AREVA NP

AREVA Technical Center

Scientific Thermal Hydraulic Testing Capabilities

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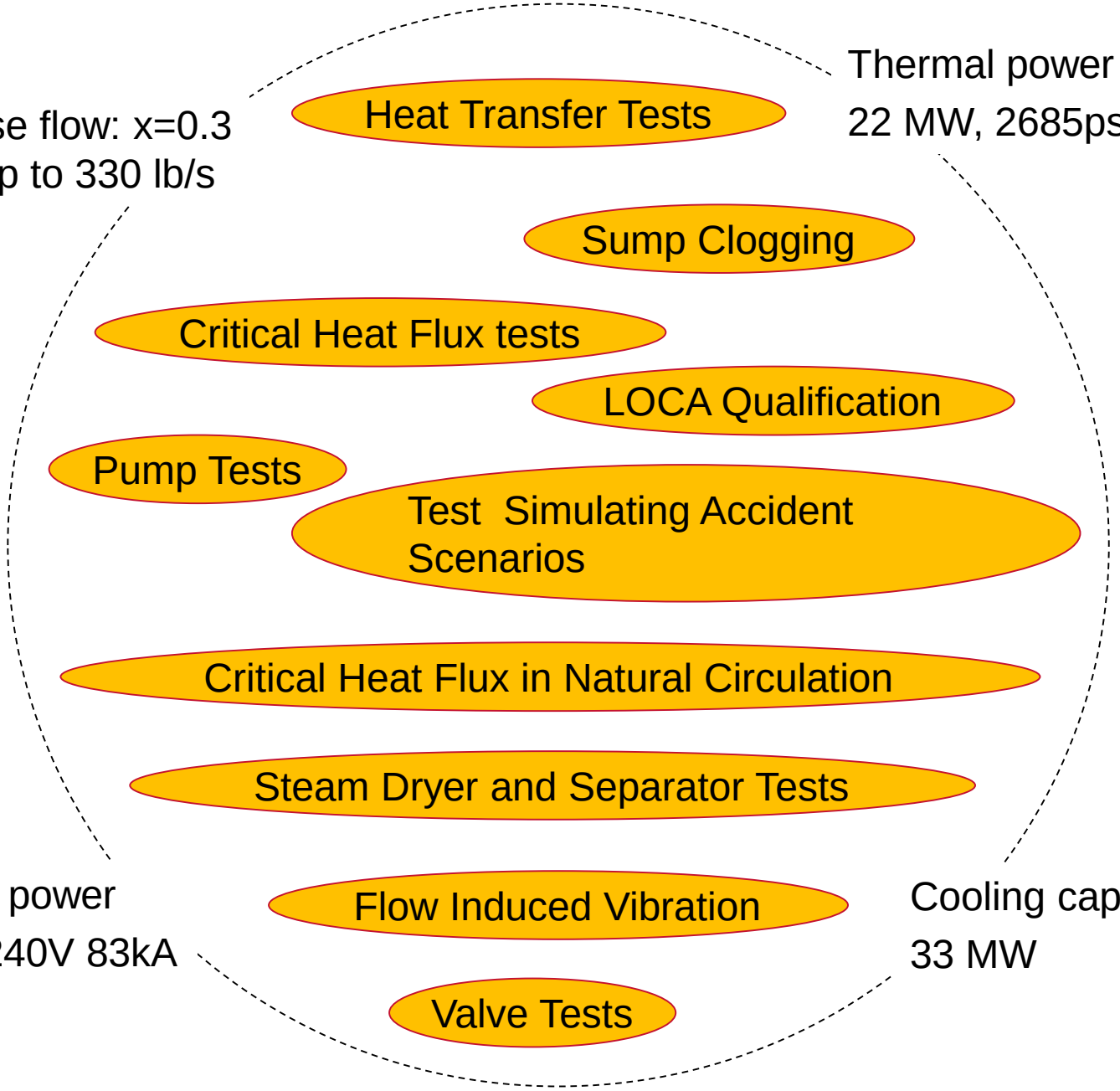
Government Operations

