



**The Abdus Salam
International Centre for Theoretical Physics**



1962-35a

Joint ICTP-IAEA School of Nuclear Knowledge Management

1 - 5 September 2008

IT/IM Initiatives to Support Nuclear Education & Training

A. PRYAKHIN
*IAEA, Nuclear Power Engineering Section
Wagramerstrasse 5
P.O.Box 100
Vienna A-1400
AUSTRIA*

IT/IM Initiatives to support Nuclear Education and Training

Part 2. NPP Simulators for education

A.Pryakhin, IAEA

School of Nuclear Knowledge Management,
1-5 September 2008,
ICTP, Trieste, Italy



IAEA

International Atomic Energy Agency

NPP Simulators for Education

- Why do we want simulators for education?
- Nothing like seeing the effect of decisions?
- Cannot practice on a reactor, or often even on a full scope simulator
- Trainee can try the “What-If” approach without harm.
- Fundamental behaviour can be seen simply.
- Simple to use and immediate response
- Can be used by many different groups of people



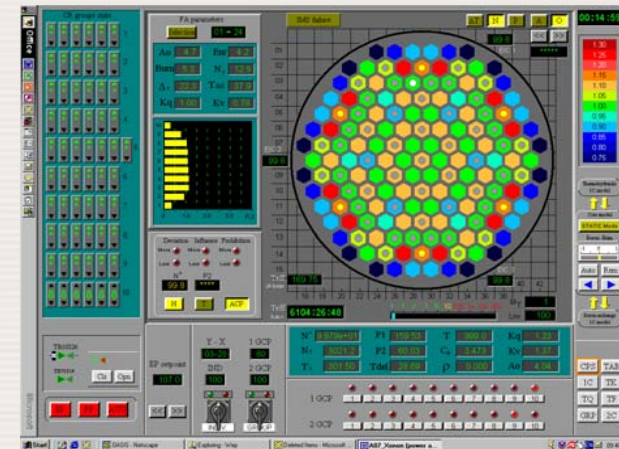
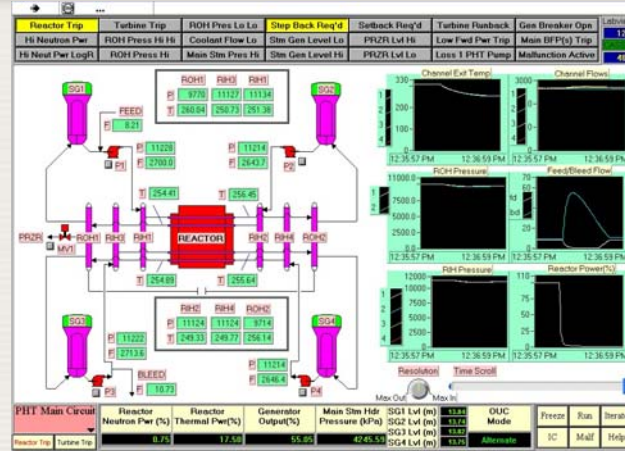
NPP Simulators for Education

- Computer-based tools are becoming standard components of education programmes
- The simulators operate on PCs and simulate responses of NPPs to operating and accident conditions
- The simulators provide insight to the general plant design and operational characteristics



NPP Simulators for Education

- The simulators include:
 - PWR
 - PCTRAN
 - BWR
 - WWER-1000
 - CANDU
 - ACR700
 - PWR with passive safety system



Workshop on NPP Simulators for Education

- Purpose - to provide university professors and engineers involved in teaching nuclear engineering with simulators to demonstrate NPP operational response characteristics.
- The simulators are also supplied directly to students engineers and scientists interested in broadening their understanding
- The Workshop consists of lectures and exercises using the simulators



Workshop on NPP Simulators for Education

- The Workshop is conducted by experts involved in developing and using NPP simulators for education, for example:-
 - Professor George BEREZNAI (Dean of School of Nuclear Technology and Safety, Ontario Institute of Technology, Canada)
 - Dr. Wilson LAM (CTI Simulation, USA/Canada)
 - Dr. Nikolai TIKHONOV (Moscow Engineering Physics Institute, Moscow, State University, Russia).



Workshop on NPP Simulators for Education

- Expected Results

- Understanding of the general design and operational characteristics of various NPP types
- Provision of teaching tools to demonstrate the operational response characteristics of various NPP types



NPP Simulators for Education

- **More information**
(individuals, potential hosting organizations):
 - **IAEA web site:**
 - <http://www.iaea.org/NuclearEnergy/Education/>
 - **E-Mail:**
 - J.Cleveland@iaea.org, A.Pryakhin@iaea.org
 - **Fax:**
 - +43 1 2600 29598



NPP Simulators for Education

User Friendly Education with Nuclear Reactor Simulation - Microsoft Internet Explorer provided by IAEA

File Edit View Favorites Tools Help



Address <http://www.iaea.org/OurWork/ST/NE/NENP/NPTDS/Projects/edu.html> Go Links



About IAEA Our Work News Center Publications Data Center FONT SIZE A + A -

You are in : Home » Our Work » Technology » NE » NENP » NPTDS » Projects User Friendly Education with Nuclear Reactor

> NPTDS Highlights

- Why NPTDS exists
- Where NPTDS fits
- How NPTDS ensures that its work is relevant
- What the Section does
- Projects
- Three Agency Study on Innovative Nuclear Reactor Development
- Active Co-ordinated Research Projects as of September 2004
- Technical Documents Published by NPTDS 1997-2004
- INPRO

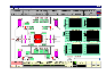
> NPTDS' Brochure (PDF File)

September 2006

NUCLEAR POWER PLANT SIMULATORS FOR EDUCATION

Computer-based tools are becoming standard components of training programmes. In the nuclear industry, important strides have been taken in recent years to provide a wider range of education and training services based on the use of nuclear reactor simulators for education.

To assist Member States in nuclear education and training, the Agency sponsors the development of nuclear reactor simulators for education which operate on personal computers and which simulate responses of a number of reactor types to various conditions.



The simulators are designed to provide insight and understanding of the general design and operational characteristics of various power reactor systems. They are not full scope simulators for operator training, nor are they for detailed design or safety analyses. However, they do provide the general response characteristics of HWRs and PWRs, and have very illustrative screens to provide the plant response information in a very interesting way helping to motivate students to learn about nuclear power plants.

The Agency arranges for the supply or development of such simulation programs and training material, sponsors training courses and workshops, and distributes documentation and the simulators.

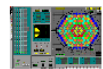
Since 1997, fourteen workshops have been held, in Egypt, Saudi Arabia, the Republic of Korea, Italy, USA and at the IAEA Headquarters in Vienna, Austria. Training has been given, and reactor simulators have been distributed to more than 260 participants from close to 50 countries, for educational purposes. The workshops are currently an annual activity sponsored by the International Centre for Theoretical Physics (ICTP) in Trieste, Italy.

Six different NPP Simulators are available for distribution covering different types of reactors, including pressurized water reactors, boiling water reactors and heavy water reactors.

The simulator manuals can be downloaded from here

- [Advanced PWR Manual](#)
- [Advanced BWR Manual](#)
- [2-loop PWR \(PCTRAN\) Manual](#)
- [CANDU-9 Manual](#)
- [ACR-700 Manual](#)
- [WWER-1000 Manual](#)

In order to obtain the simulation programs please download the [acknowledgment for the simulator](#). The completed form should be sent to the competent official authority (Ministry of Foreign Affairs, National Atomic Energy Authority, or to the applicant's Member State Permanent Mission to the IAEA in Vienna, Austria) for transmission to Mr. J. Cleveland, the International Atomic Energy Agency, P.O. Box 100, Vienna International Centre, A-1400 Vienna, Austria.



