Implementation of the Severe Accident Management in Slovenské elektrárne

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Slovenské elektrárne, subsidiary of Enel

Enel world presence

Presence in
40 countries

Installed capacity
97,839 MW

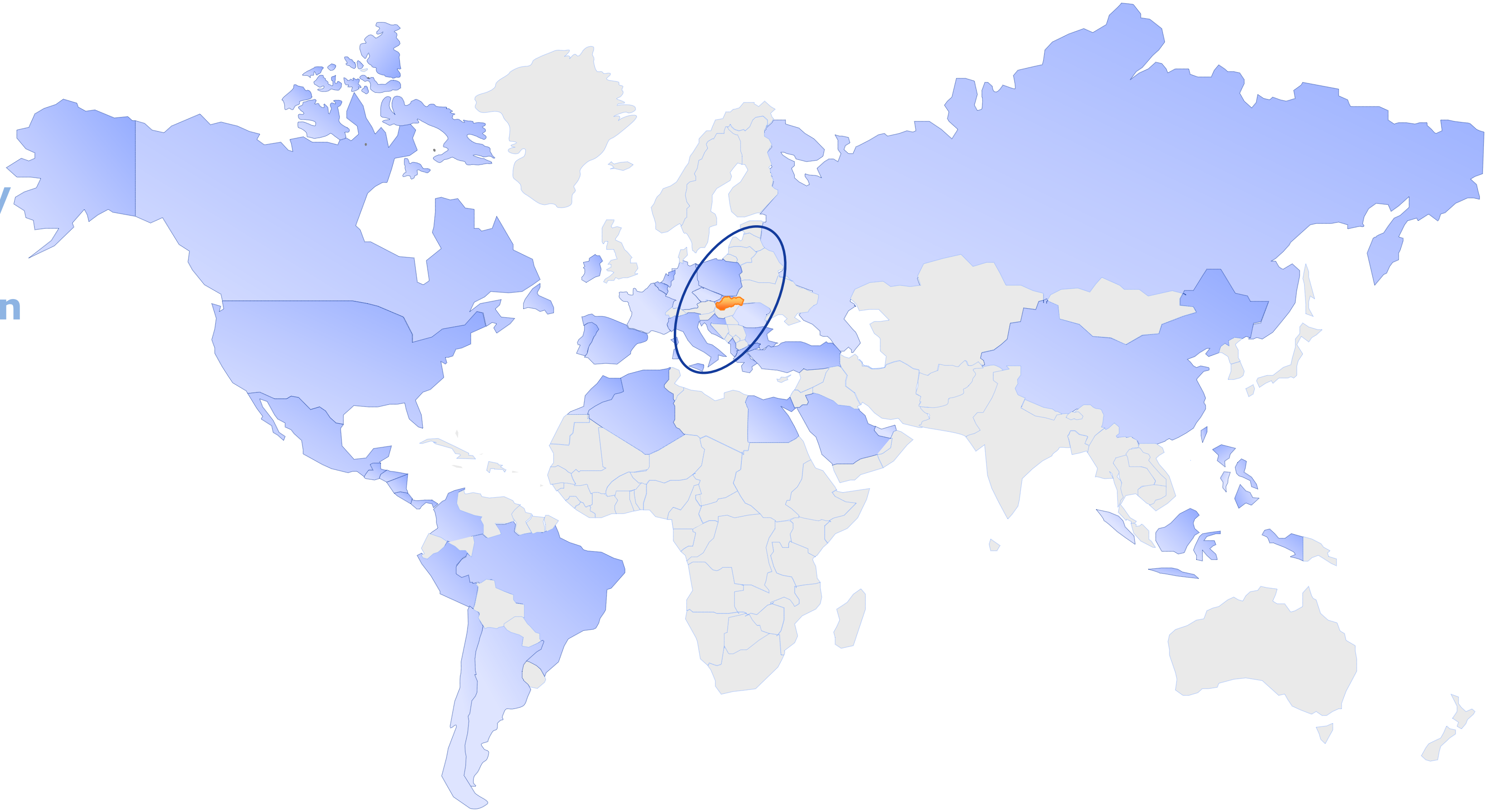
Annual production[1]
295.7 TWh

EBITDA