AREVA

Locations



Thermal Hydraulic Platform

Accredited Measurement Range & ILAC Acceptance

Measurements	Range
Temperature	0°C - 1000°C
Pressure	10 Pa - 40 MPa
Volume flow rate	0,1 l/h - 1.500 m³/h
Mass flow rate	01 kg/h - 4.000 kg/s
Force	1 N - 10.000 kN
Momentum	up to 50.000 Nm
Distance	1µm - 10 m
Velocity	1 mm/s - 100 m/s
Acceleration	0,5 - 1.000 g
Current	1 mA - 85.000 A
Voltage	1 mV - 4 kV
Electrical power	up to 20 MW

Accredited Test Body
Under the term of ISO 17025:2005

International Laboratory Accreditation Cooperation; world wide cross acceptance e.g.:

- **ANSI-ASQ National Accreditation Board (ACLASS), USA**
- China National Accreditation Service for Conformity Assessment (CNAS), People's Republic of China
- Comite Francais d'Accreditation (COFRAC), France
- Deutsche Akkreditierungsgesellschaft (DAkkS), Germany
- National Accreditation Board for Testing & Calibration (NABL), India
- Entidad Nacional de Acreditacion (ENAC), Spain
- United Kingdom Accreditation Service (UKAS), United Kingdom

Thermal-Hydraulic Platform Unique in the World

Test Facilities

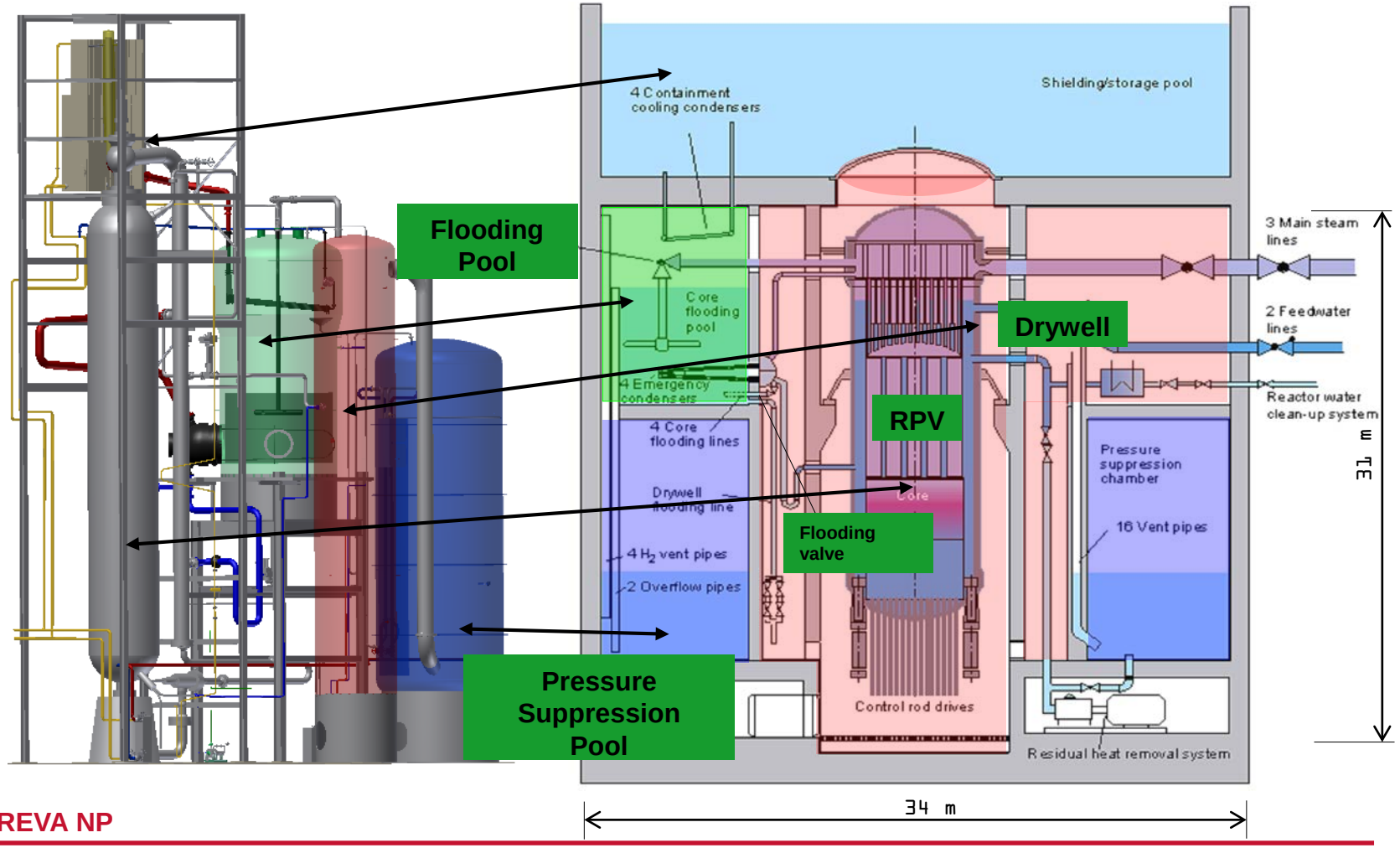
At our sites, we operate the following test facilities:

- **KOPRA** – Multifunction component test facility (fuel assemblies, CRDMs, valves)
- **BENSON** – high pressure thermal-hydraulic testing of separate effects
- **PKL** – Large scale test facility of a PWR primary loop with secondary side and auxiliary systems
- **PETER, BRIAN** – Fluid dynamic test facilities (PWR and BWR fuel assemblies)
- **SUSI** – sump strainer test facility
- **APPEL** – Pump test loop
- **GAP** – Large valve test facility
- **INKA** – Test facility for integral BWR tests
- **KATHY** – Multifunction thermal-hydraulic test loop
- **HYDRAVIB** – Vibratory validation of lower RPV internals
- **ROMÉO & JULIETTE** – RPV flow distribution in upper and lower plenum
- **CALVA** – Dynamic mechanical testing of components
- **MAGALY** – Vibration behavior of Rod Cluster Control Assembly (RCCA) and Control Rod Guide Assembly (CRGA) for various flow conditions

BWR Generation III+ Test Loop INKA

Integral Test Facility

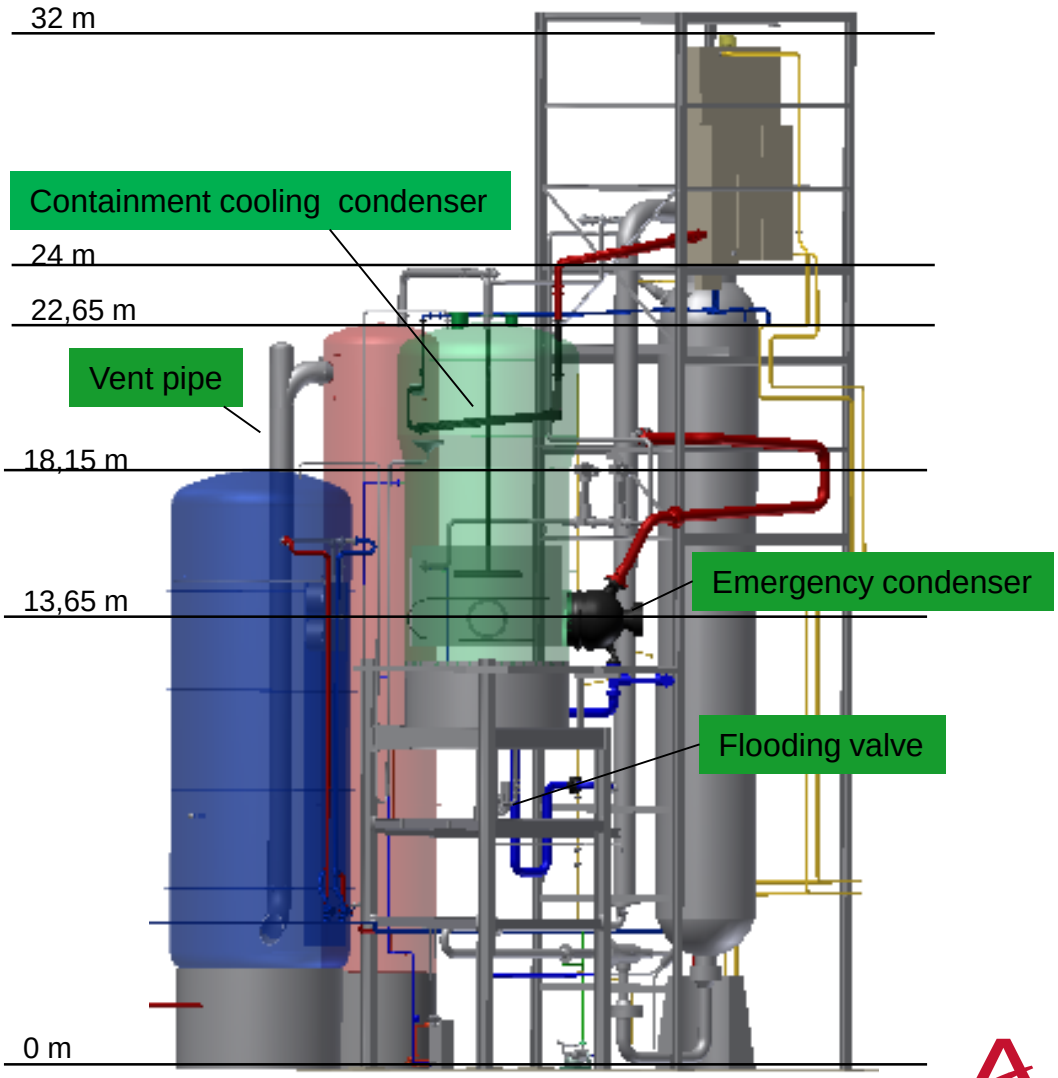
Generation III+ BWR



INKA
Key data

- **Volumes**
  - **Flooding Pool Vessel: 219 m³**
  - **Wetwell Vessel: 350 m³**
  - **Drywell Vessel: 188 m³**
  - **GAP/RPV: 125 m³**
  - **Shielding/Storage Pool V.: 30 m³**
- **Scaling**
  - **Heights: 1:1**
  - **Components size 1:1**
    - EC and CCC: 1 out of 4
    - Vent pipe: 1 out of 16
  - **Volumes: 1:24**
    - GAP/RPV 1:6,3
    - Shielding/St. Pool V. 1:88*

    *with additional heat exchanger
- **Supply: 22 MWth**



AREVA NP

Key Data of Similar Test Loops

Facility	Drywell (m^3)	Wetwell (m^3)	RPV pressure (bar)	Power Supply (MW)
INKA	420	300	89/160	22
PANDA (CH)	198	234	10	1.5
PUMA (US)	14	18	10.3	0.5
Tiger (JP)	30	-	?	?
THAI (DE)	60	-	14	1.5
APEX (US)	No Containment		32	1

