THE SOCIETY FOR MODELING & SIMULATION INTERNATIONAL

POWERPLANTSIM
Simulation Conference 2018
JANUARY 14-17, 2018
JW Marriott Houston Downtown, Houston, Texas

Education on nuclear fundamentals with iPWR Basic Principle Simulator

60 Years providing Solutions to our Clients

Company Milestones

1957 — COMPANY FOUNDATION

1962 — ZORITA NPP PROGRAM STARTS

70's — DEVELOPMENT OF SPANISH NPP PROGRAM

1975-1979
- Automated Inspection Systems
- Full Scope Simulators

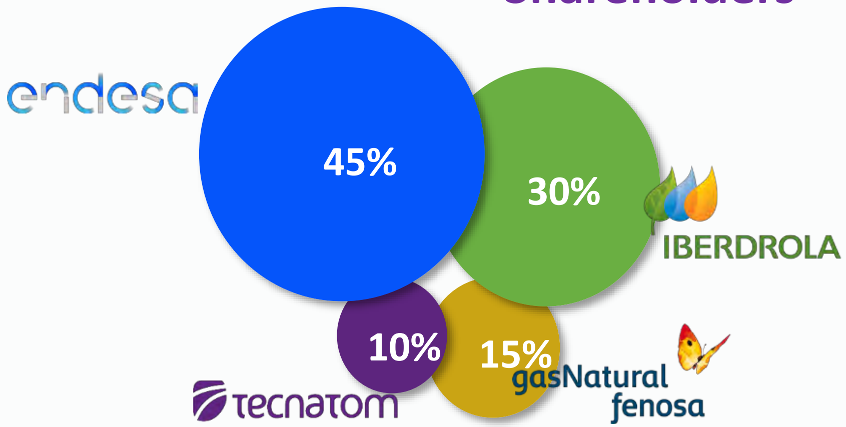
80's — TECHNOLOGICAL INDEPENDENCE ACHIEVED

90's
- Internationalization in Nuclear Markets
- Consolidation of Strategic Alliances

2000's
- Diversification to Synergic Markets

2010's — grupo tecnatom — TECNATOM AS INTERNATIONAL GROUP

Shareholders



Corporate Presentation

International Footprint

group tecnatom

tecnatom

tecnatom Mexico

tecnatom Abu Dhabi

tecnatom Metalscan

tecnatom brasil

M2M

tecnatom china–中国

CITEC

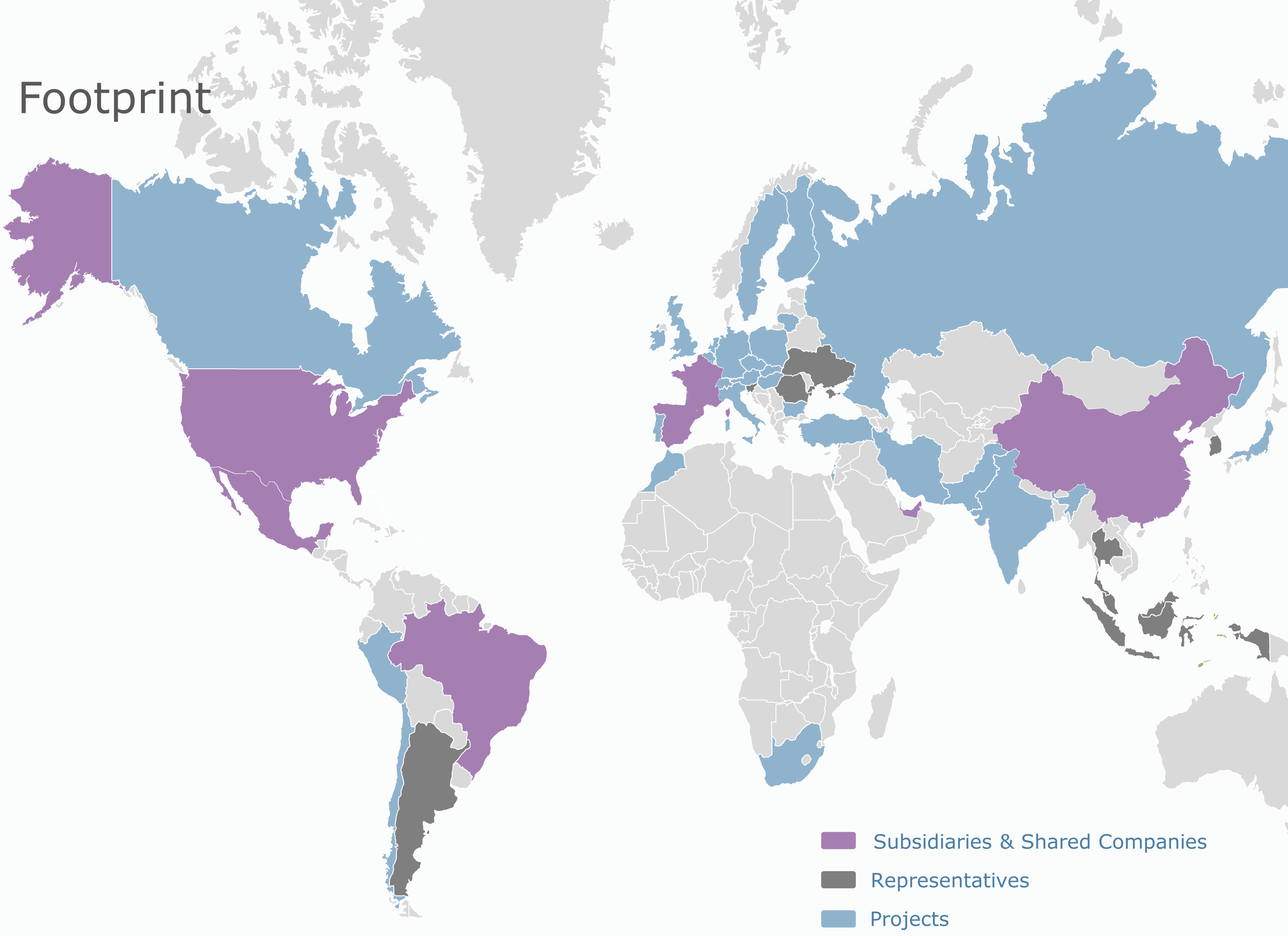
tecnatom USA

IBERCAL S.L.U. Inspectores y Consultores

sertec

SNGC

FarField



Value proposition

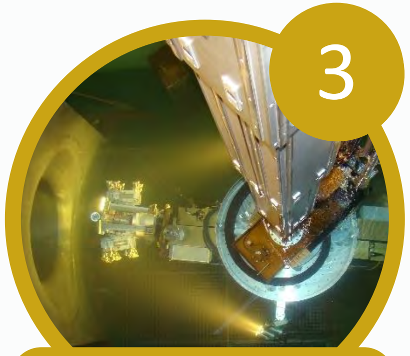
Develop and implement integrated and innovative solutions that promote the safety, efficiency and reliability of your assets, processes and the performance of people

1

Training & Safety

2

Operation



3

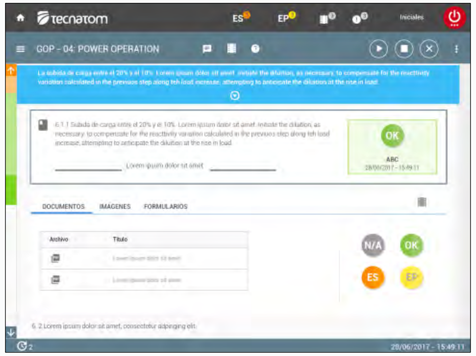
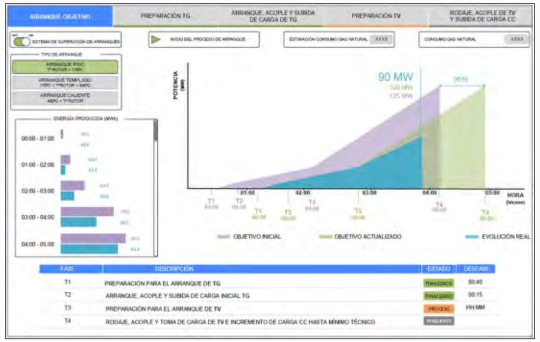
Inspection & Testing