16.7 bln. €

Capex 2012-16
27.2 bln. €

Customers
60.5 million

Employees
73,702



Stock exchange

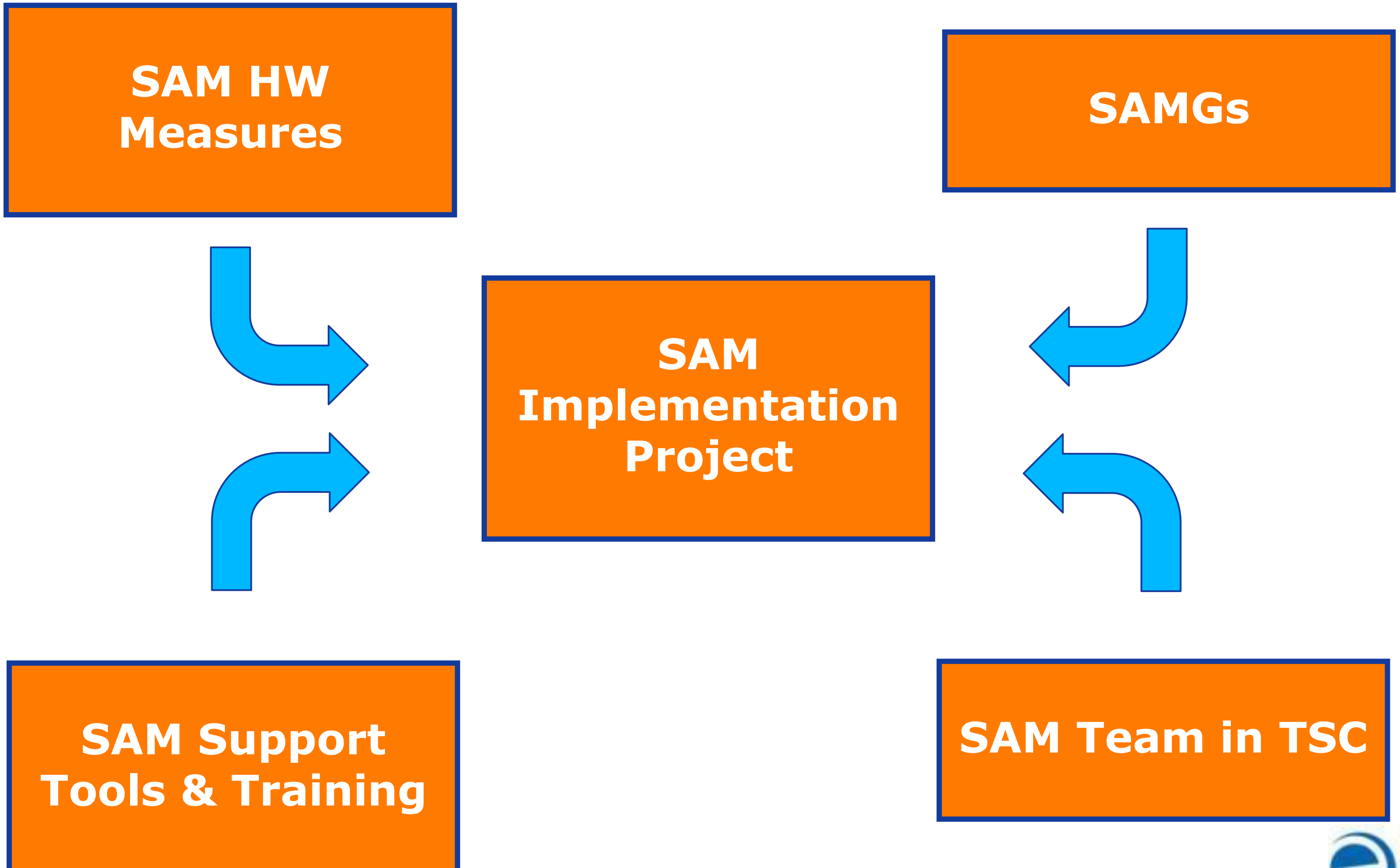
Enel is listed on the Milan stock exchange (~1.36 mln shareholders). 14 companies of the Group are listed on Milano, Madrid, Mosca, New York stock exchanges and in other Latin American countries