INKA
Testing capabilities

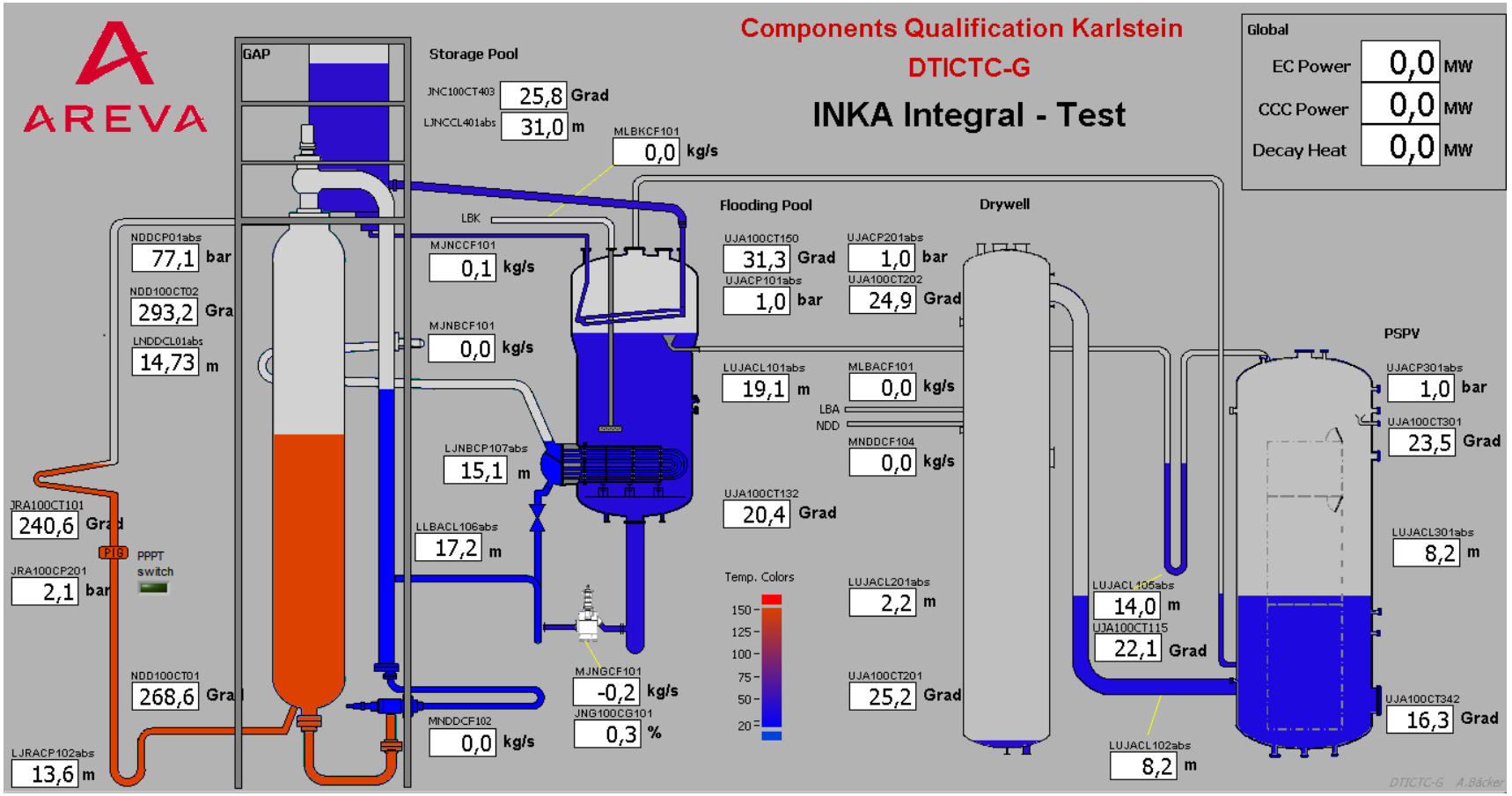
Performed Tests (and ongoing)

- **AREVA R&D-Program (-2013)**
  - **Single Component Tests in full scale**
    - Emergency Condenser
    - Containment Cooling Condenser
    - Passive Core Flooding System
- **EASY-Project (2015-2018) funded by German Government**
  - **Partners: GRS, TUD, THD, RWTH**
  - **Integral Effect Tests**
    - Simulation of LOCA (MSLB, FWLB etc.) and non-LOCA (SBO) scenarios
    - Interaction of Passive Systems
    - Code validation (ATHLET, COCOSYS)

