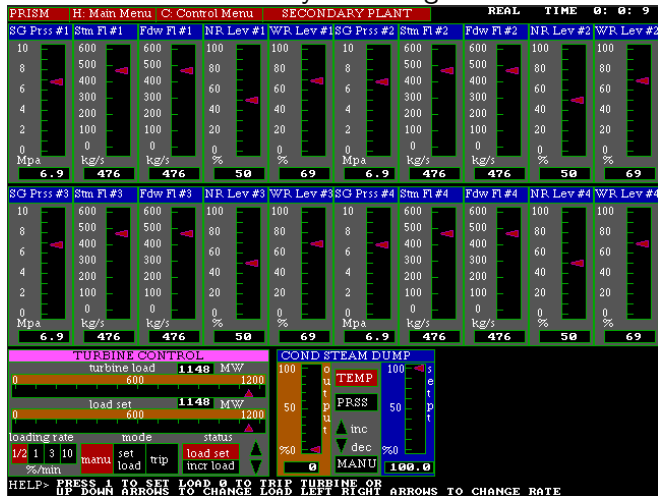
Original Fortran

Screenshot of the Primary Data Page for DOS based GUI



Original Fortran

Screenshot of the Secondary Data Page for DOS based GUI



Original Fortran

Screenshot of the Alarm Panel for DOS based GUI

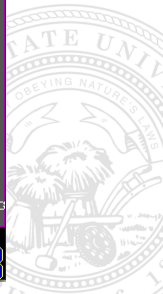
PRISM [H: Main Menu] ALARM PANEL REAL TIME: 0: 0:12

HIGH FLUX TRIP >109%	LOW RCS PRESS TRIP	HIGH RCS PRESS TRIP	MANUAL TRIP	HIGH PRZR LEVEL TRIP	OVER TEMP D/T TRIP
HIGH FLUX RATE TRIP	SAFETY INJ ACT TRIP	TURBINE TRIP	LOW SG NR LEVEL TRIP	LOSS OF RC FLOW TRIP	OVER POWER D/T TRIP
PRZR PRESS LOW	PRZR PRESS HIGH	PRZR LEVEL LOW	PRZR LEVEL DEVIATION	RCS TAVG DEVIATION	LOW RCS TAVG
MAIN STEAM ISOLATION	FEEDWATER ISOLATION	STEAM DUMP OPEN	STEAM DUMP ARMED	SAFETY INJ BLOCKED	AUX FEED PUMP TRIP
#1SG LEVEL DEVIATION	#1SG ASDV OPEN	#1SG MSIV CLOSED	#1STM LINE HIGH RAD	LOSS OF AC POWER	CONDENSER VACUUM HI
#2SG LEVEL DEVIATION	#2SG ASDV OPEN	#2SG MSIV CLOSED	#2STM LINE HIGH RAD	CNTRL ROD OUT BLOCK	TURBINE RUNBACK
#3SG LEVEL DEVIATION	#3SG ASDV OPEN	#3SG MSIV CLOSED	#3STM LINE HIGH RAD	PRZR SAFTY /PORV OPEN	
#4SG LEVEL DEVIATION	#4SG ASDV OPEN	#4SG MSIV CLOSED	#4STM LINE HIGH RAD	CONTAINMT HIGH RAD	

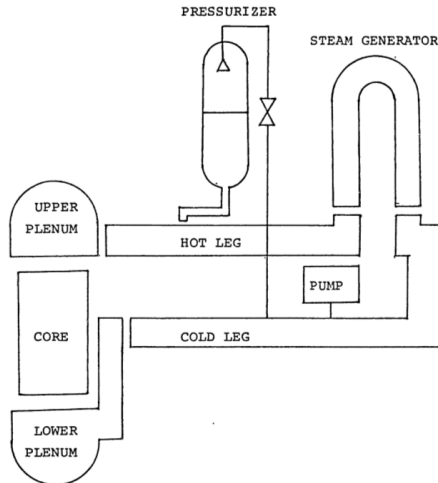
■ NORMAL
■ FIRST TRIP
■ SECOND TRIP
■ WARNING
■ PAST WARNING

HELP> PRESS C TO CLEAR PAST WARNING ALARMS

F1:NSSS	F2:Malfunction	F3:Primary	F4:Secondary	F5:ALARM	D:Stren/off	E:Stren/on
F6:Chart-RC	F7:Chart-SG	F8:Realtime	F9:Fasttime	F10:Freeze/Run	R:Reset	X:Exit PRISM



PRISM Noding Scheme



Component Models

Core Model

- Point kinetics model with 6 delayed groups
- Lumped-fuel heat transfer model
- Single Node Model

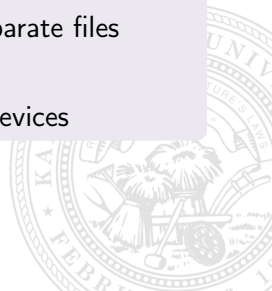
Pressurizer Model

- Uniform properties in each phase
- No metastability in either phase
- Rainout prevents subcooling by maintaining sat vapor
- Flashing prevents superheating by maintaining sat liquid
- Spray enters the vessel as a sat liquid
- No heat is transferred at the liquid-vapor interface

Graphical User Interface

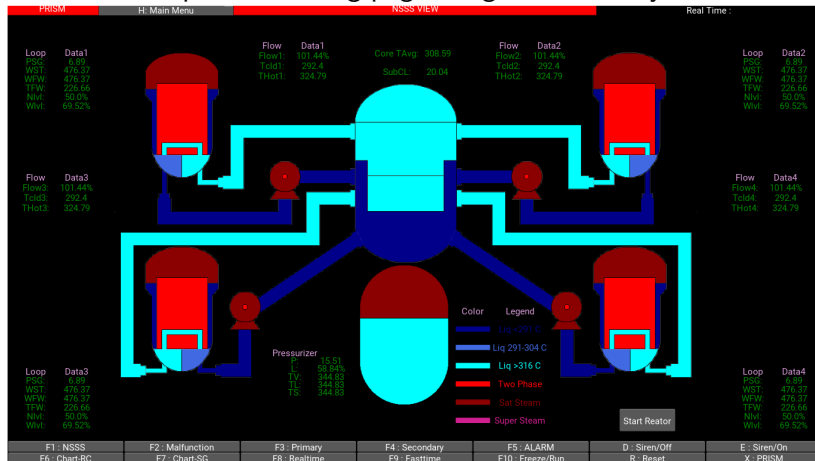
Kivy Library

- Created in February 2011
 - Matthew Virbel and others
 - French Programmer
- Separates mechanics and graphics into two separate files
- Python library that uses the KV language
- Designed to port to all platforms and mobile devices



PRISM Redesigned

Updated landing page designed with Kivy



Conclusions

Conclusions

- DOS based PRISM is outdated
- Python and Kivy are used to update PRISM
- Program will be used as teaching tool primarily
- Nearly completed implementation





Future Work

- Verification and Validation
- Deploy on various platforms
- Update physical models

Acknowledgements

Kansas State Electrical Power
Affiliates Program (EPAP)

References I

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-  S.-P. KAO, *A Multiple-Loop Primary System Model for Pressurized Water Reactor Plant Sensor Validation*, Ph.D. thesis, Massachusetts Institute of Technology (1984).
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