Data as of 31.12.2012

Slovak NPPs EBO and EMO

SEVERE ACCIDENT MANAGEMENT

EBO 2009-2013 and in EMO 2011-2015

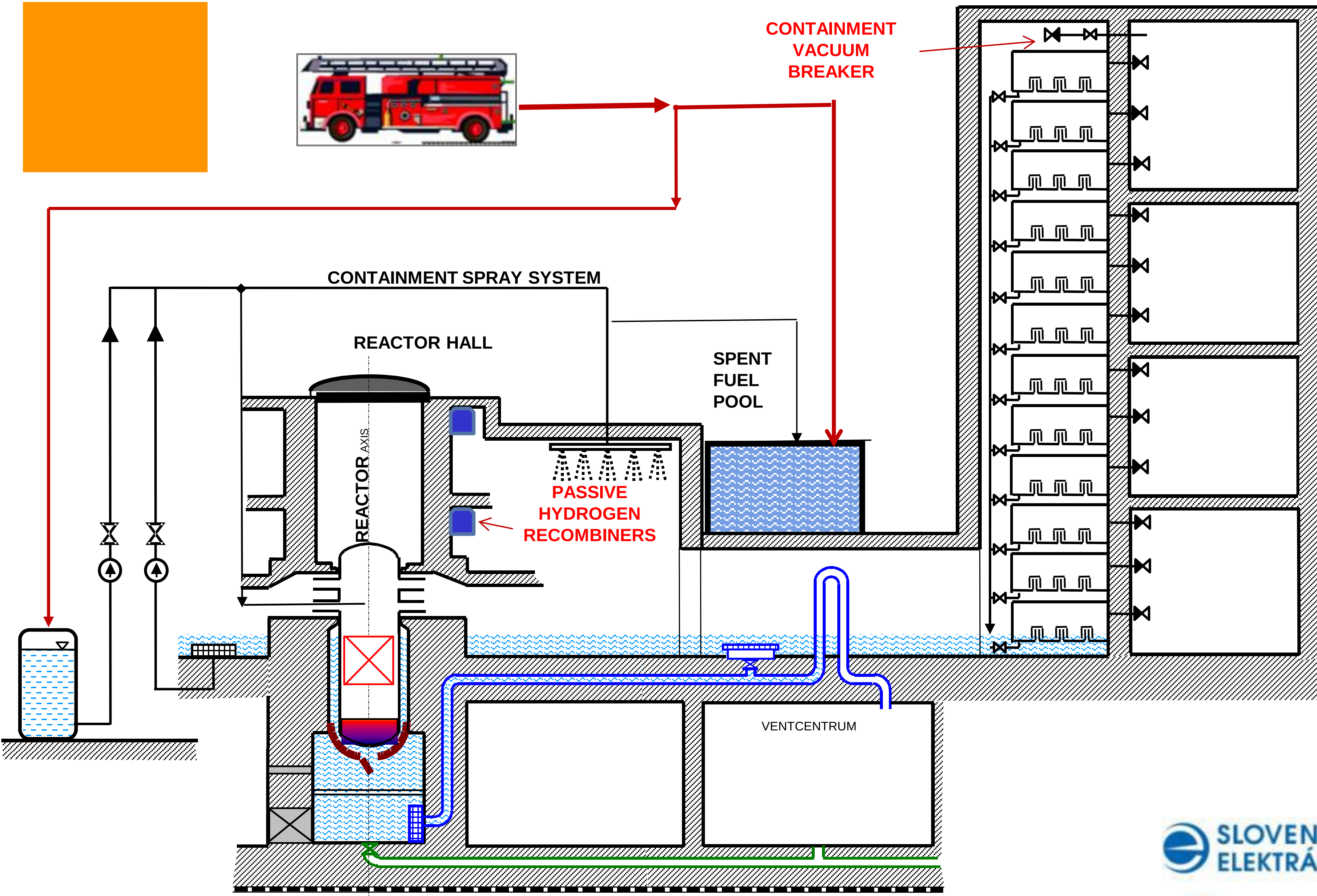


SEVERE ACCIDENT MANAGEMENT HW MEASURES

EBO 2009-2013 and in EMO 2011-2015

The SAM project is divided into following subprojects:

- „SIPHON" AND REACTOR CAVITY FLOODING
- DEPRESSURIZATION OF PRIMARY CIRCUIT
- MANAGEMENT OF HYDROGEN IN CONTAINMENT
- BREAKER OF VACUUM IN CONTAINMENT
- ALTERNATIVE COOLANT SYSTEM
- ALTERNATIVE ELECTRIC POWER SUPPLY SYSTEM
- INFORMATION SOURCES I&C FOR SAM - PAMS AND CONTROL
- LONG-TERM HEAT REMOVAL FROM CONTAINMENT


CONTAINMENT VACUUM BREAKER
CONTAINMENT SPRAY SYSTEM
REACTOR HALL
SPENT FUEL POOL
REACTOR AXIS
PASSIVE HYDROGEN RECOMBINERS
VENTCENTRUM

„SIPHON“ AND REACTOR CAVITY FLOODING

Localization and stabilization of corium under SA conditions

- Essential in support of management of SA consequences
- IVR (in-vessel retention) strategy for corium localization and stabilization adopted in VVER-440 design due to small reactor size
- Corium cooling is maintained by cooling of RPV from the outside
- Measures implemented to provide for an intentional flooding of reactor cavity under SA conditions

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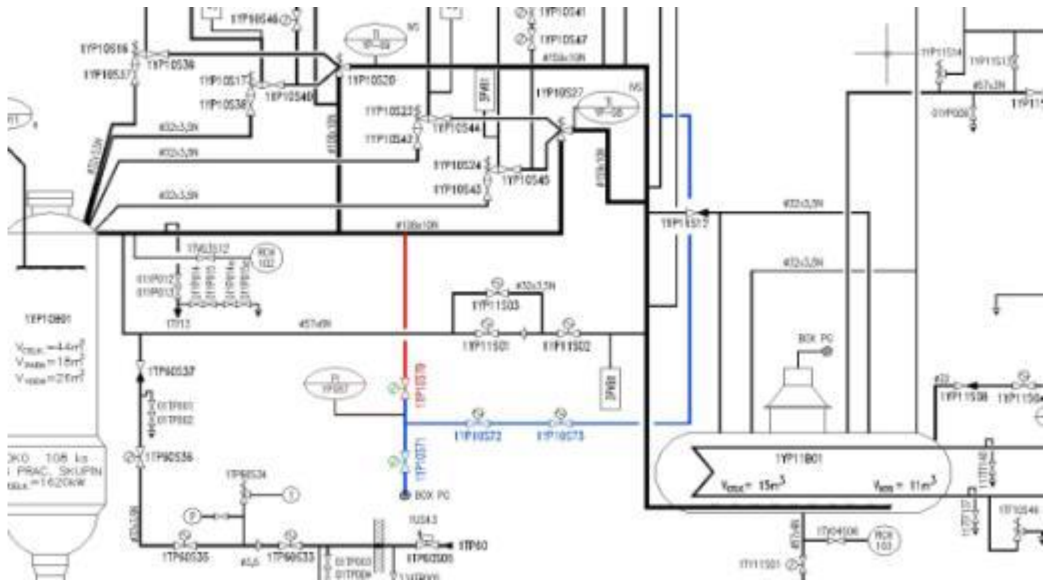
DEPRESSURIZATION OF PRIMARY CIRCUIT