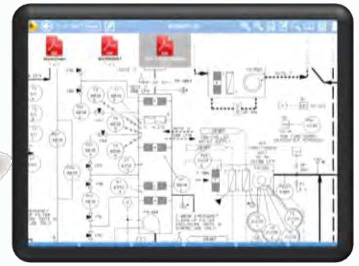
4

Technology & Product

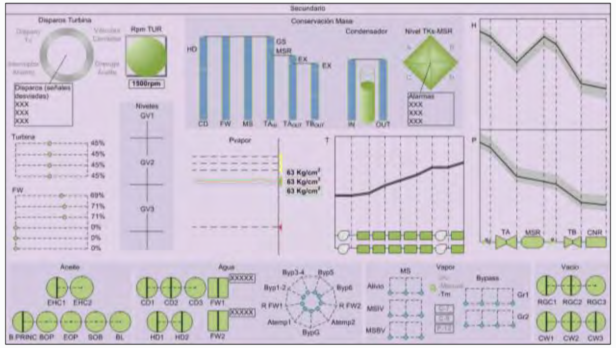
Digital Operation and Asset Management

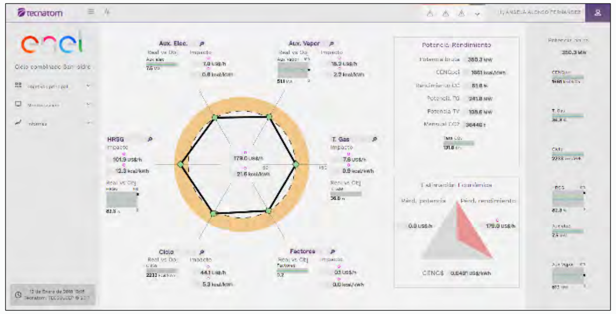
Operation support

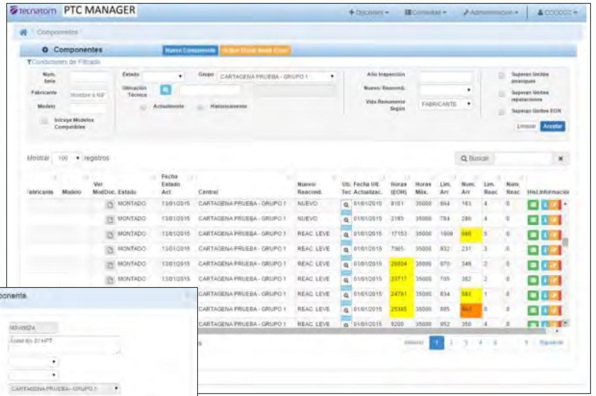


Monitoring

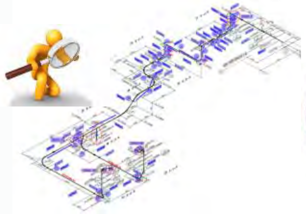


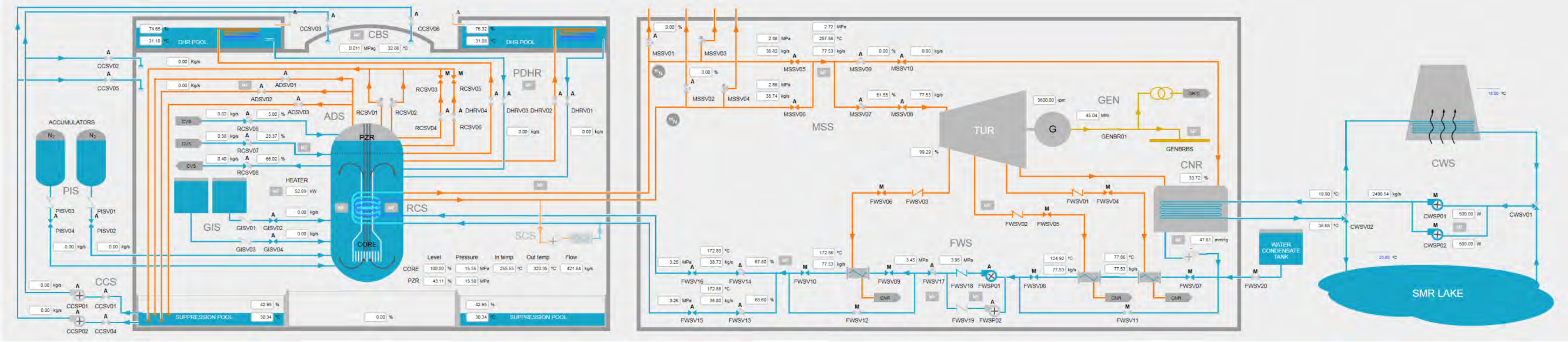
Asset management








Integral Pressurized Water Reactor (iPWR) Simulator

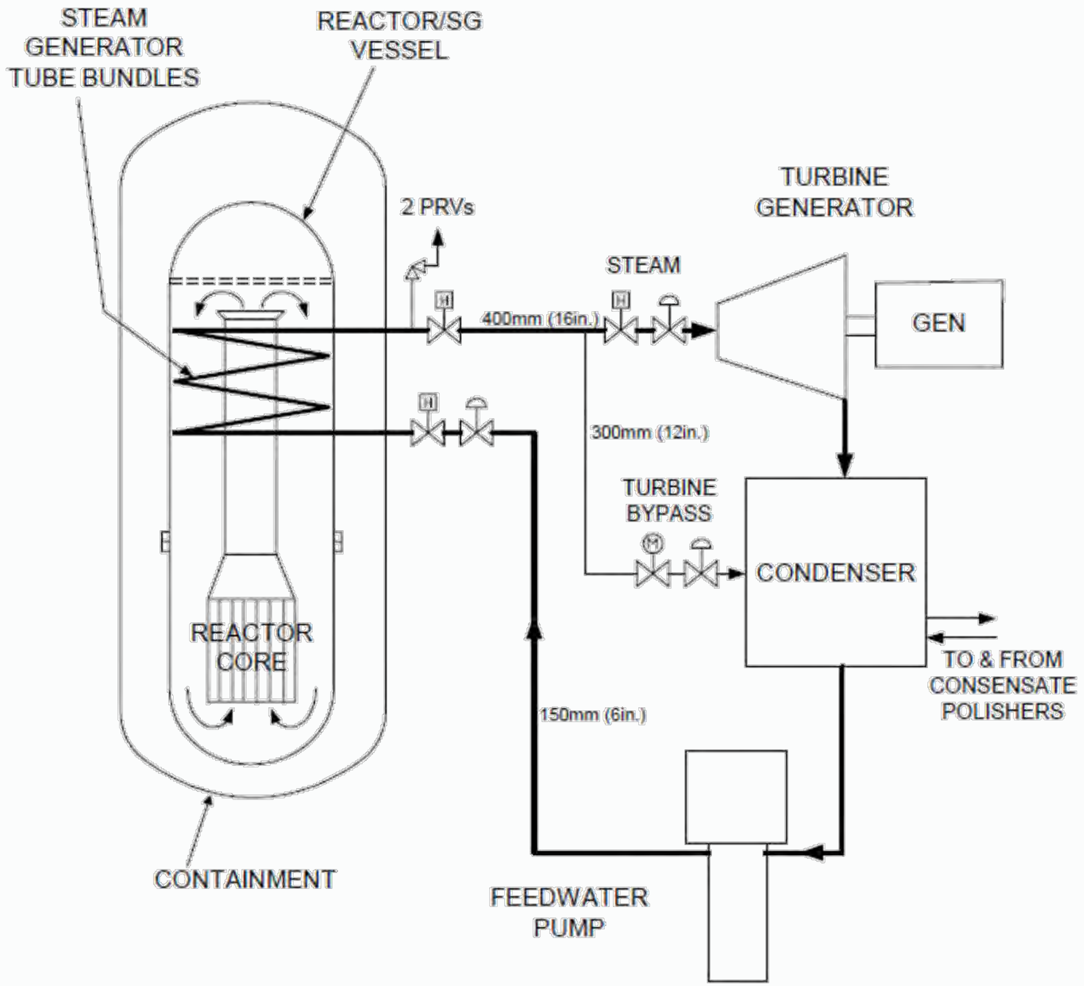


Scope:

Basic Principle Simulator – Generic behavior
Small Modular Reactor, iPWR type
Part of IAEA´s collection of Basic Principle Simulators for Education
Fully developed with Tecnatom´s simulation technology

https://www.iaea.org/NuclearPower/Simulators/

Integral Pressurized Water Reactor (iPWR) Simulator



Main thermal-hydraulic parameters:

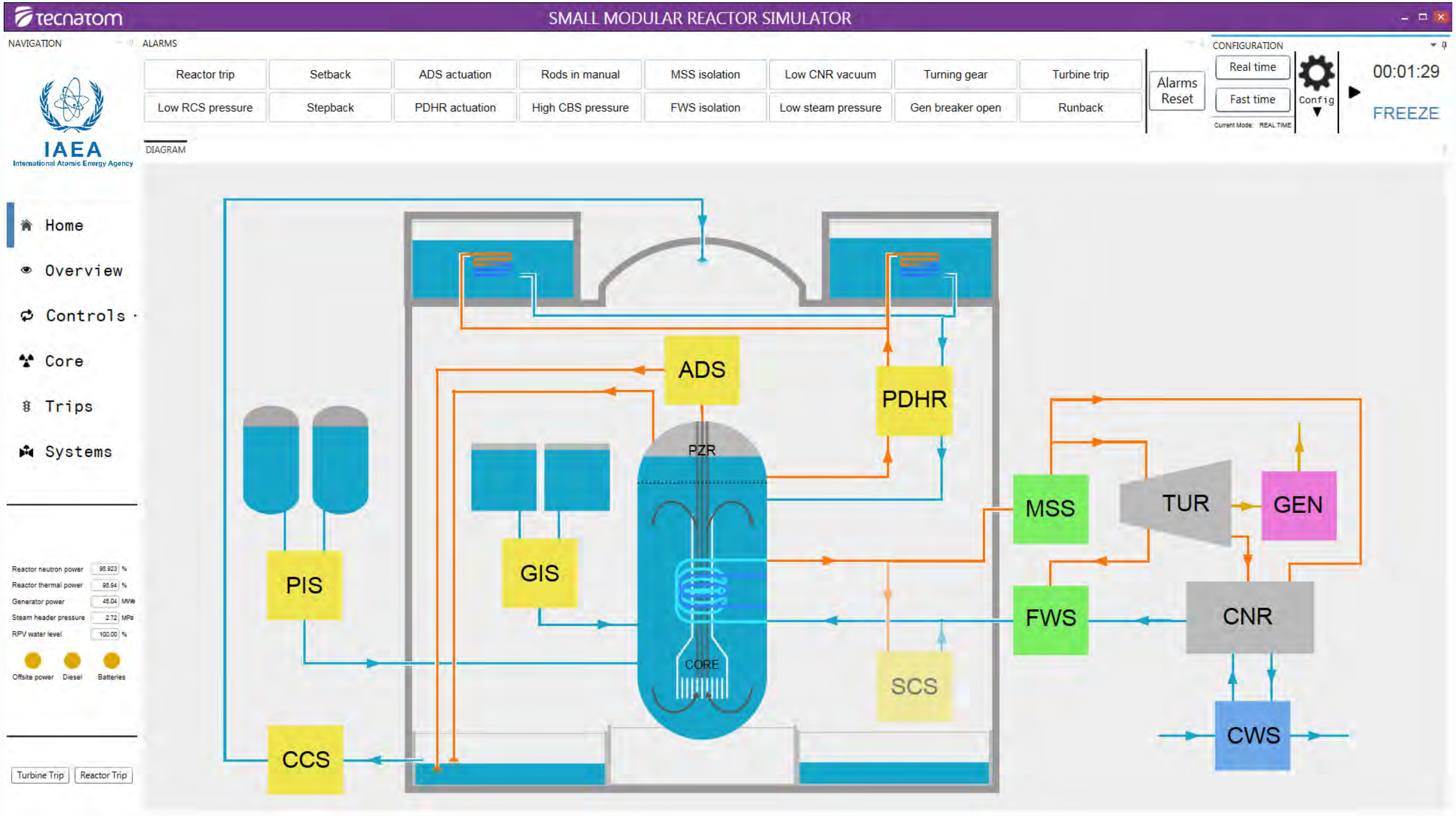
- Reactor termal power ~ 150 MW
- Electrical power ~ 45 Mwe
- PZR pressure ~ 15.5 Mpa
- Feedwater flow ~ 79 Kg/s

Passive safety:

- Automatic Depressurisation system (ADS)
- Pressure Injection system (PIS)
- Gravity Injection system (GIS)
- Passive decaay heat removal (PDHR)

Education on nuclear fundamentals with iPWR Basic Principle Simulator

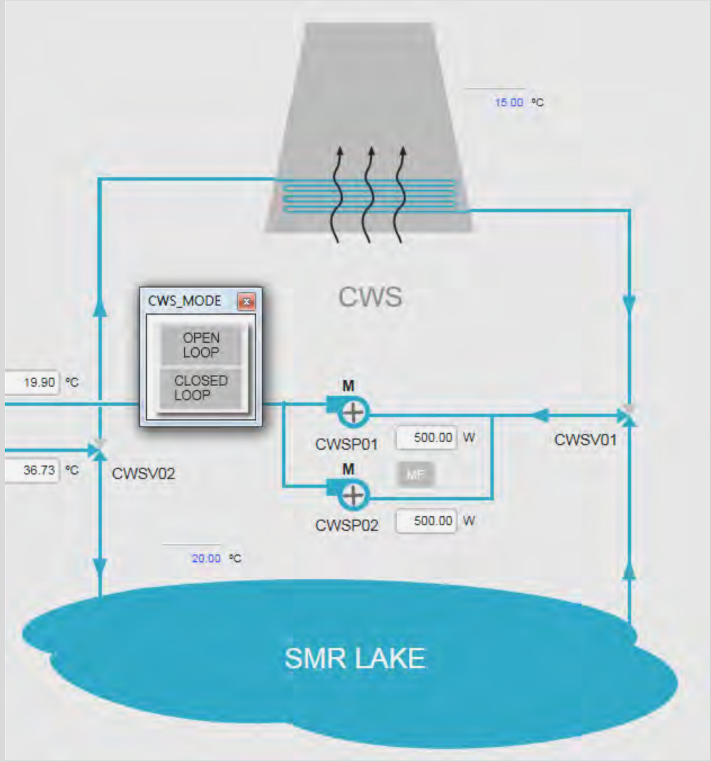
Integral Pressurized Water Reactor (iPWR) Simulator