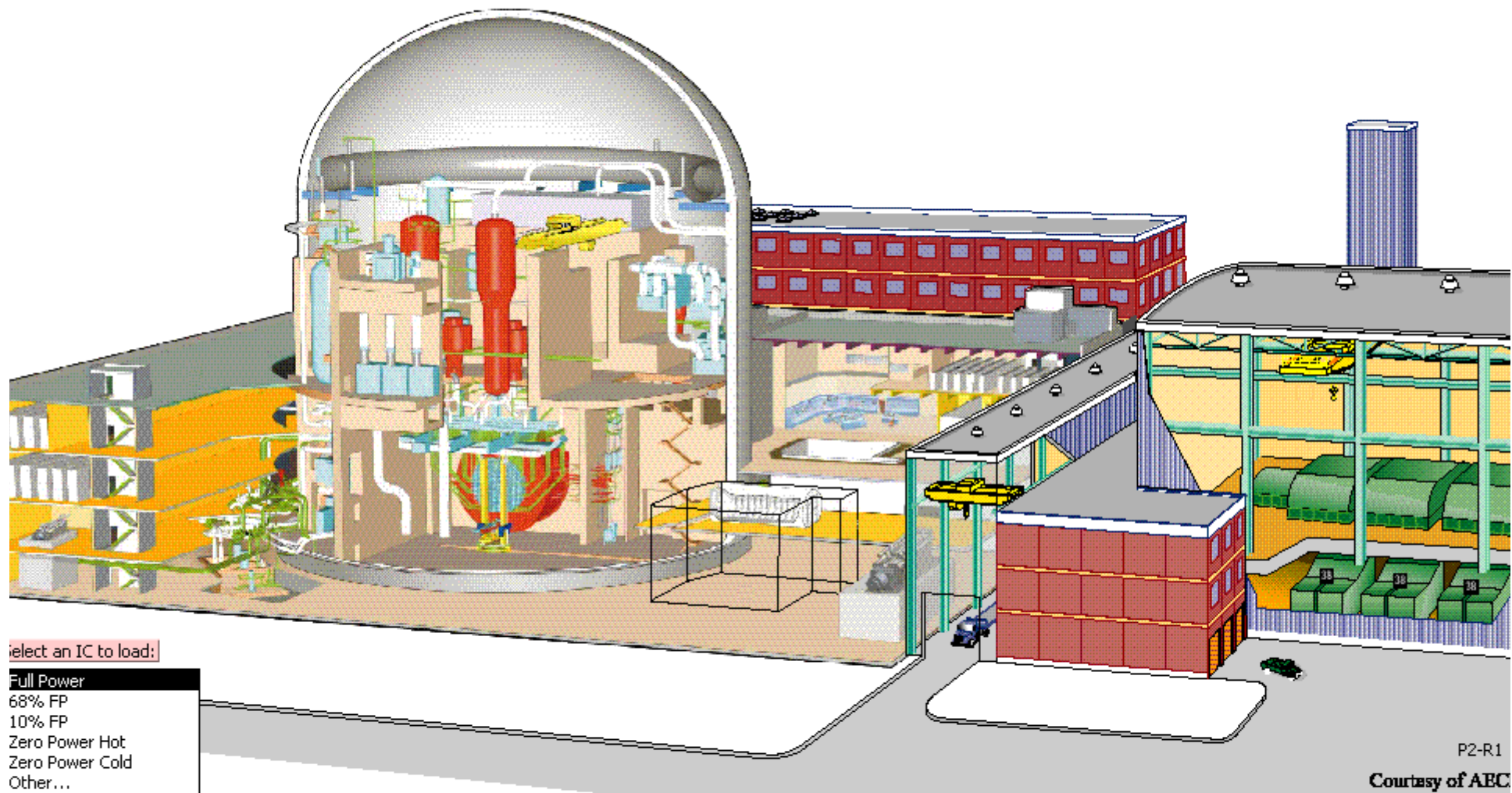
The application of the simulation programs is limited to providing general response characteristic of selected types of power reactor systems and they are not intended to be used for plant-specific purposes such as design, safety evaluation, licensing or operator training.

Done

Local intranet



GENERIC CANDU SIMULATOR



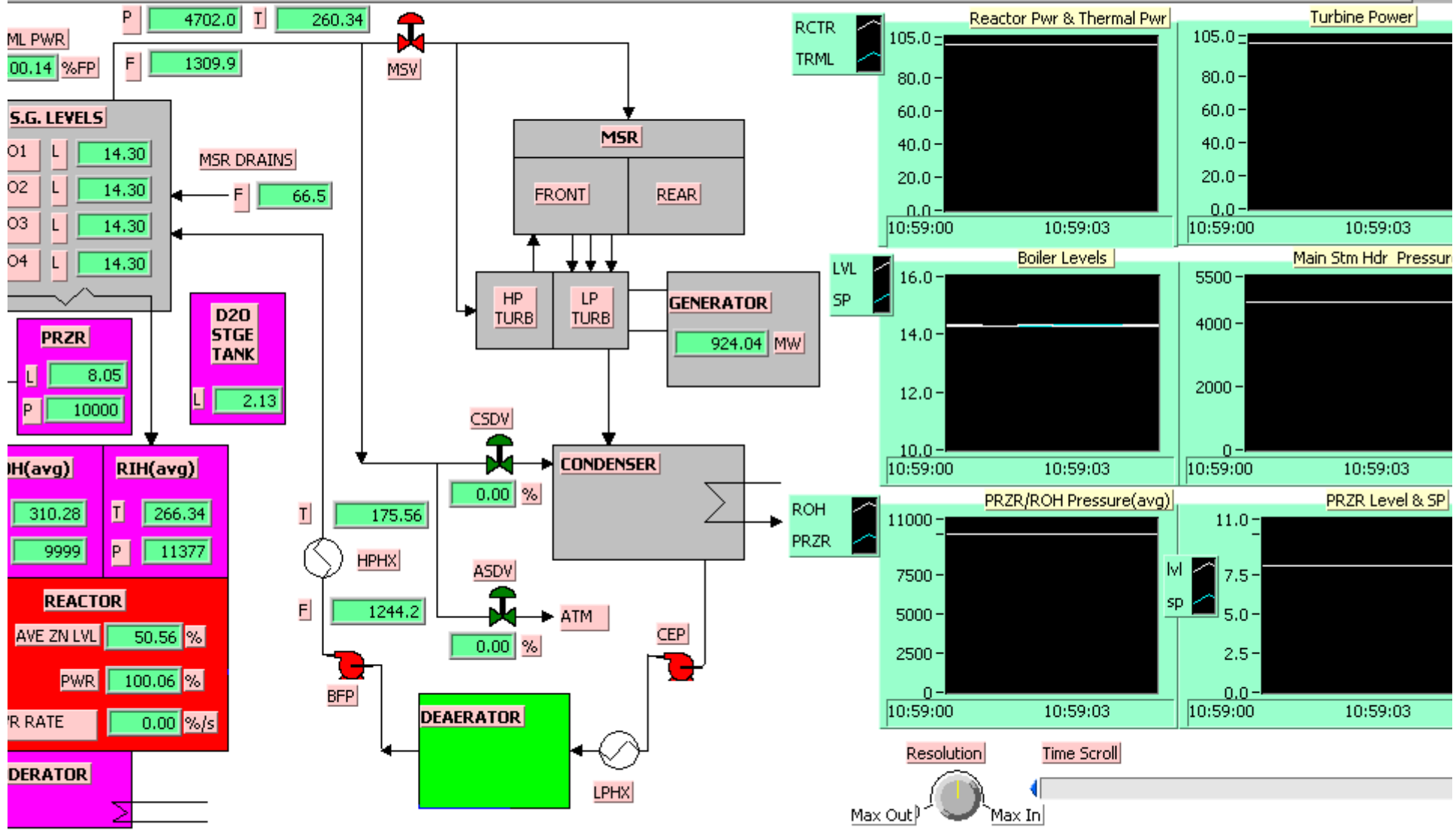
IC Filename: FP_100.IC

About ...

CASSIOPEIA TECHNOLOGIES INC.