Prevention of High Pressure Core Melt Scenario

- Primary circuit is required to be depressurized prior to the core melt relocation in RPV
- Depressurization is required for the execution of IVR strategy
- Prevention of HPME (high pressure melt ejection) is essential to maintain high degree of containment survivability under SA conditions



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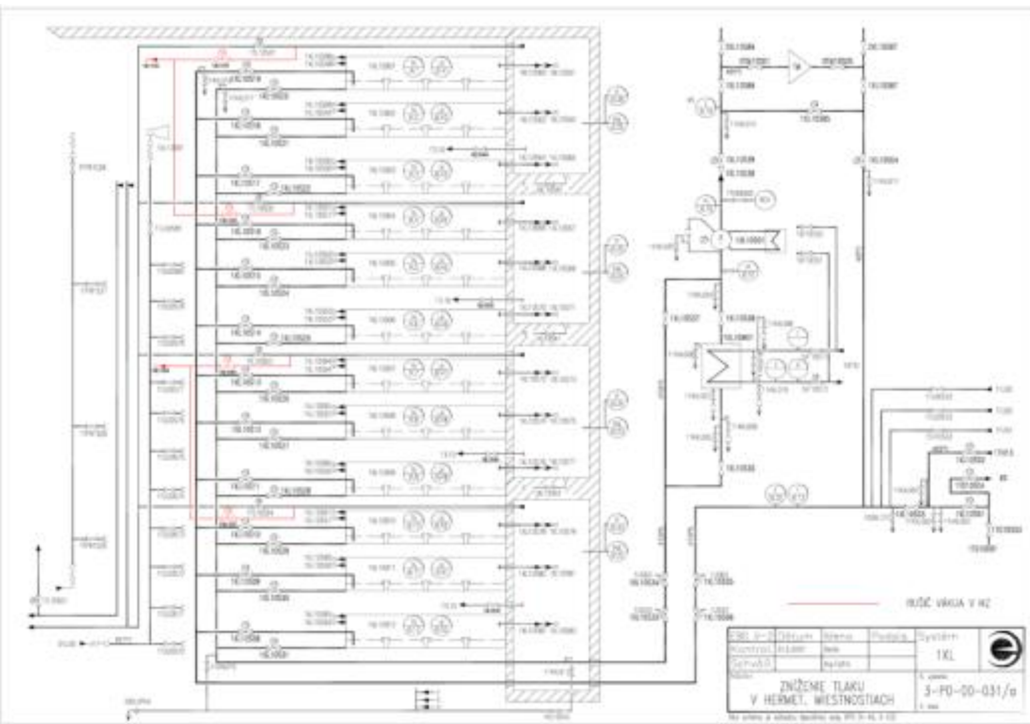
CONTAINMENT VACUUM BREAKER

Management of Underpressure in Containment under SA Conditions

- Due to specific design of VVER-440/V213 containment, excessive underpressure may occur as a result of hydrogen management
- Management of underpressure in the containment, needed to prevent high containment loads, is executed by manual connection of bubbler tower airtraps with SG compartment