Configuration capabilities

Operating modes

- ✓ Reactor Leading Mode
- ✓ Turbine Leading Mode

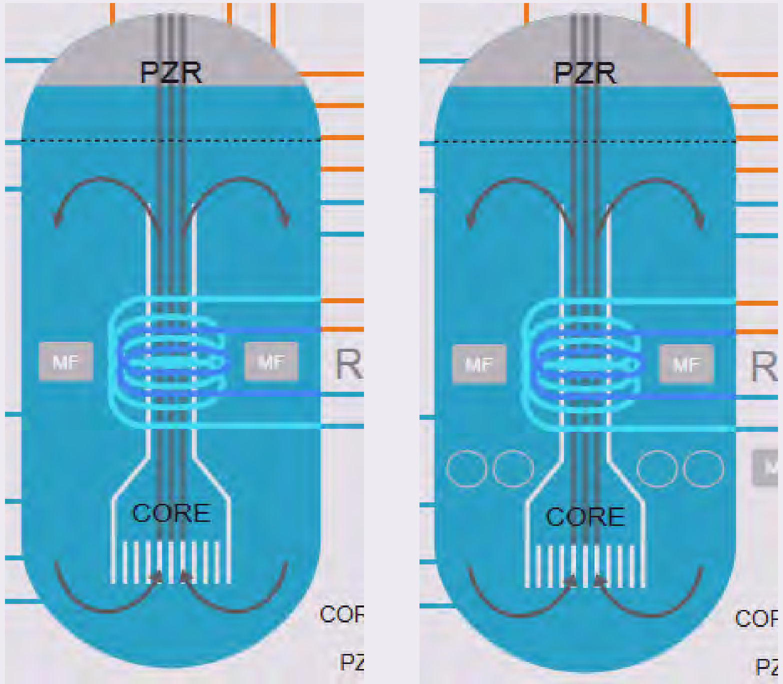


Circulating water cooling

- ✓ Open loop
- ✓ Closed loop

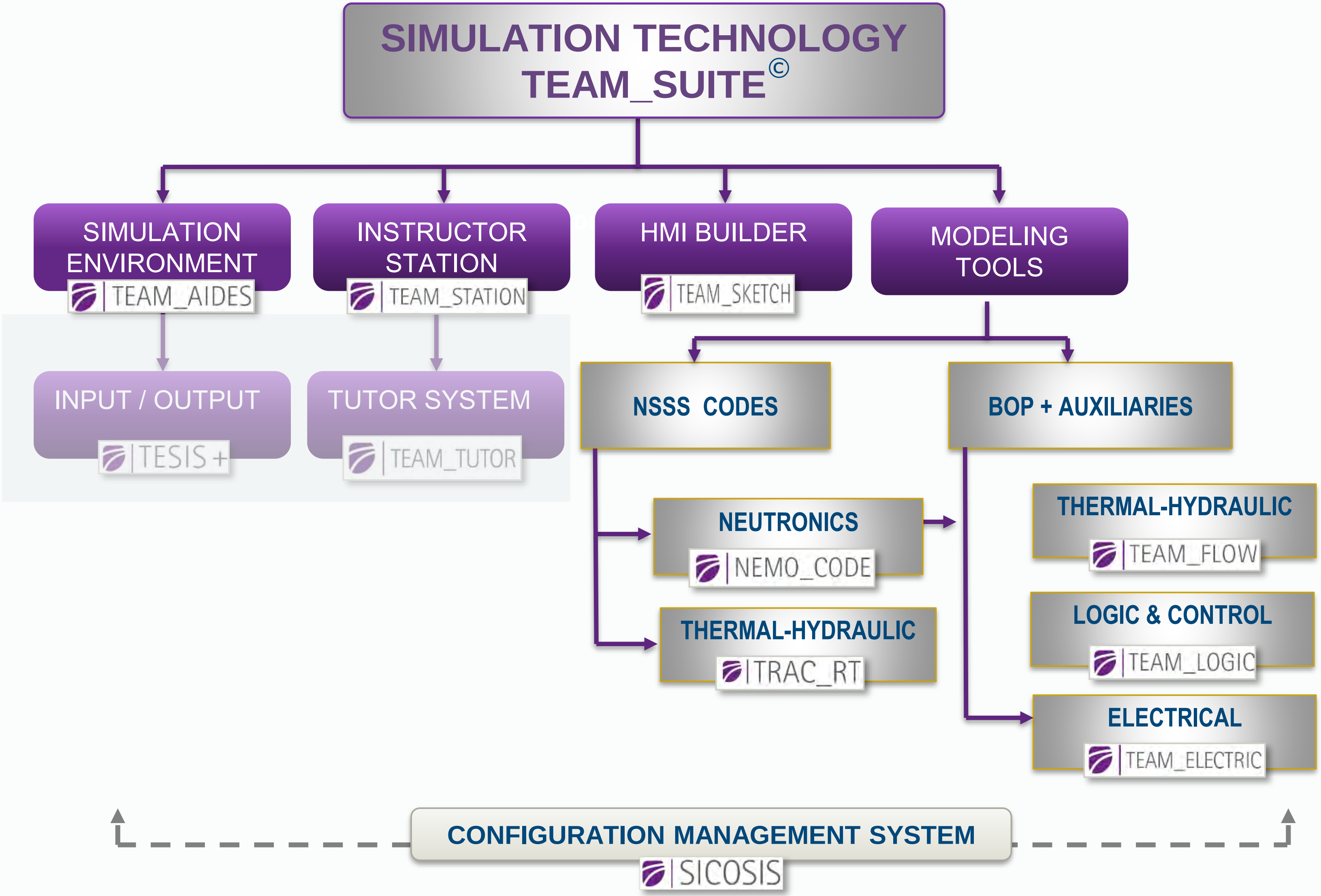
Core cooling

- ✓ Natural circulation
- ✓ Forced circulation

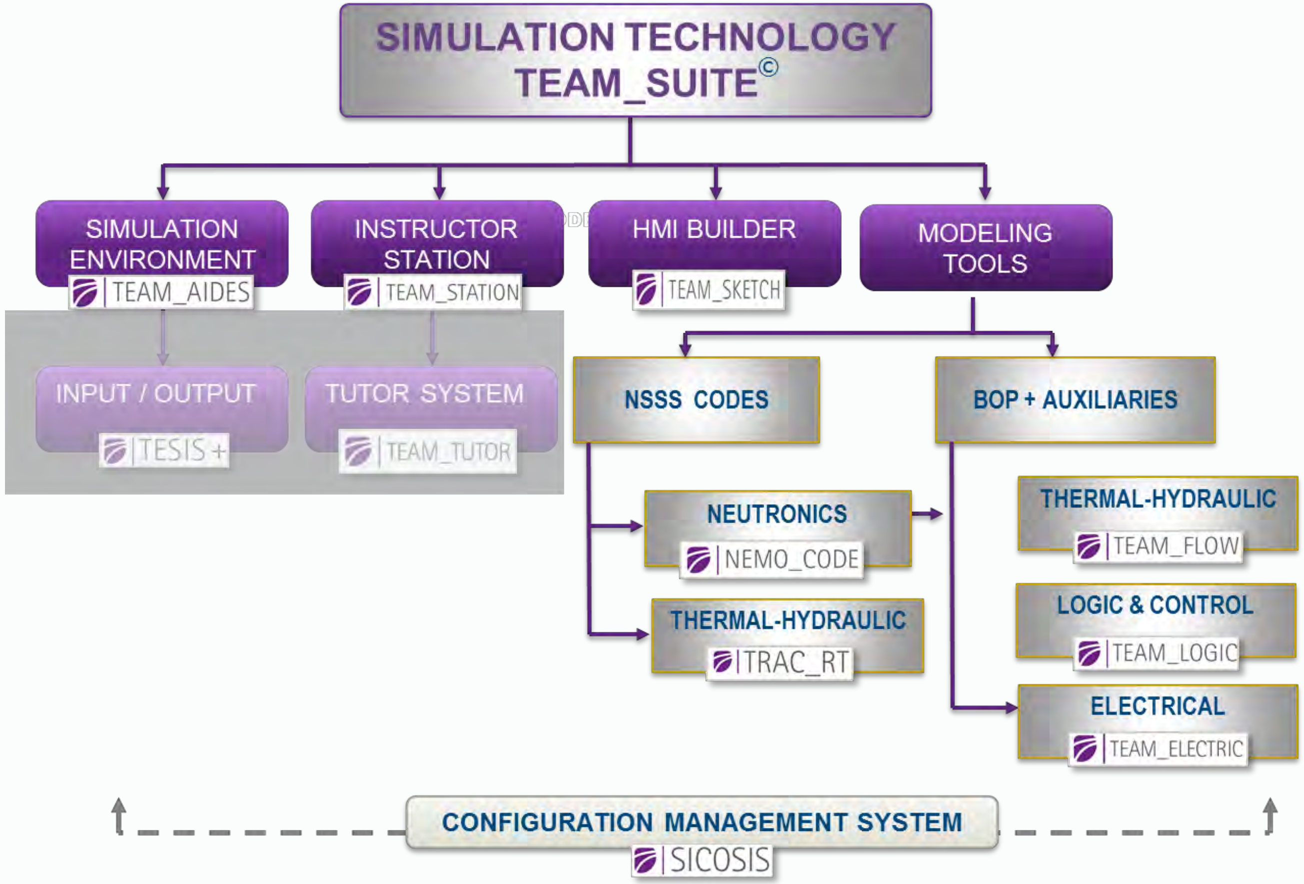


Setpoints

Technological approach



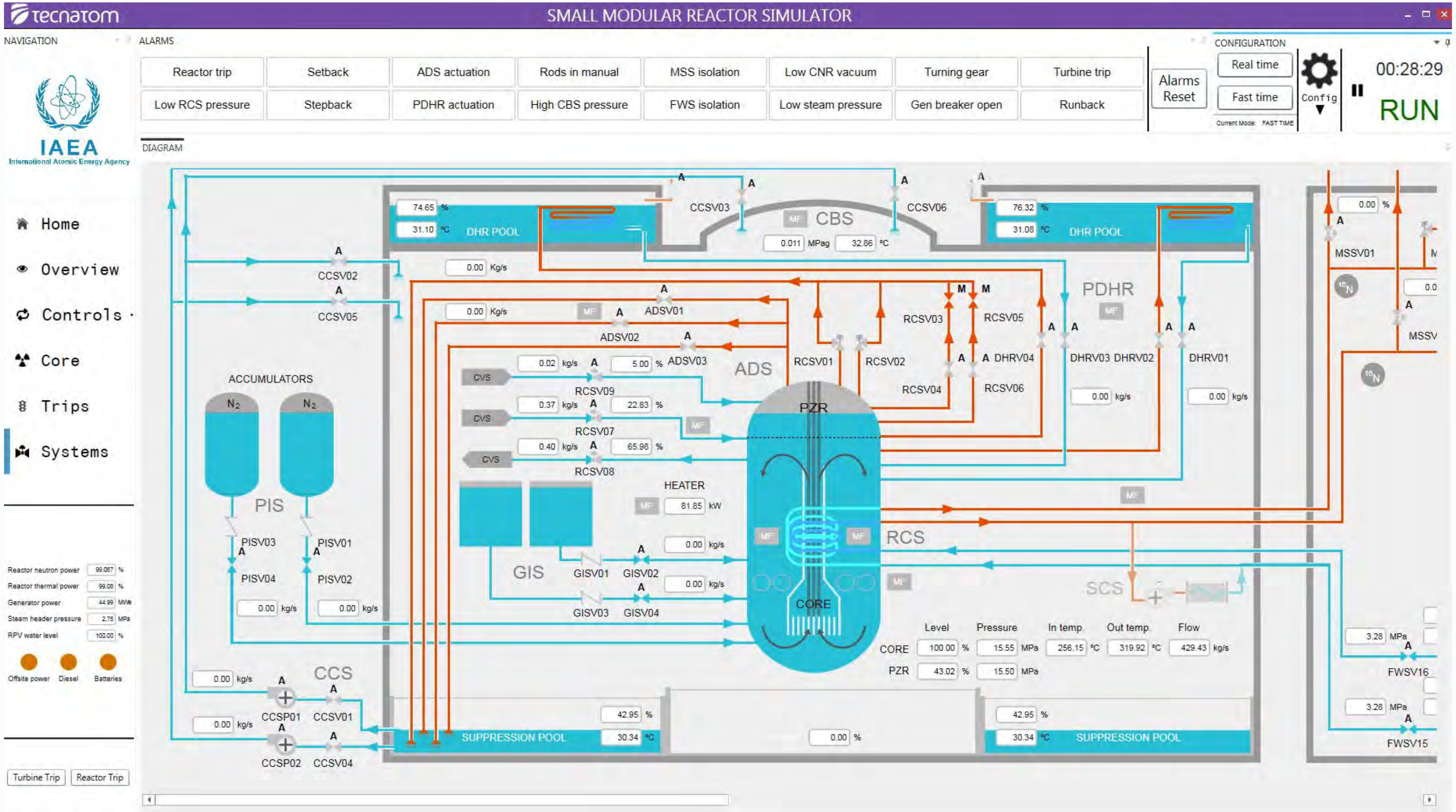
Technological approach



NEUTRONICS – NEMO_CODE	Neutronic model
THERMAL-HYDRAULIC – TRAC_RT	Reactor Coolant System Main Steam Feedwater Turbine Containment building & pools
THERMAL-HYDRAULIC – TEAM_FLOW	Condenser cooling Emergency core cooling Containment cooling
LOGIC & CONTROL – TEAM_LOGIC	Reactor and Protection System Valves / pumps logics
ELECTRICAL – TEAM_ELECTRIC	Generator system