Simulation and Control Solutions for a Competitive Edge

Reactor Trip	Turbine Trip	ROH Pres Lo Lo	Step Back Req'd	Setback Req'd	Turbine Runback	Gen Breaker Opn
Hi Neutron Pwr	ROH Press Hi Hi	Coolant Flow Lo	Stm Gen Level Lo	PRZR Lvl Hi	Low Fwd Pwr Trip	Main BFP(s) Trip
Hi Neut Pwr LogR	ROH Press Hi	Main Stm Pres Hi	Stm Gen Level Hi	PRZR Lvl Lo	Loss 1 PHT Pump	Malfunction Active

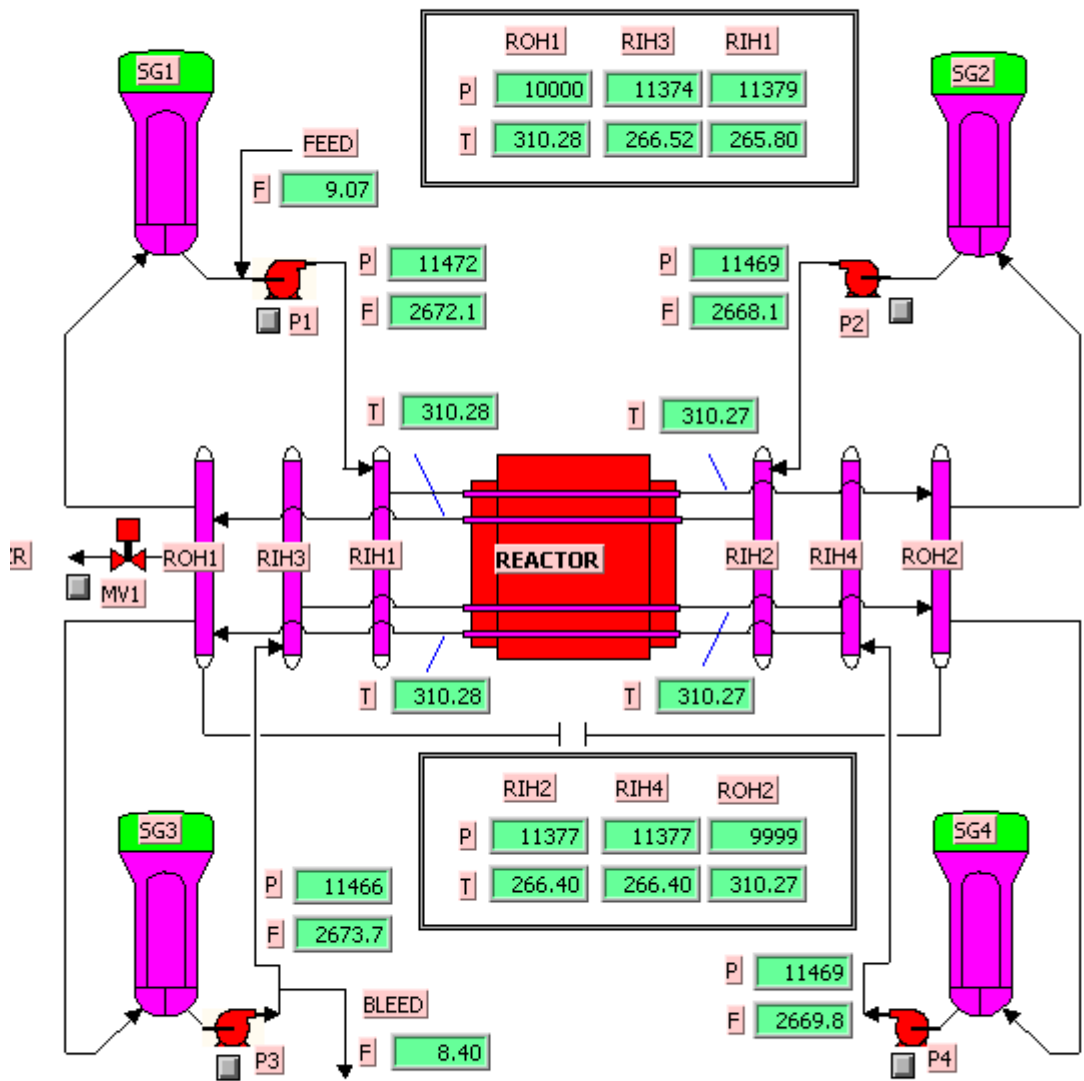


Plant Overview	Reactor Neutron Pwr (%)	Reactor Thermal Pwr (%)	Turbine Pwr (%)	Main Stm Hdr Pressure (kPa)	SG1 Lvl (m)	14.30	UPR Mode	Freeze	Run	Iter
					SG2 Lvl (m)	14.30				
	100.06	100.14	100.00	4701.96	SG3 Lvl (m)	14.30	Normal	IC	Malf	He
					SG4 Lvl (m)	14.30				



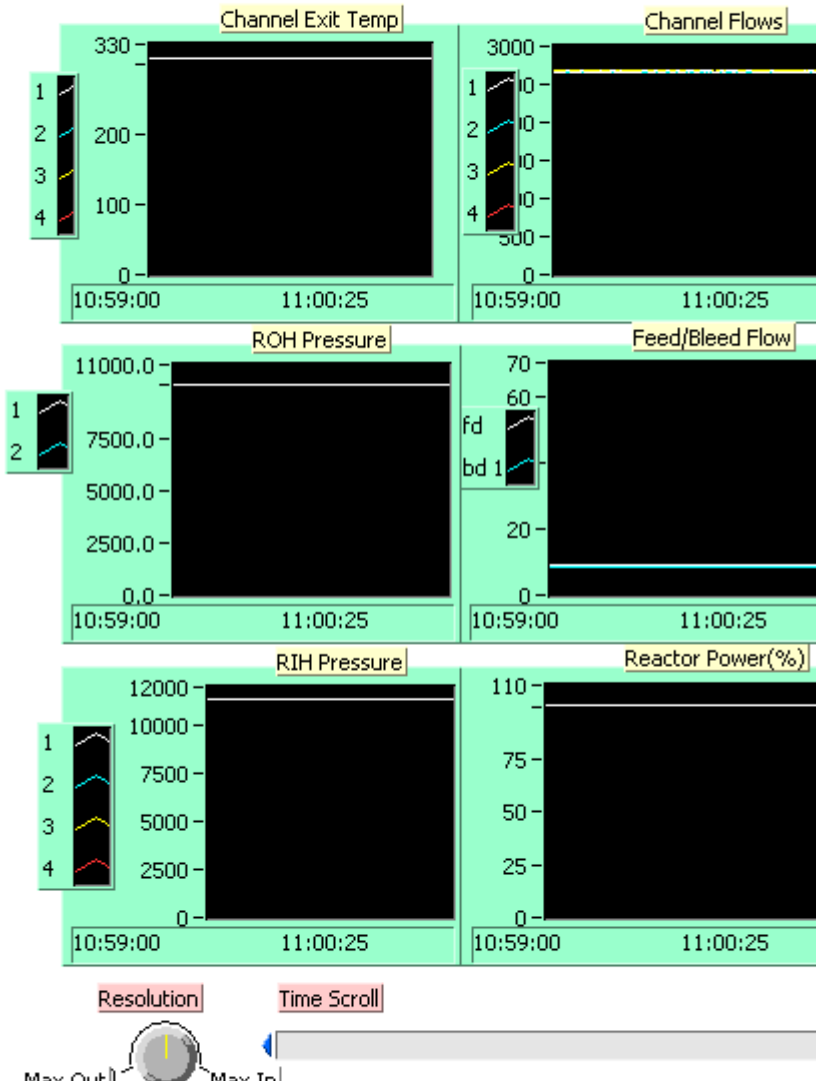
Reactor Trip	Turbine Trip	ROH Pres Lo Lo	Step Back Req'd	Setback Req'd	Turbine Runback	Gen Breaker Opn
Hi Neutron Pwr	ROH Press Hi Hi	Coolant Flow Lo	Stm Gen Level Lo	PRZR Lvl Hi	Low Fwd Pwr Trip	Main BFP(s) Trip
Hi Neut Pwr LogR	ROH Press Hi	Main Stm Pres Hi	Stm Gen Level Hi	PRZR Lvl Lo	Loss 1 PHT Pump	Malfunction Active

Labvi
CAS



	ROH1	RIH3	RIH1
P	10000	11374	11379
T	310.28	266.52	265.80

	RIH2	RIH4	ROH2
P	11377	11377	9999
T	266.40	266.40	310.27



T Main Circuit
tor Trip Turbine Trip

Reactor Neutron Pwr (%)	Reactor Thermal Pwr(%)	Turbine Pwr (%)	Main Stm Hdr Pressure (kPa)	SG1 Lvl (m)	14.30	UPR Mode
100.05	100.13	100.00	4701.92	SG2 Lvl (m)	14.30	Normal
				SG3 Lvl (m)	14.30	
				SG4 Lvl (m)	14.30	