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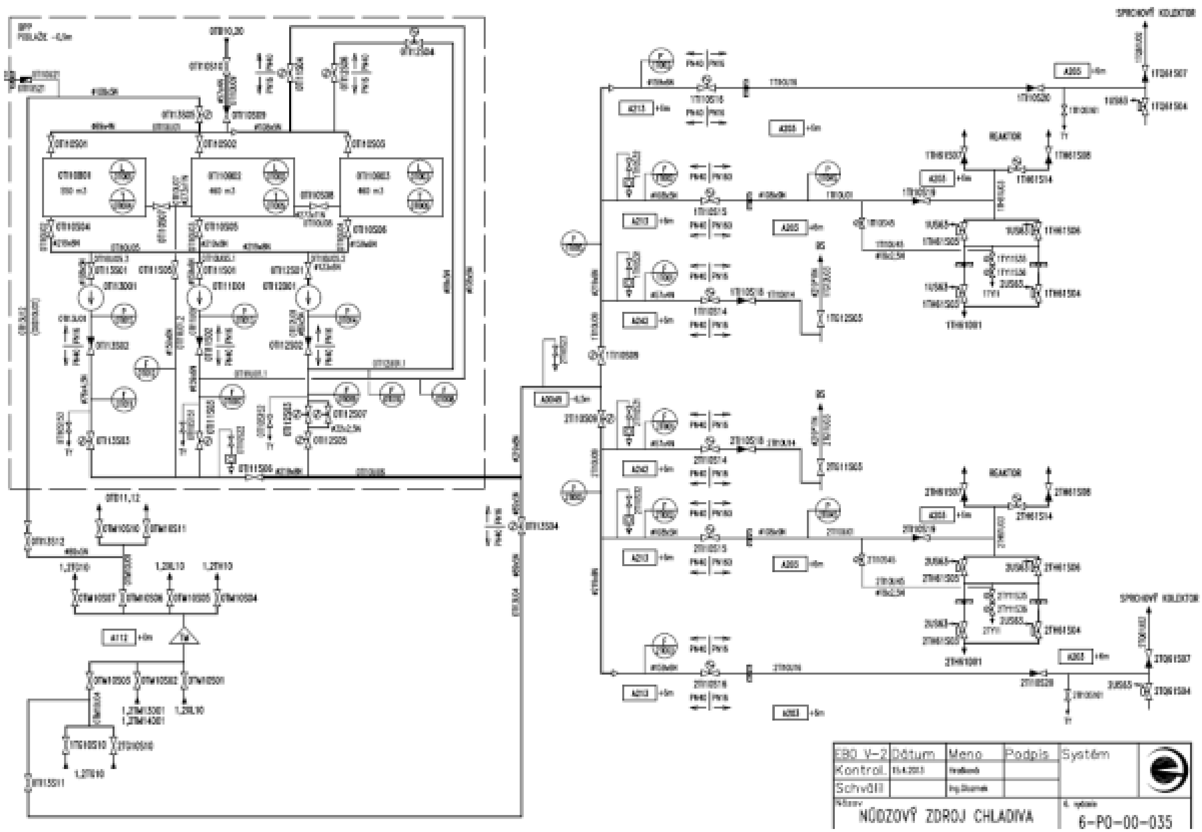
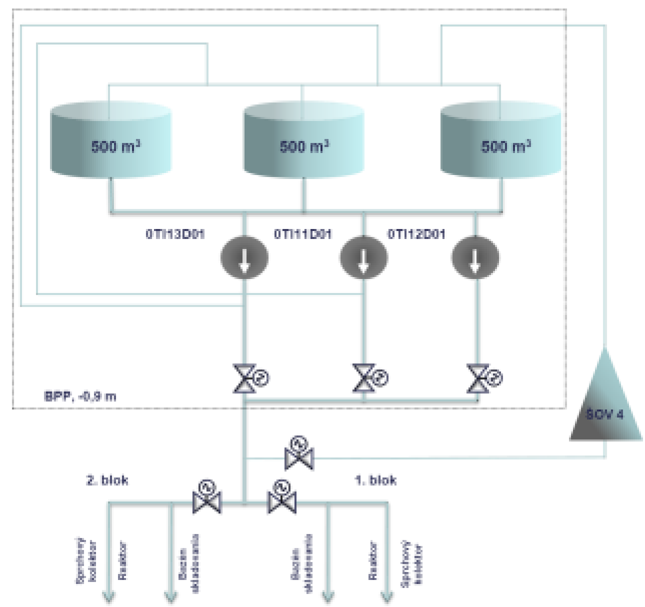
ALTERNATIVE COOLANT SYSTEM

Diverse Core Make-up and Containment Spray System for SA Conditions

- Possibility to inject boron water into the RPV, spent fuel pool and into the containment (via spraying)
- Diverse system allowing to execute SAMG strategies (inject into RPV, inject in the containment,…) with high degree if confidence