Education on nuclear fundamentals with iPWR Basic Principle Simulator

Graphical User Interface

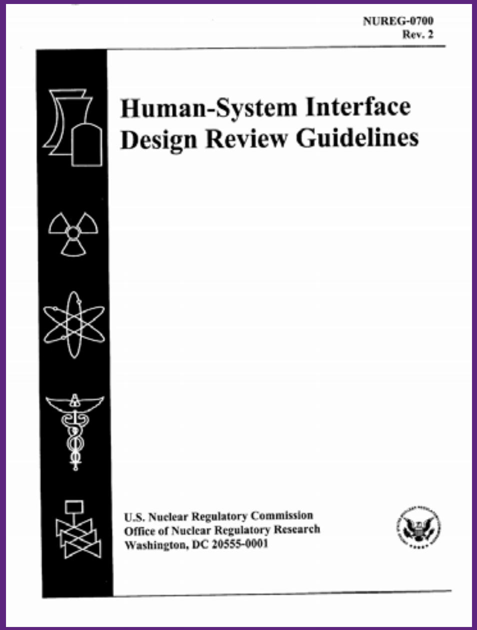


HMI BUILDER

TEAM_SKETCH

Human Factors Engineering principles & methods

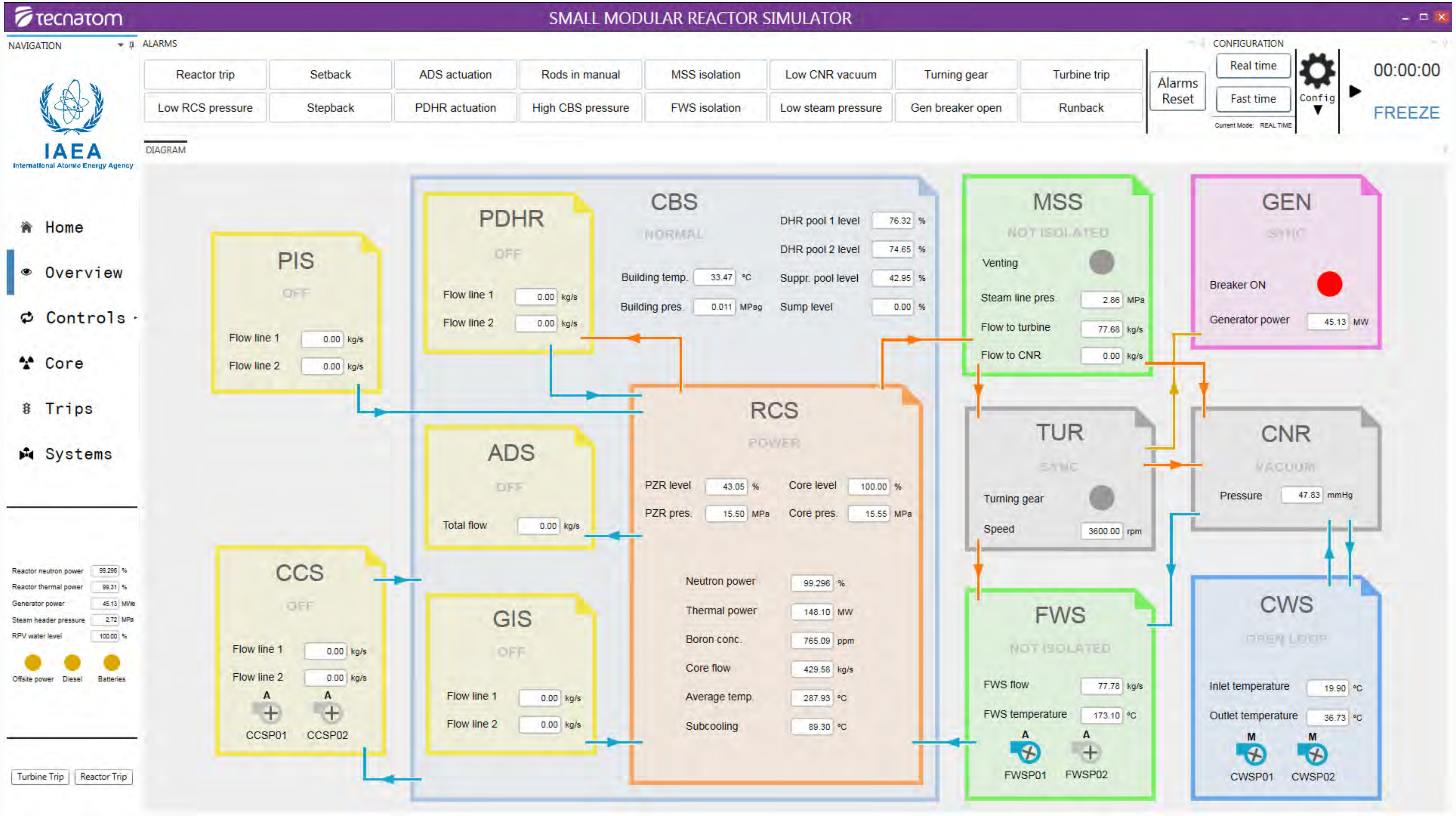
NUREG-0700


NUREG-0700
Rev. 2

Human-System Interface Design Review Guidelines

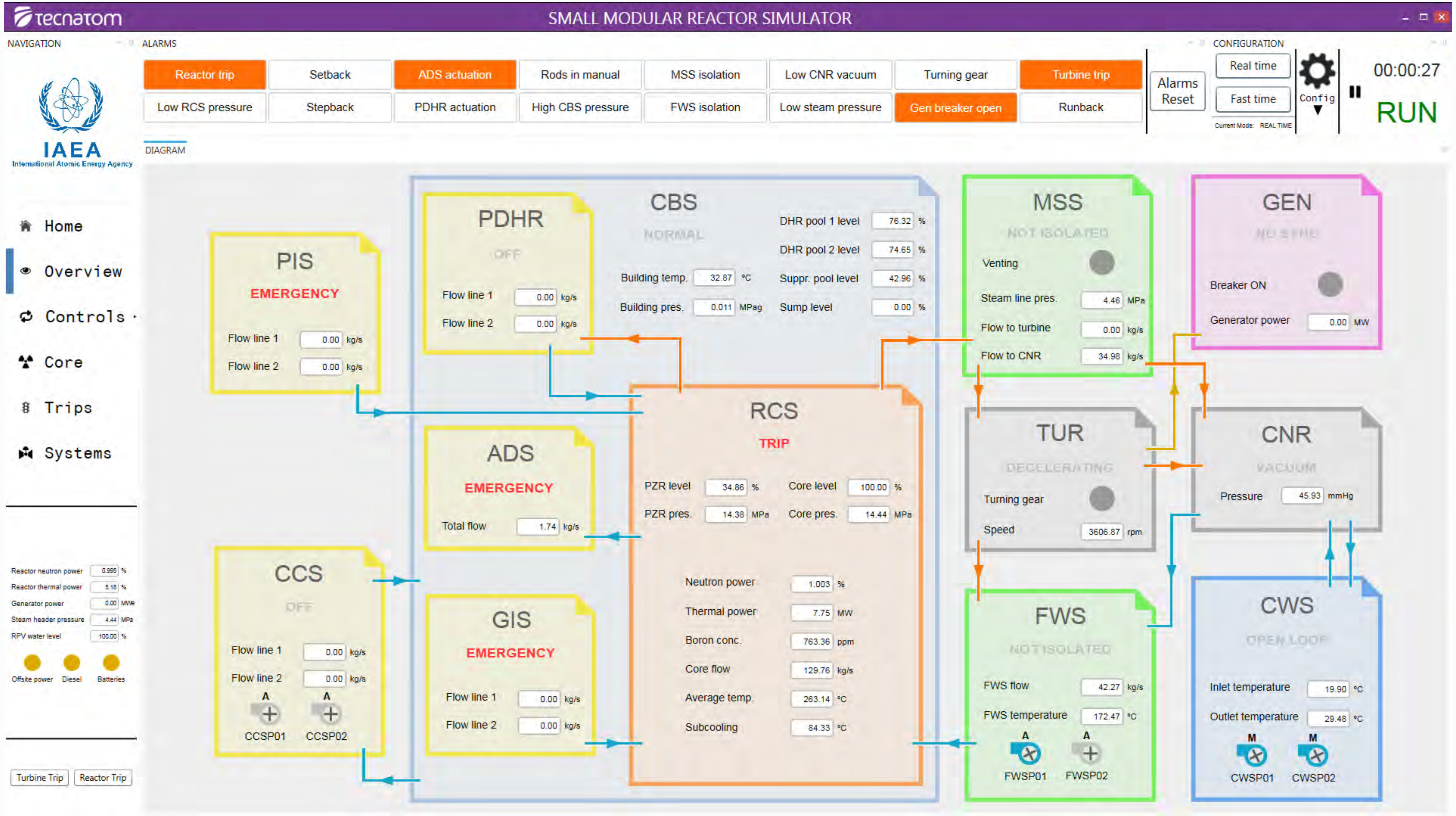
U.S. Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington, DC 20555-0001