Freeze	Run	Iter
IC	Malf	He

IAEA Generic Boiling Water Reactor Simulator

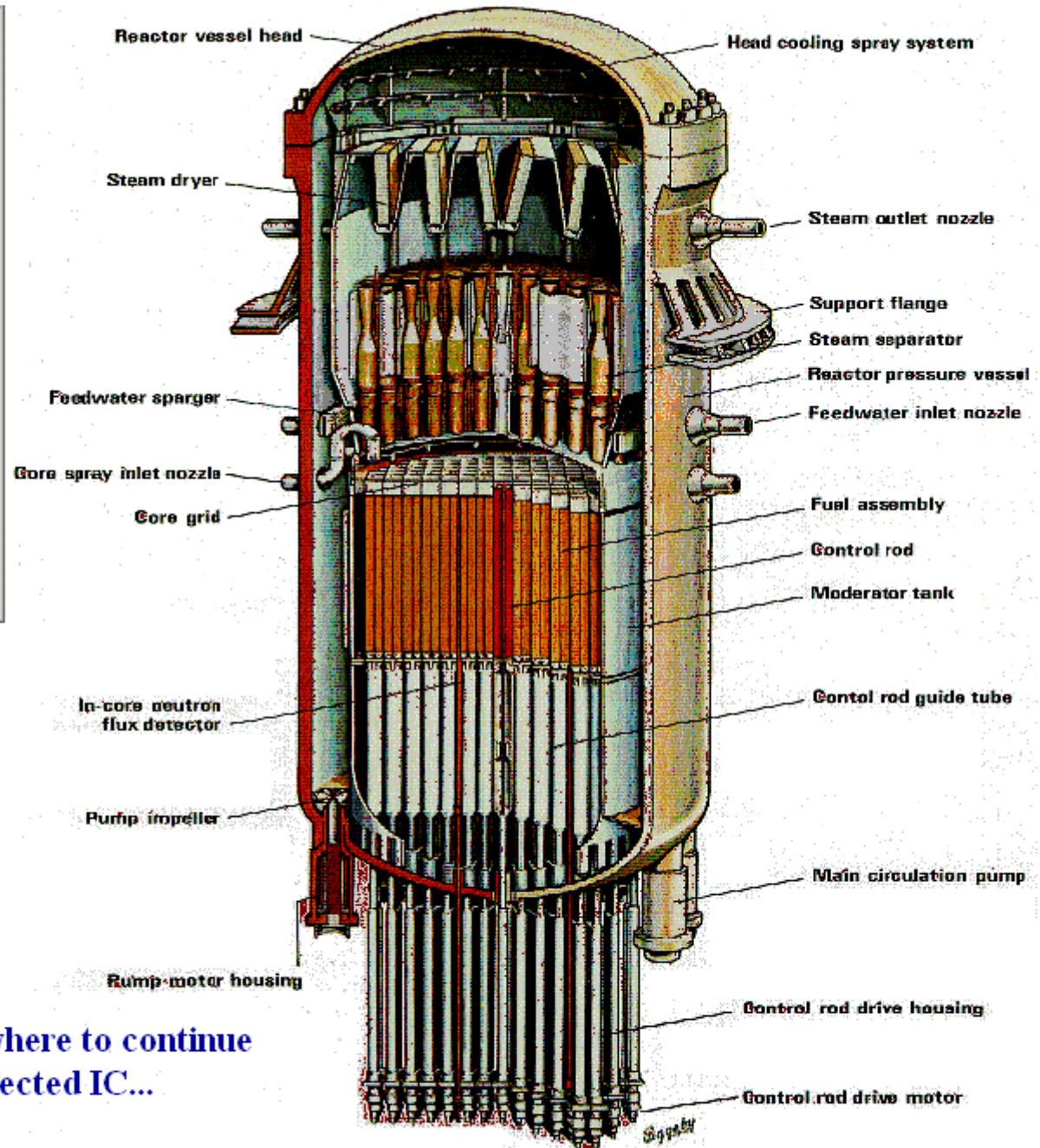


Select an IC to load:

- Full Power
- 8% FP
- 0% FP
- Zero Power Hot - No Scram
- Zero Power Hot - After Scram
- Other...

IC Filename:

[Click anywhere to continue
with the selected IC...](#)



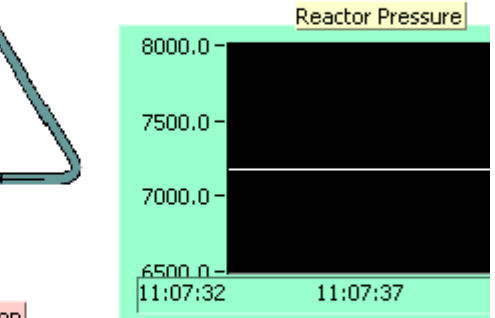
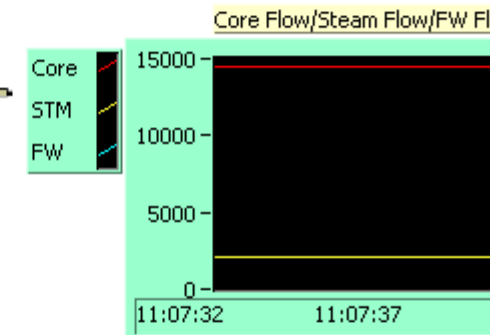
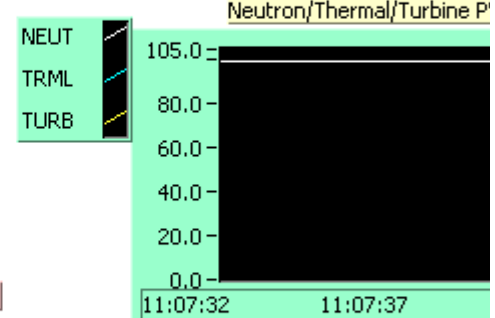
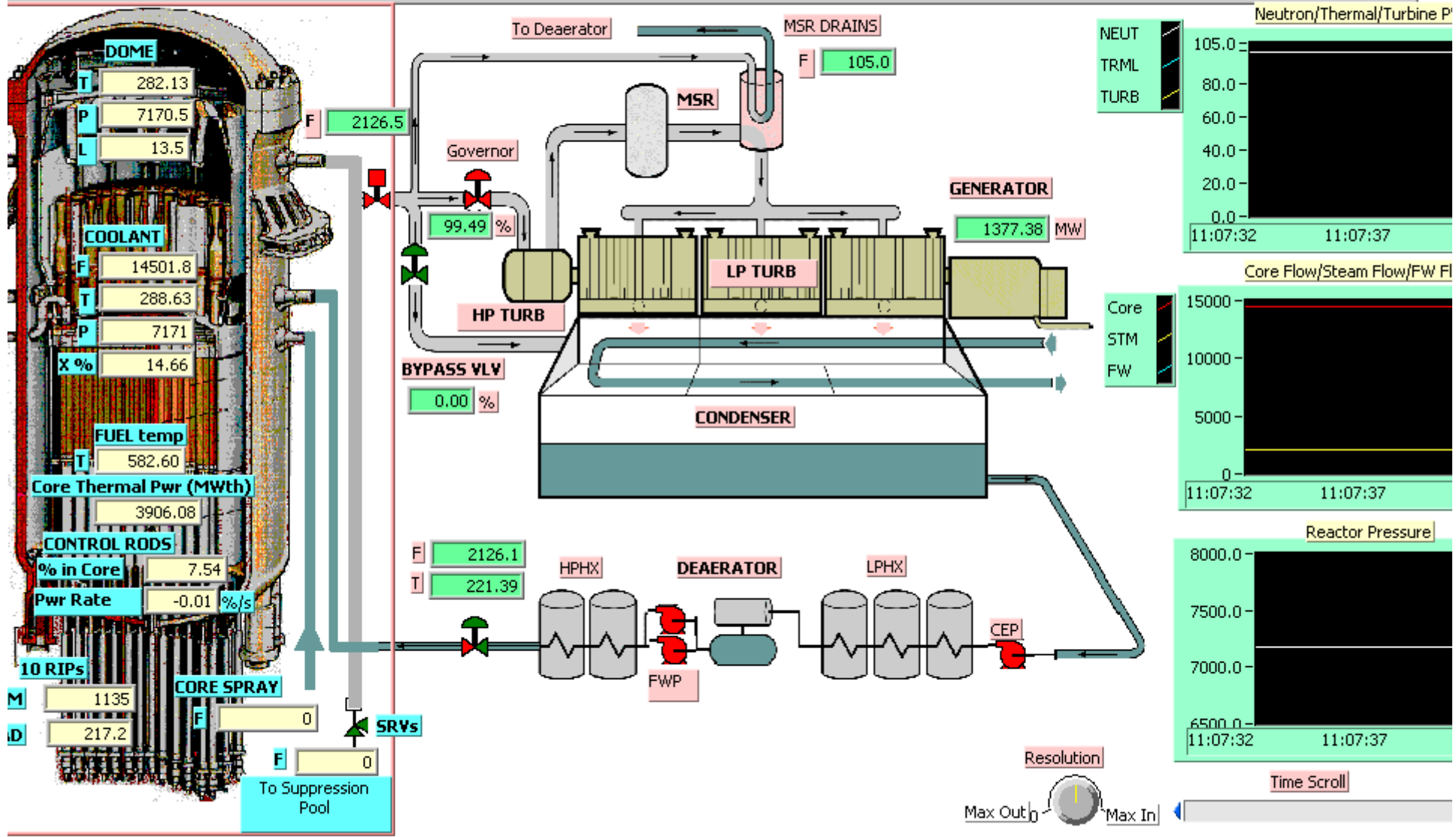
Developed by

Cassiopeia Technologies Inc.