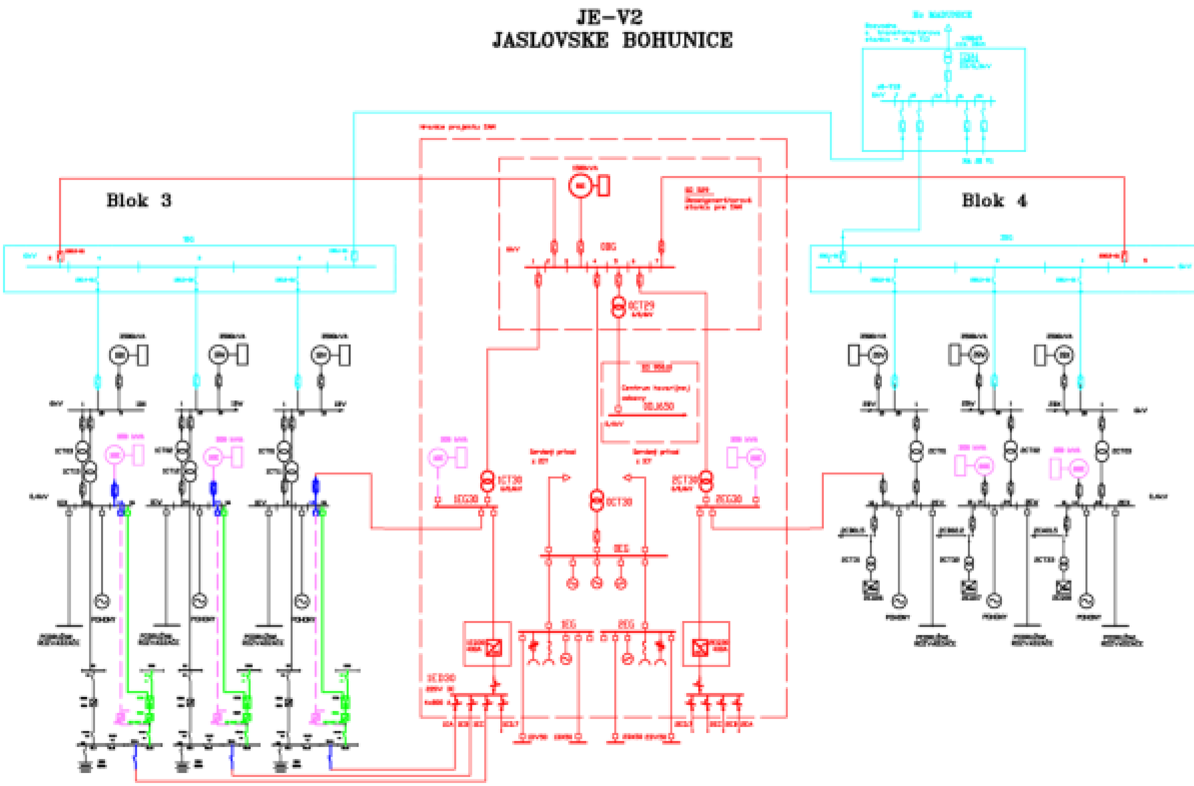




ALTERNATIVE ELECTRIC POWER SUPPLY SYSTEM

Diverse Electric Power Supply System for SA Conditions

- Alternative and diverse power supply for SA management
- Consumers considered essential for SA management are supplied from dedicated SAM DG



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I&C FOR SAM - PAMS & CONTROL

I&C System for SA Conditions

- Instrumentation for SA conditions (PAMS + dedicated SA measurements)
- Control of equipment considered essential for SA management
- Dedicated SAM control panel in the unit control room and Emergency response center

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LONG-TERM HEAT REMOVAL FROM THE CONTAINMENT

Long-term Heat Removal under SA Conditions	– Recovery strategy of existing systems for long-term heat removal during SA conditions adopted – Existing systems for containment spray and essential feedwater system modified for SA conditions – New pipelines are designed to ensure the ultimate coolant delivery to the reactor cavity, spent fuel pool and alternative coolant system tanks (make up)

MOBILE DG EQUIPMENT – ONE PER UNIT

Power	**[kVA/kW]**	**350 / 280**
Voltage	**[V]**	**230 / 400**
Current	**[A]**	**507**
Frequency	**[Hz]**	**50**
Fuel tank	**[l]**	**900**

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MOBILE FEEDWATER EQUIPMENT – ONE PER UNIT

Volume flow	**[m3/hr]**	**32**
Discharge pressure	**[bar]**	**70**
Power	**[kW]**	**70**

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Emergency Response Center

ERC Bunker

ERC SAM - operators

ERC Radiation - group

ERC TSC - group

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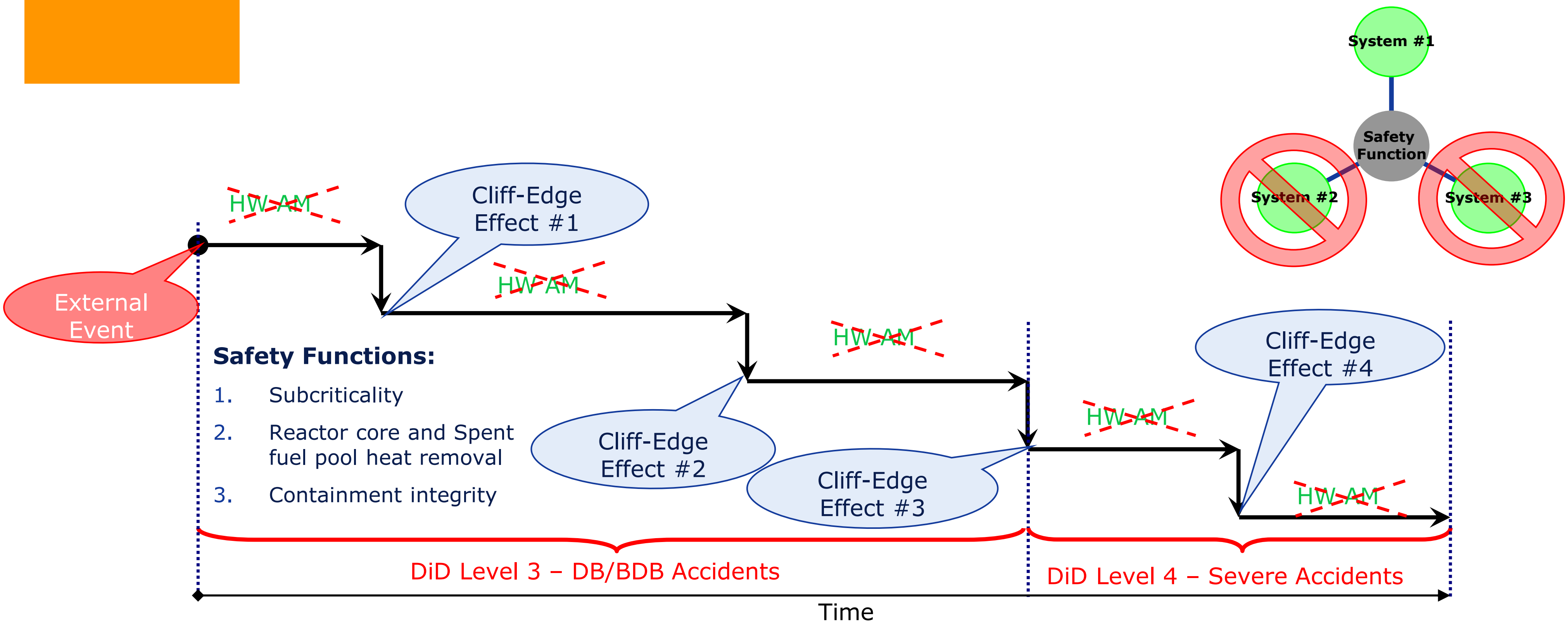
GENERAL IDEA – CONFIGURATION MATRIX TOOL 1