Overview of the plant systems

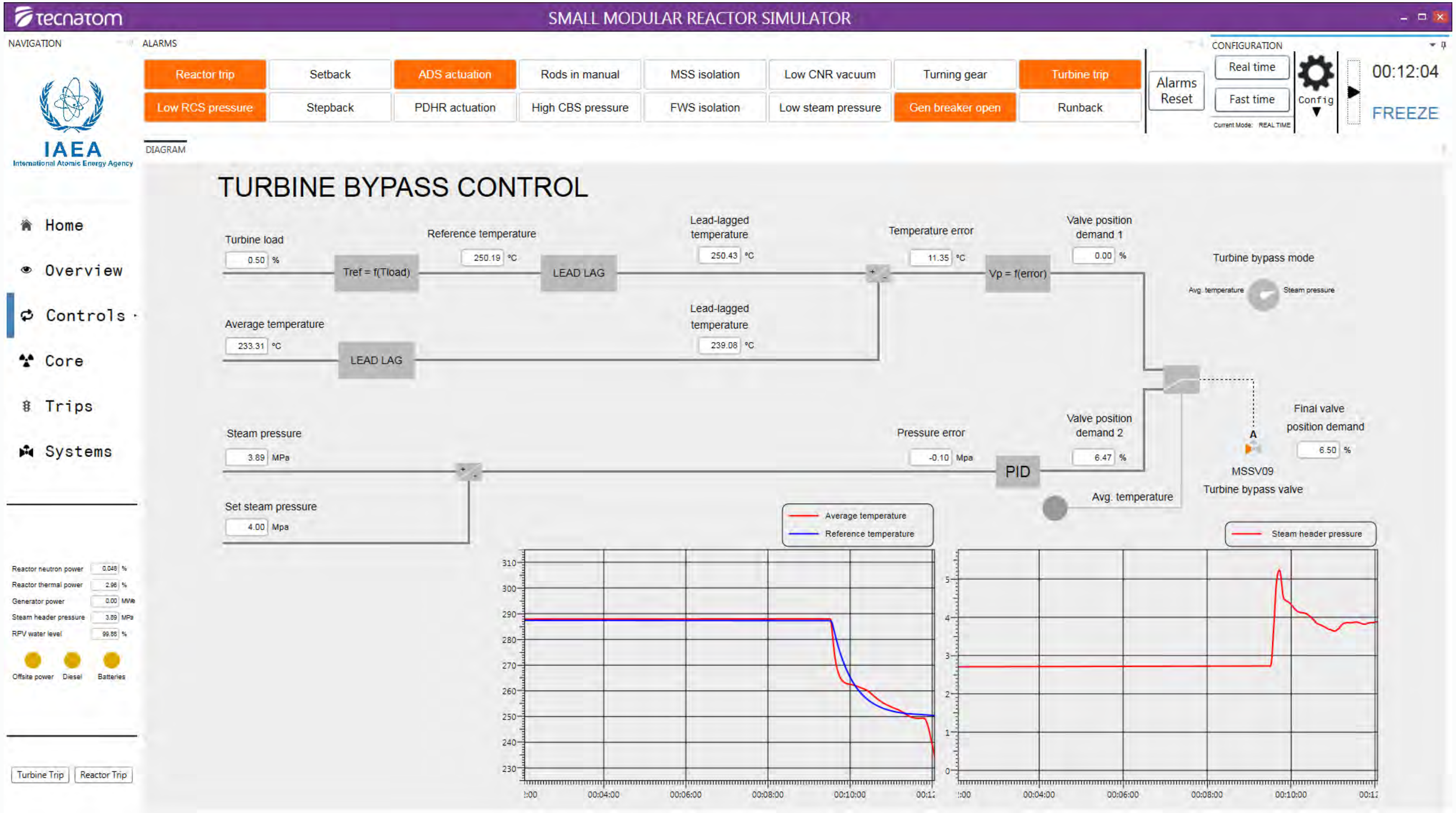


Education on nuclear fundamentals with iPWR Basic Principle Simulator

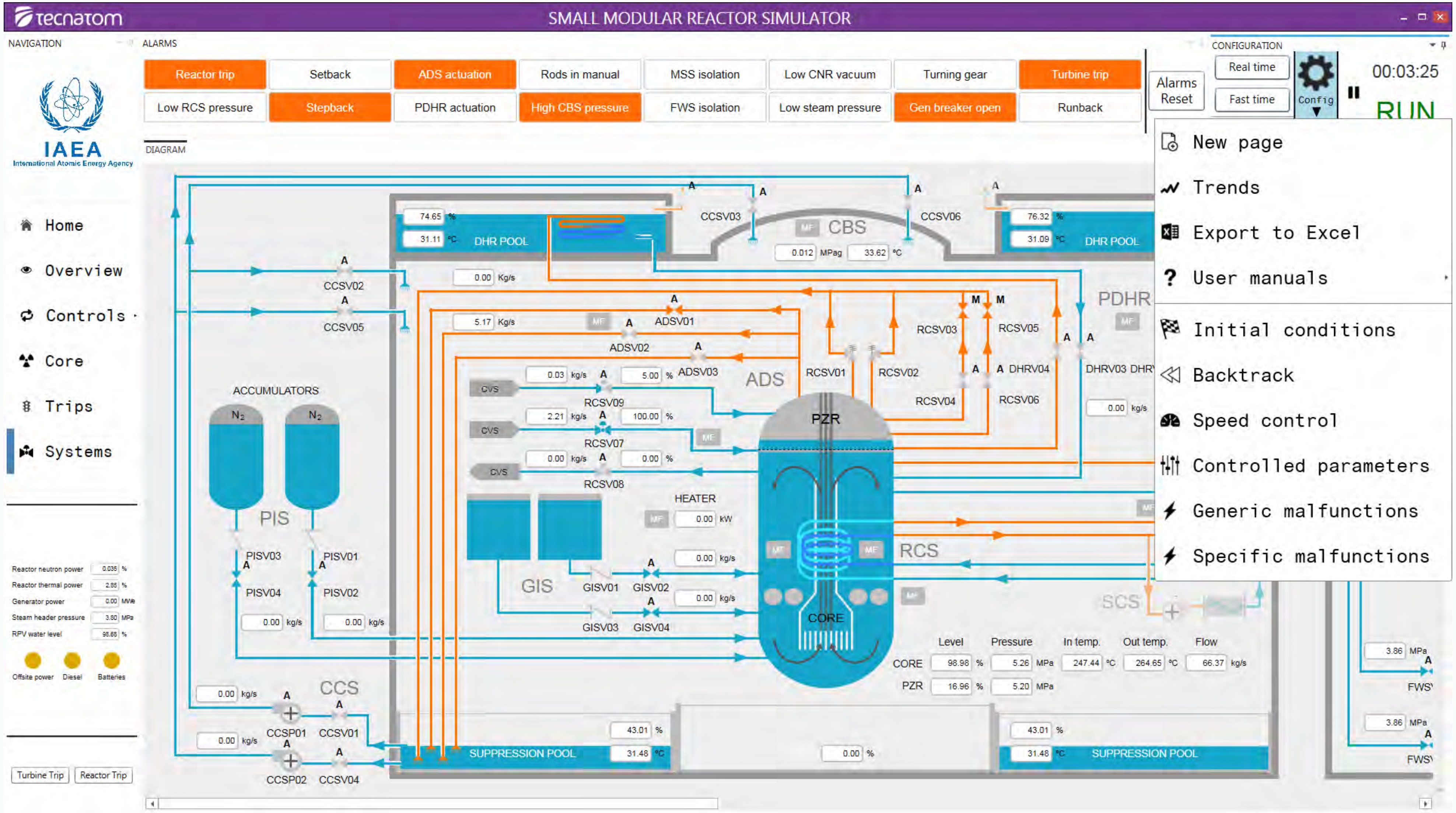
Overview of the plant systems



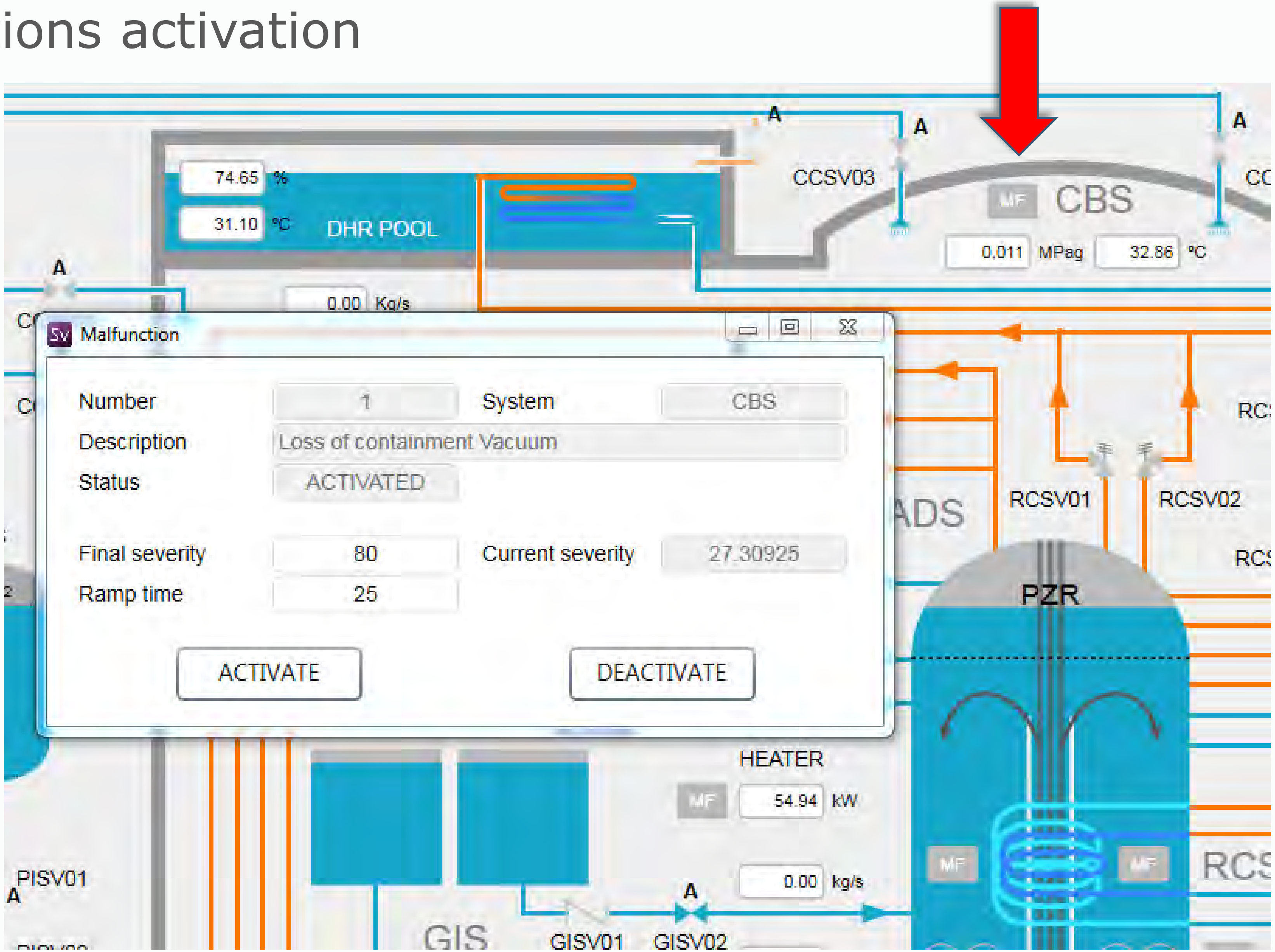
Control loops



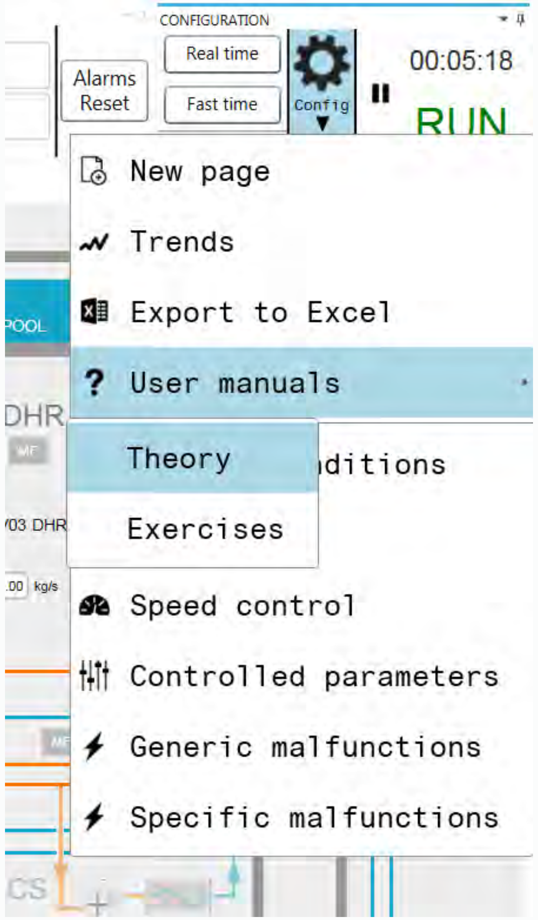