Important - Click to read



Reactor Scram	Turbine Trip	Reactor Pres V. Lo	Rods Run-in Req'd	Hi Dryw P/LOCA	Turbine Runback	Gen Breaker Opn	Labvie
Reactor Isolated	Reactor Pres V. Hi	Reactor Pres Lo	Reactor Level Lo	Reactor Lvl V. Lo	Lo Turb Fwd Pwr	FW Pump(s) Trip	CAS
	Reactor Press Hi	Core Flow Lo	Reactor Level Hi	Spdr Gear in Man	Loss RIP Pmp(s)	Malfunction Active	



Resolution

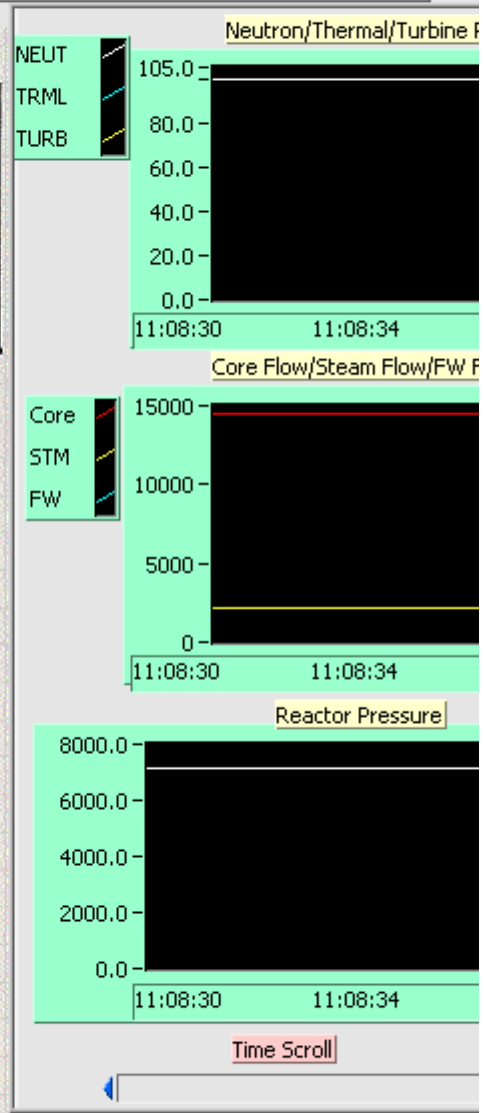
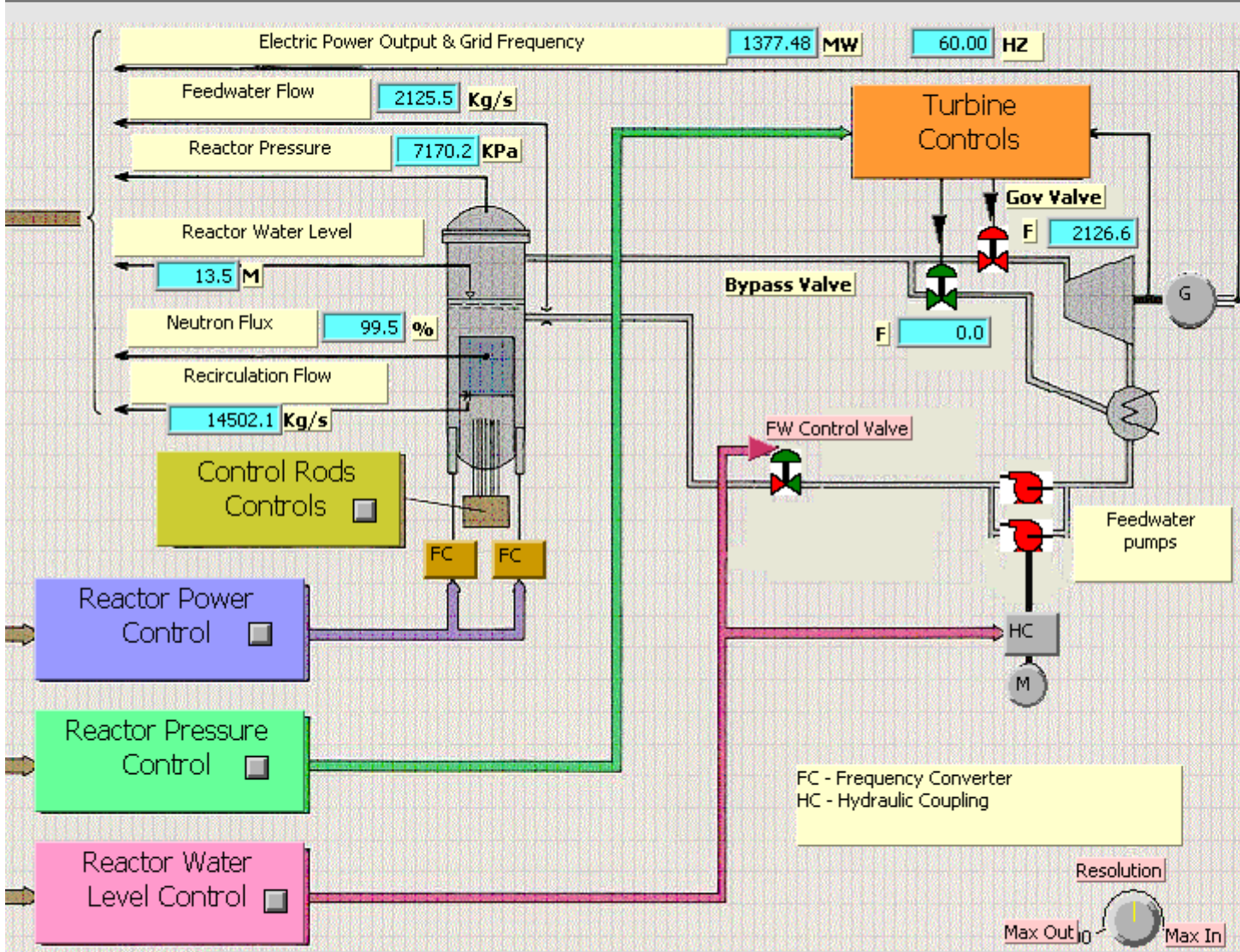
Max Out Max In

Time Scroll

BWR Plant Overview	Reactor Neutron Pwr (%)	Reactor Thermal Pwr (%)	Generator Output (%)	Reactor Pressure (kPa)	Core Flow (kg/s)	RCTR Lvl	13.5	Freeze	Run	Itera
						BOP STM Flow	2126.5			
						FW Flow	2126.1	IC	Malf	Hel



Reactor Scram	Turbine Trip	Reactor Pres V. Lo	Rods Run-in Req'd	Hi Dryw P/LOCA	Turbine Runback	Gen Breaker Opn
Reactor Neut Pwr vs Flow	Reactor Pres V. Hi	Reactor Pres Lo	Reactor Level Lo	Reactor Lvl V. Lo	Lo Turb Fwd Pwr	FW Pump(s) Trip
Reactor Isolated	Reactor Press Hi	Core Flow Lo	Reactor Level Hi	Spdr Gear in Man	Loss RIP Pmp(s)	Malfunction Active



VR Control Loops	Reactor Neutron Pwr (%)	Reactor Thermal Pwr (%)	Generator Output (%)	Reactor Pressure (kPa)	Core Flow (kg/s)	RCTR Lvl	13.5	Freeze	Run	Iter:
	Reactor Trip	99.46	99.48	99.46	7170.21	14502.08	BOP STM Flow			
							FW Flow	2125.5	IC	Malf
							Fuel Temp	582.6		He

IAEA Generic Pressurized Water Reactor Simulator



Click anywhere to continue
with the selected IC...