- Database of valuable SSC data with respect to AM (seismic, flooding and environment robustness, electrical supply,…)
- Database of pre-developed configurations of plant systems capable to provide for specific safety function

Set of **computational aids** to predict:

– Mission times of configurations
– Time needed to set up particular configurations

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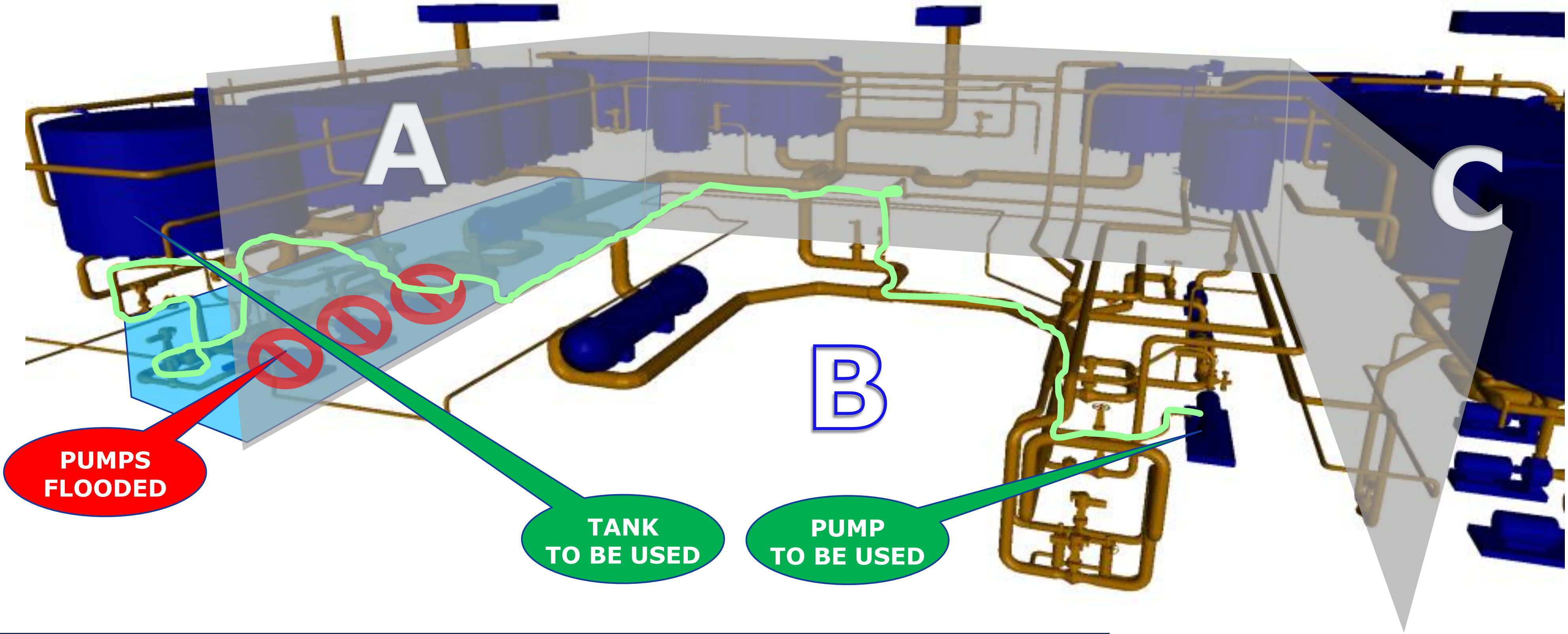
GENERAL IDEA – CONFIGURATION MATRIX TOOL 2



- Pumps flooded in room A, BUT tanks are operable and can be used
- It is possible to use pumps located in room B or room C

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MAIN ADVANTAGES OF CONFIGURATION MATRIX

EOPs and SAMGs provide only strategies not particular SSC configurations directly linked with safety functions, what CMT does:

- All information about SSCs and system dependencies (cooling, electrical supply,…) stored at one place
- Direct solutions of setting up particular system and all of its dependent subsystems
- Computational aids help to prioritize individual steps in AM strategy

Quick assessment of the existence of necessary measures for the provision of safety functions:

- Possibility to systematically check for the plant robustness of safety functions provision under user defined IEs
- Gradual increase in the severity of IE allows one to search for potential cliff-edge effects

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CONCLUSIONS

- ✓ SAM implementation has started before Fukushima accident as management decision.