Simulator control and supervision

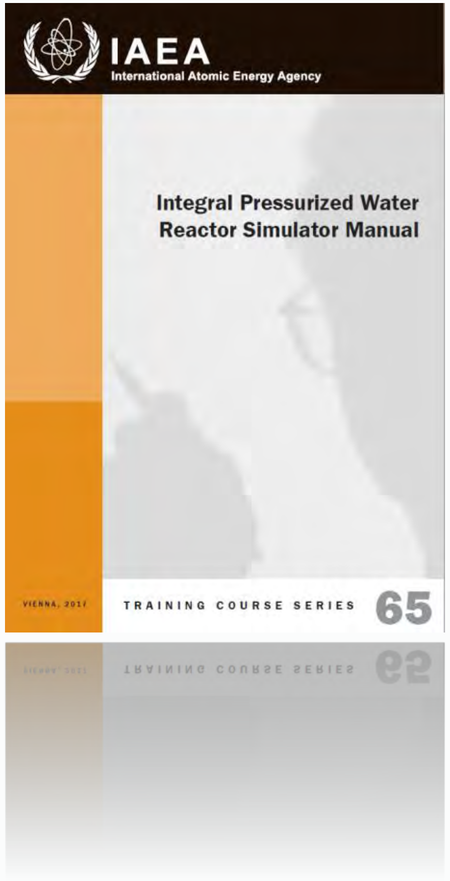


Malfunctions activation



Training material





Exercises for standard operations:

- Load maneuvering in turbine leading mode
- Reactor power decrease from 100% to 0%
- Reactor trip and restart
- …