Select an IC to load:

Full Power
68% FP
10% FP
Zero Power Hot - No Scram
Zero Power Hot - After Scram
Other...

IC Filename: FP_100.IC

STEAM
GENERATOR #1

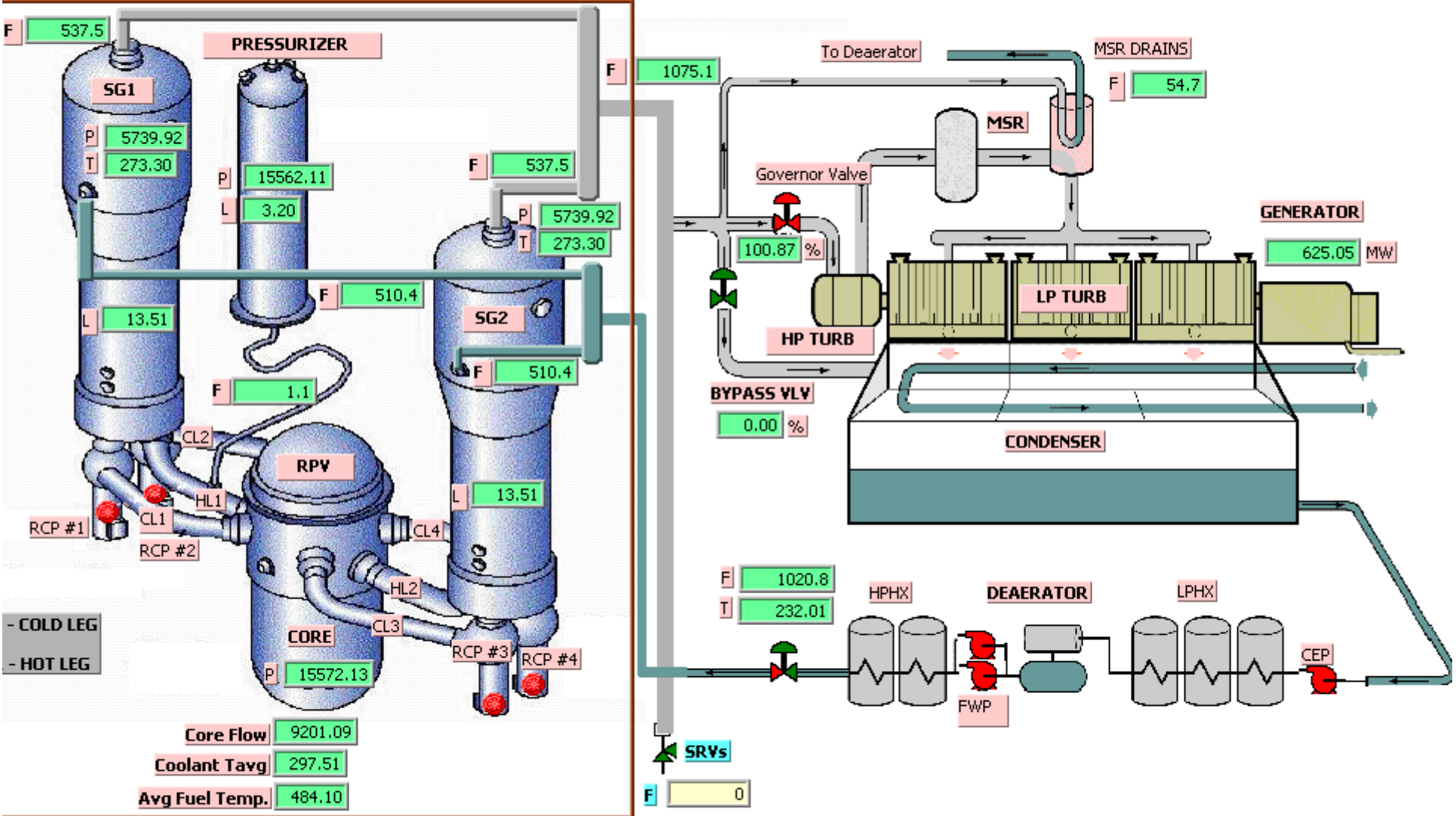
PRESSURIZER

STEAM
GENERATOR #2

REACTOR
PRESSURE
VESSEL



Reactor Trip	Turbine Trip	RC Press Lo Lo	Step Back Req'd	Setback Req'd	Turbine Runback	Gen Breaker Opn	Labvie
Hi Neutron Pwr	RC Press Hi Hi	Coolant Flow Lo	Stm Gen Level Lo	PRZR Lvl Hi	Low Fwd Pwr Trip	Main BFP(s) Trip	CASS
Hi Neut Pwr LogR	RC Press Hi	Main Stm Pres Hi	Stm Gen Level Hi	Spdr Gear in Man	Loss RC Pmp(s)	Malfunction Active	