- ✓ Complementary measures have been implemented in light of Fukushima experience mainly for SBO with mobile devices.

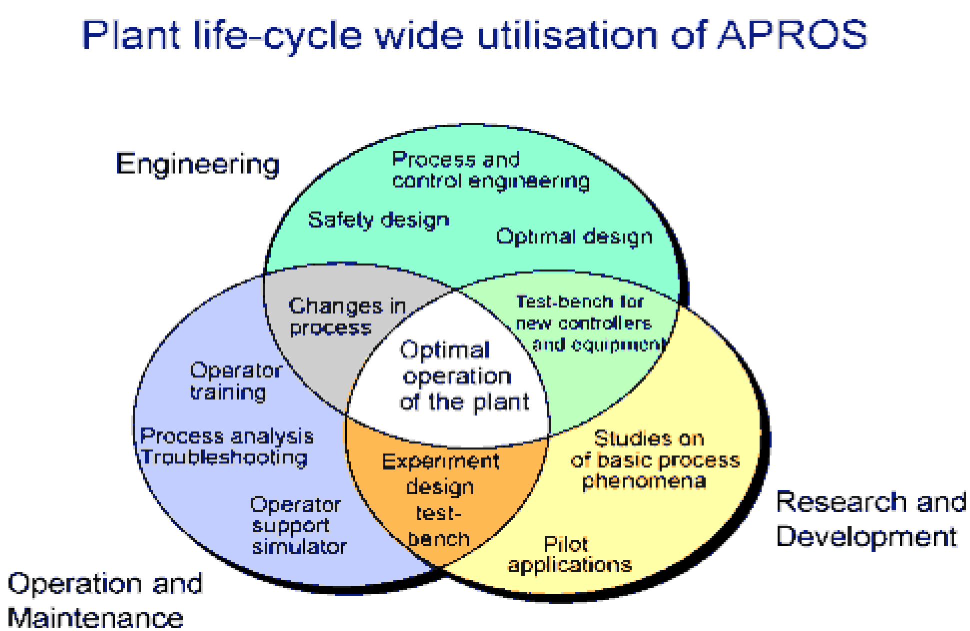
- ✓ Action plan resulted from performed stress tests in Slovakia is realized and majority of adopted measures will be finished by 2015.

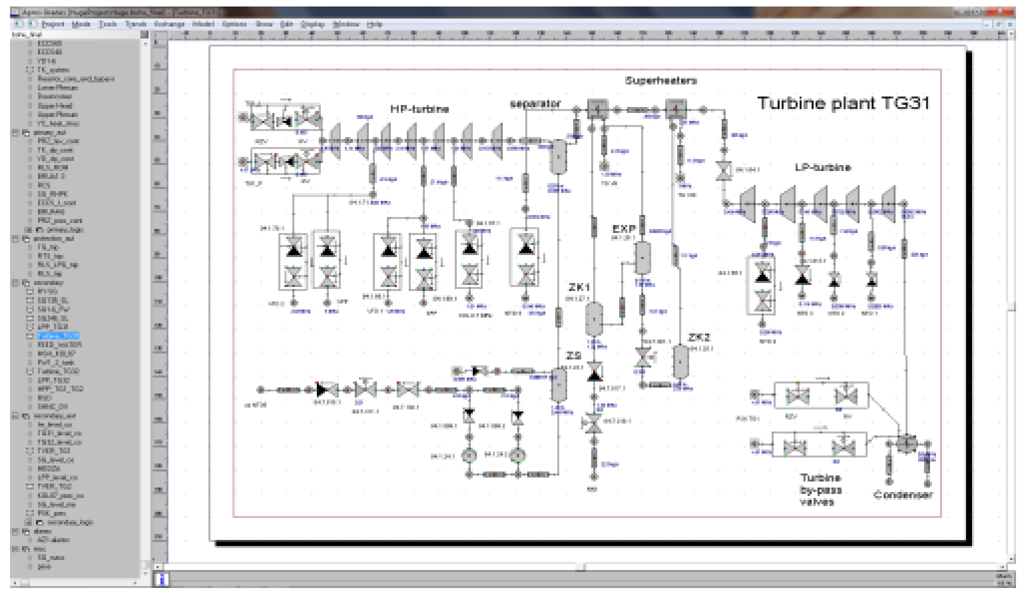
BACK UP

THERMAL-HYDRAULIC CALCULATIONS IN SE, a.s.

Development of In-house TH modelling Capabilities

- Project started in 2009
- Bohunice plant and containment models developed
- Further developments ongoing





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APROS in SE, a.s.

Future Model Developments

- Bohunice plant specific SA model
- Mochovce specific plant, containment and SA model

Planned Usage of APROS

- Sensitivity studies in support of Design Basis development (comprehensive analysis of plant transients)
- Independent review of safety analyses performed by contractors
- In-house analysis for EOPs and SAMGs development and maintenance – support of TSC teams
- Controller modifications and setup
- Support for plant operation
- Staff training (TSC - SAMG, Engineering, Operations)