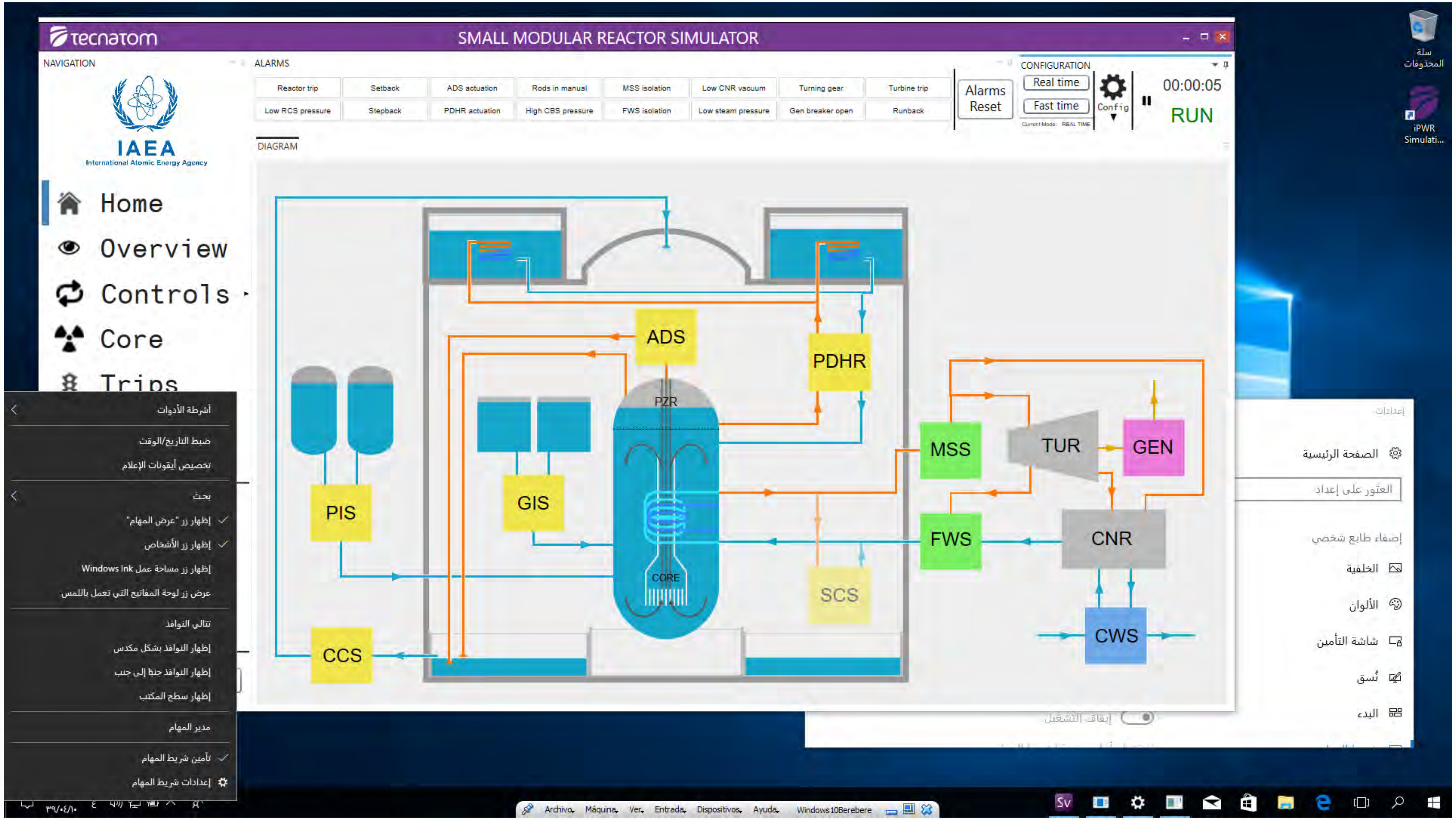
Exercises for malfunction transient Events

- Loss of feedwater Flow
- Turbine runback
- Large steam generator tube rupture
- …

TABLE 11. STATION BLACKOUT (cont.)

MALFUNCTION: SM-GEN-1	DESCRIPTION: Station blackout (total loss of AC power)			
STEP ID.	PROCEDURE STEPS	GUI SHEET	EXPECTED RESPONSE	STATE
5	Verify turbine trip: (1) Verify there is no steam flow going to the turbine.	Systems	— MSS to TUR flow (MSSFT04_TR) goes to zero (MSSV08 is a 'fail close' valve); — MSS to CNR flow (MSSFT05_TR) is zero (MSSV09 is a 'fail close' valve); — Turbine trip and generator breaker open alarms.	
6	Verify power supply: (1) Offsite power light is off; (2) Emergency diesel light is off; (3) Battery light is on.			
7	Verify main steam safety valves are dumping steam to atmosphere.	Systems	— MSSV03/4 open; — Safety valve relief setpoint is 5.70 MPa.	
NOTE	ADS valves are fail close valves. On a station blackout event, ADS valves close to avoid an unnecessary breach on the reactor coolant pressure boundary. These valves should be powered from its associated batteries before they are fully discharged.			

Different operating systems and platforms



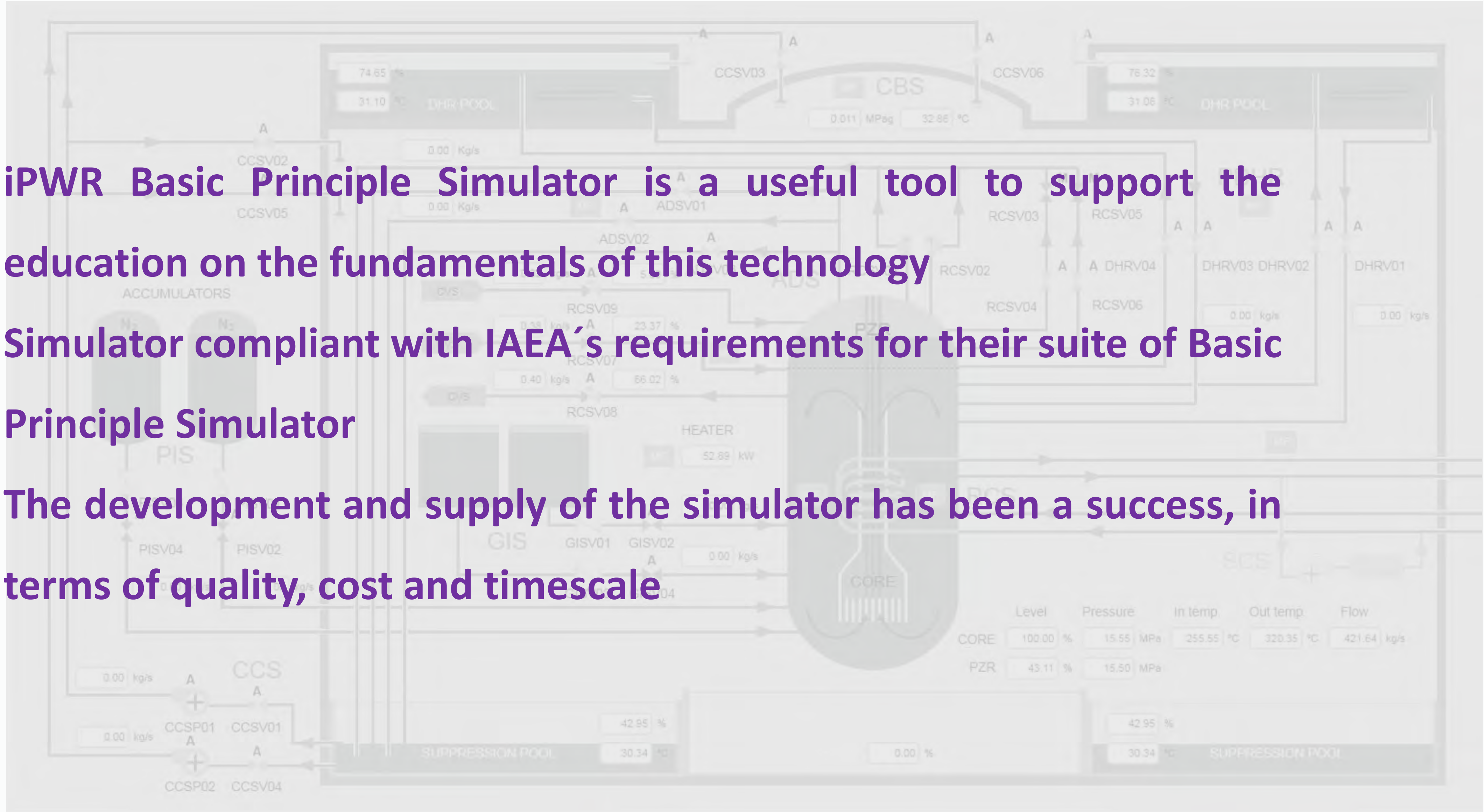
Windows 7 or higher

32-bit / 64-bit

核

Chinese, Japanese, Korean, Arabic,...

Conclusions



- ✓ iPWR Basic Principle Simulator is a useful tool to support the education on the fundamentals of this technology
- ✓ Simulator compliant with IAEA´s requirements for their suite of Basic Principle Simulator
- ✓ The development and supply of the simulator has been a success, in terms of quality, cost and timescale

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