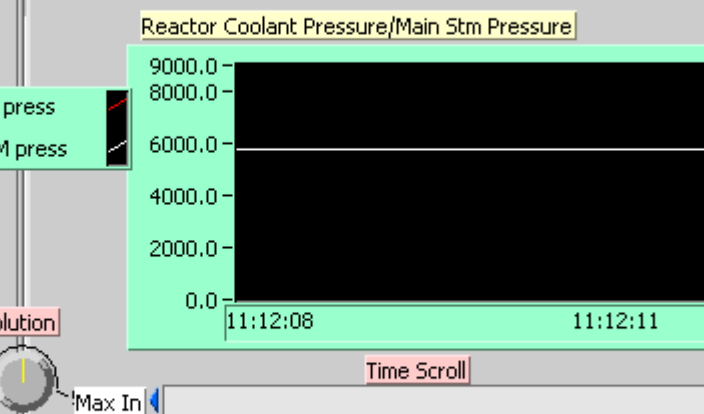
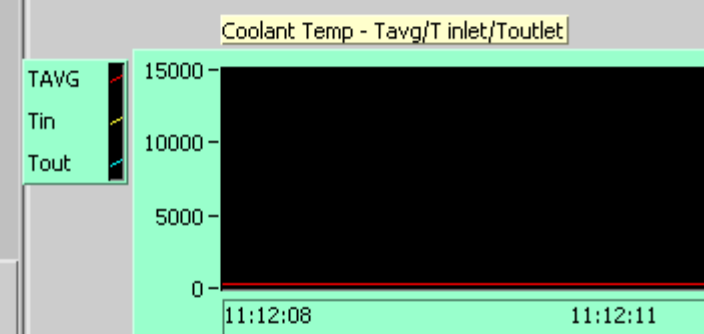
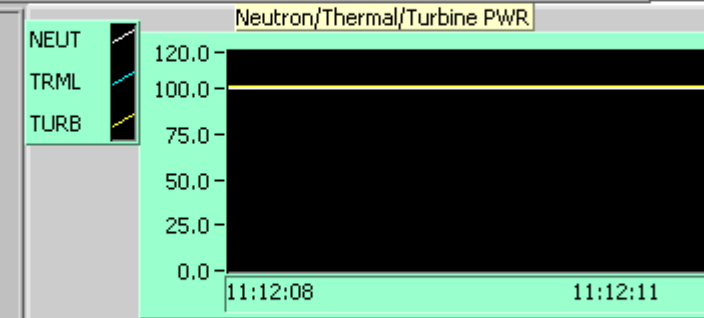
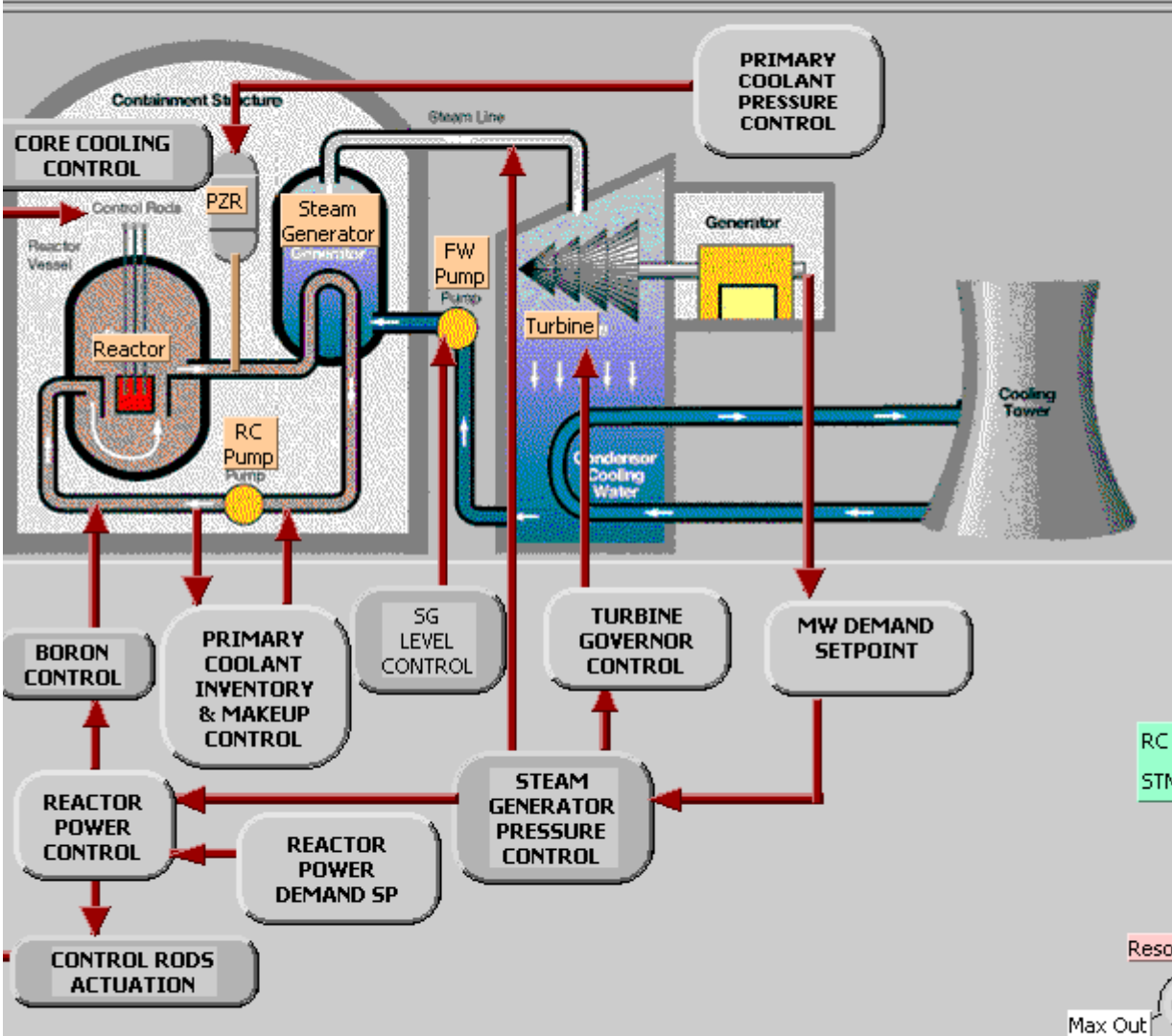
PWR Plant Overview	
Reactor Trip	Turbine Trip

Reactor Neutron Pwr (%)	Reactor Thermal Pwr(%)	Generator Output(%)	Primary Coolant Pressure (kPa)	Core Flow (kg/s)	Main STM Press	5739.9
99.97	100.31	100.98	15572.13	9201.09	BOP STM Flow	1075.1
					FW Flow	1020.8
					Fuel Temp	484.1

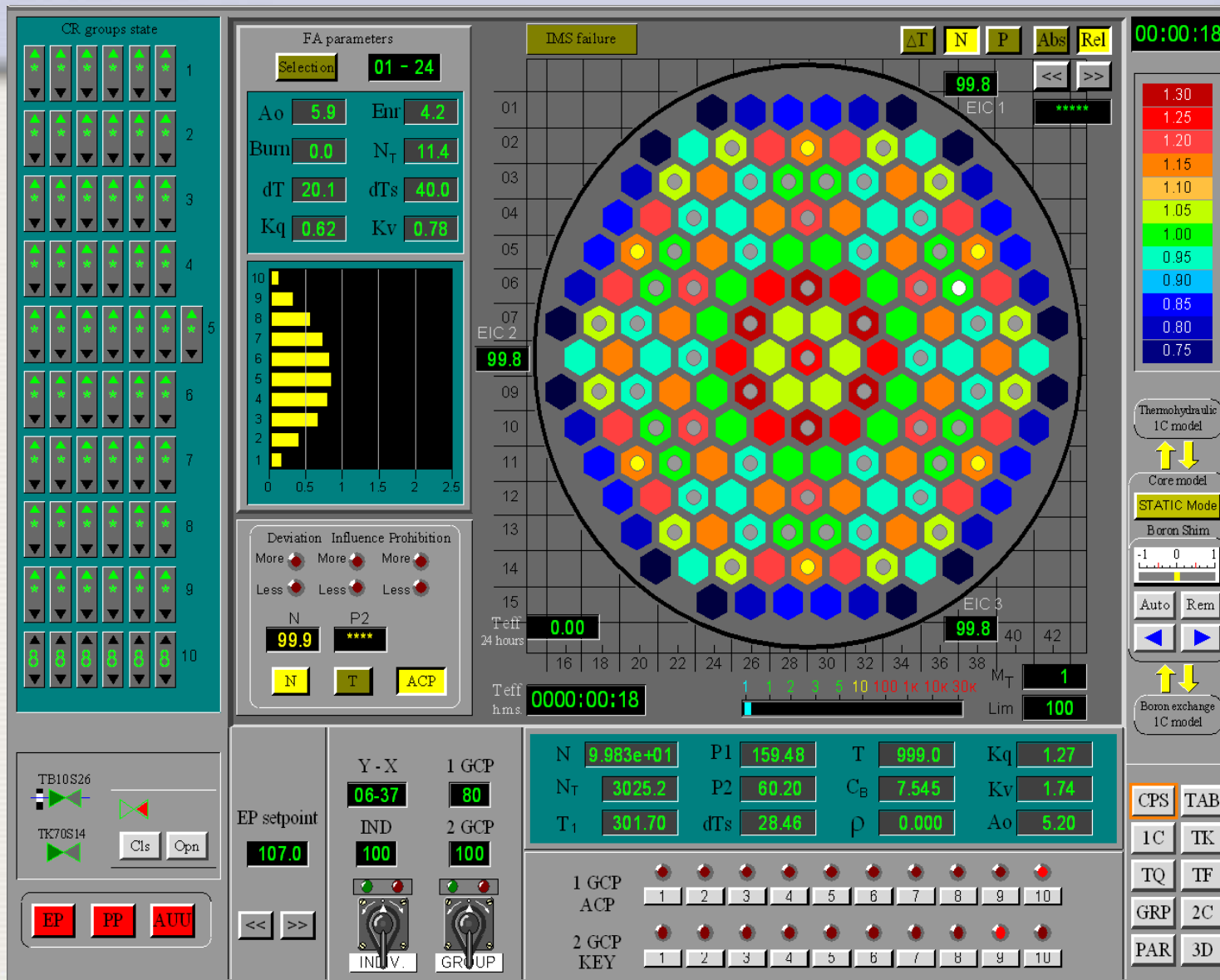
Freeze	Run	Iter
IC	Malf	He

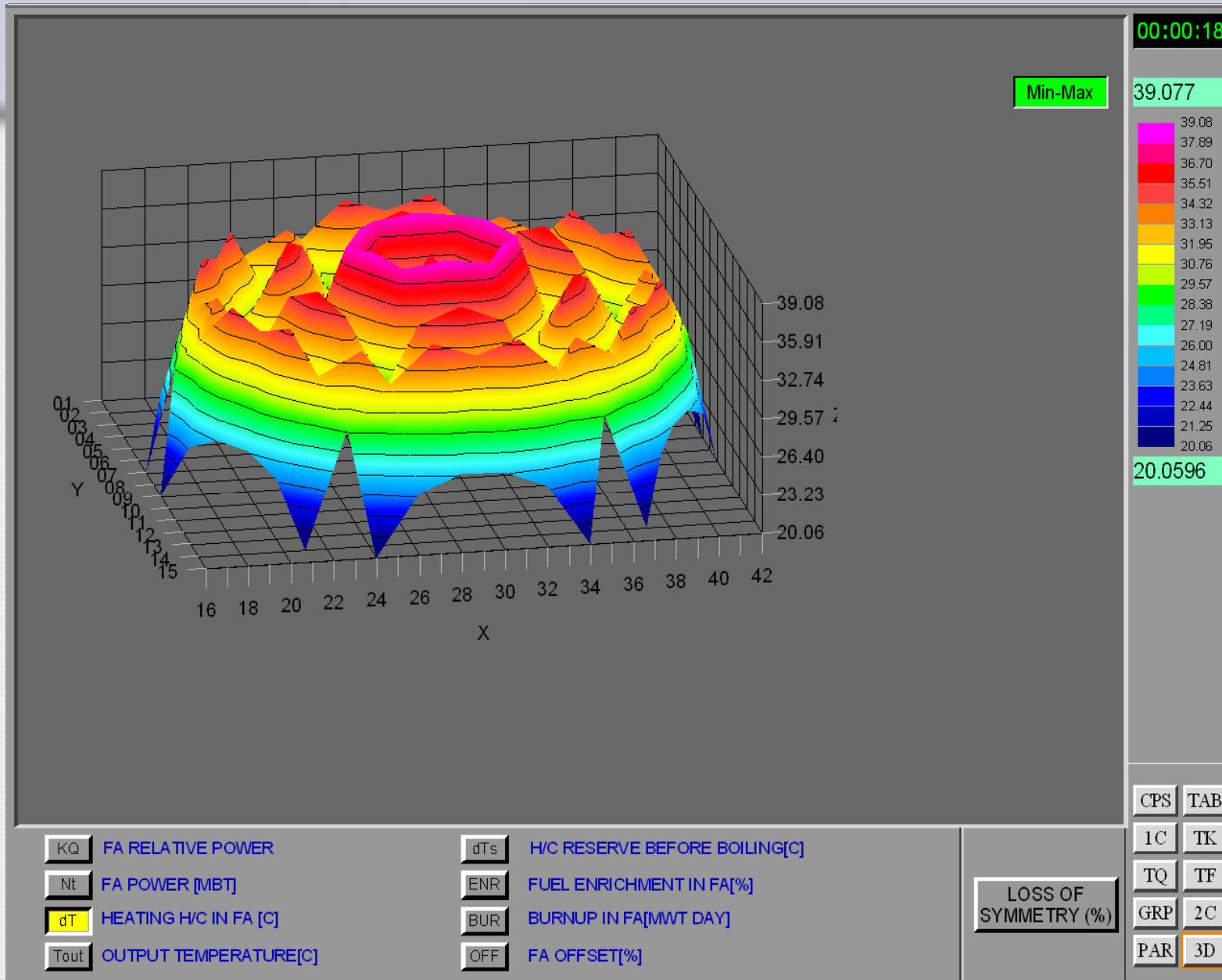


Reactor Trip	Turbine Trip	RC Press Lo Lo	Step Back Req'd	Setback Req'd	Turbine Runback	Gen Breaker Opn	Labvi
Hi Neutron Pwr	RC Press Hi Hi	Coolant Flow Lo	Stm Gen Level Lo	PRZR Lvl Hi	Low Fwd Pwr Trip	Main BFP(s) Trip	CAS
Hi Neut Pwr LogR	RC Press Hi	Main Stm Pres Hi	Stm Gen Level Hi	Spdr Gear in Man	Loss RC Pmp(s)	Malfunction Active	



WR Control Loops		Reactor Neutron Pwr (%)	Reactor Thermal Pwr (%)	Generator Output (%)	Primary Coolant Pressure (kPa)	Core Flow (kg/s)	Main STM Press	BOP STM Flow	FW Flow	Fuel Temp	Freeze	Run	Iter
Reactor Trip	Turbine Trip	99.97	100.31	100.98	15572.13	9201.09	5739.9	1075.1	1020.8	484.1	IC	Malf	He



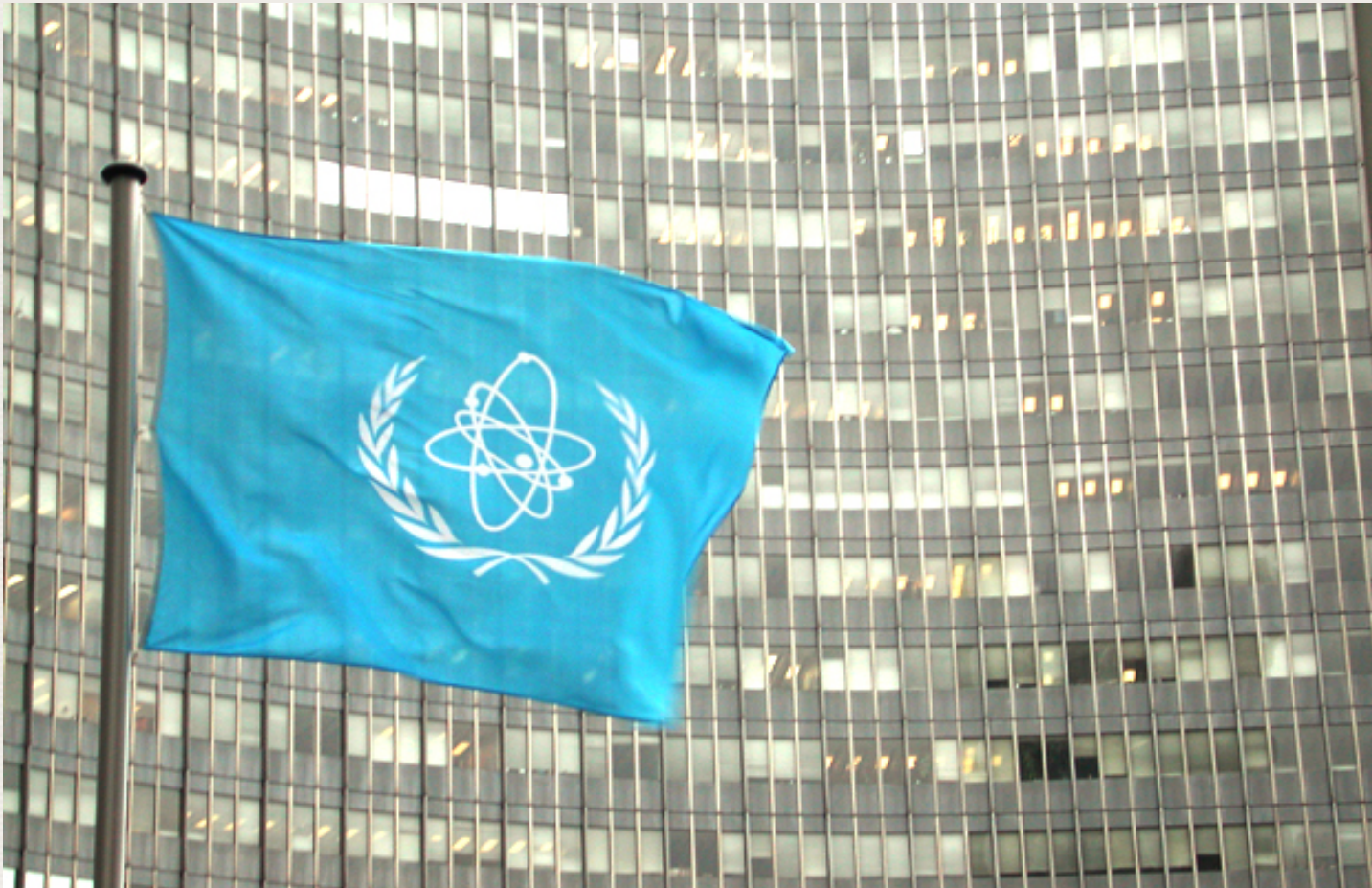


NPP Simulators for Education

- **L I V E D E M O**
 - Reactor trip (CANDU-9), 15 mins



IAEA



...atoms for peace



School of Nuclear Knowledge Management, 1-5 September 2008, ICTP, Trieste, Italy