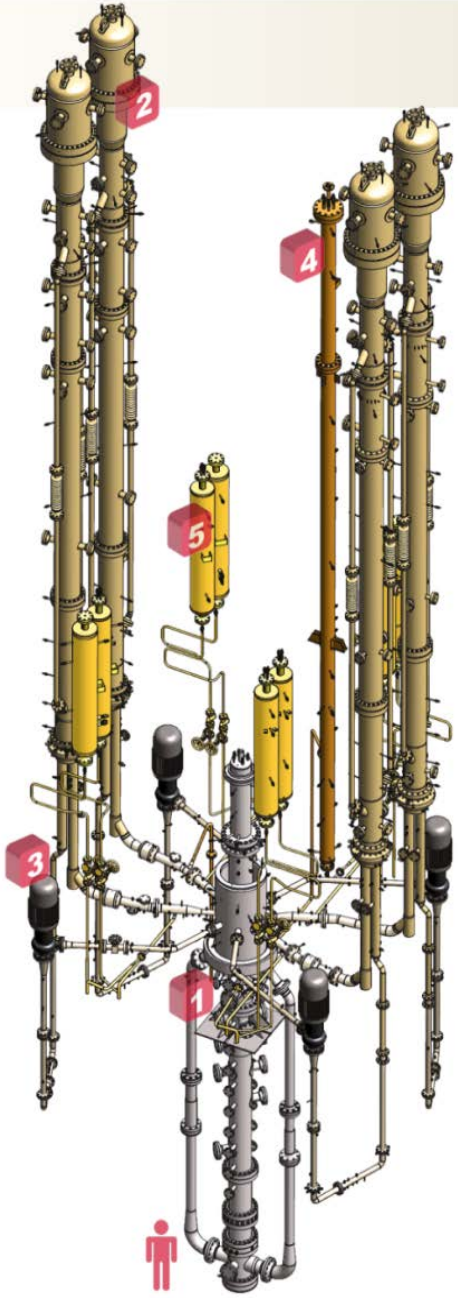
Future

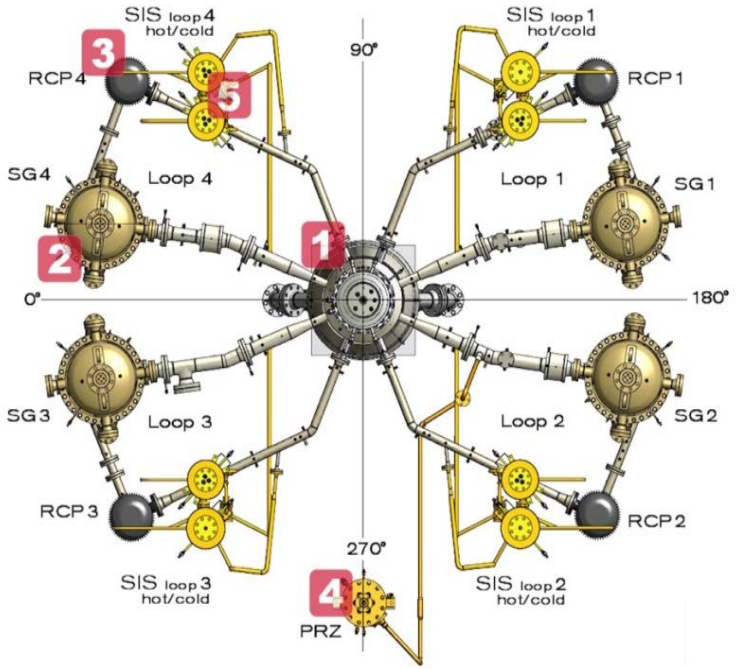
- **EASY-ip (application to EURATOM work program)**
  - **Partners: GRS, CEA, EdF et al.**
  - **Integral tests on passive systems (Passive components scalable)**
- **RCIC-pump**
- **Other applications for INKA**
  - **Tests with active systems**
  - **Subjects from Gen-II plants**

Integral Test
Feedwater Line Break inside Containment
Initial Conditions



PKL Project
Test Facility





1 Reactor pressure vessel
2 Steam generator
3 Reactor coolant pump
4 Pressurizer
5 Accumulator (pair)

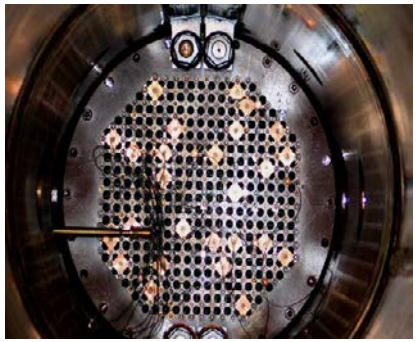
Objective

Investigation of PWR T/H behavior under accident condition

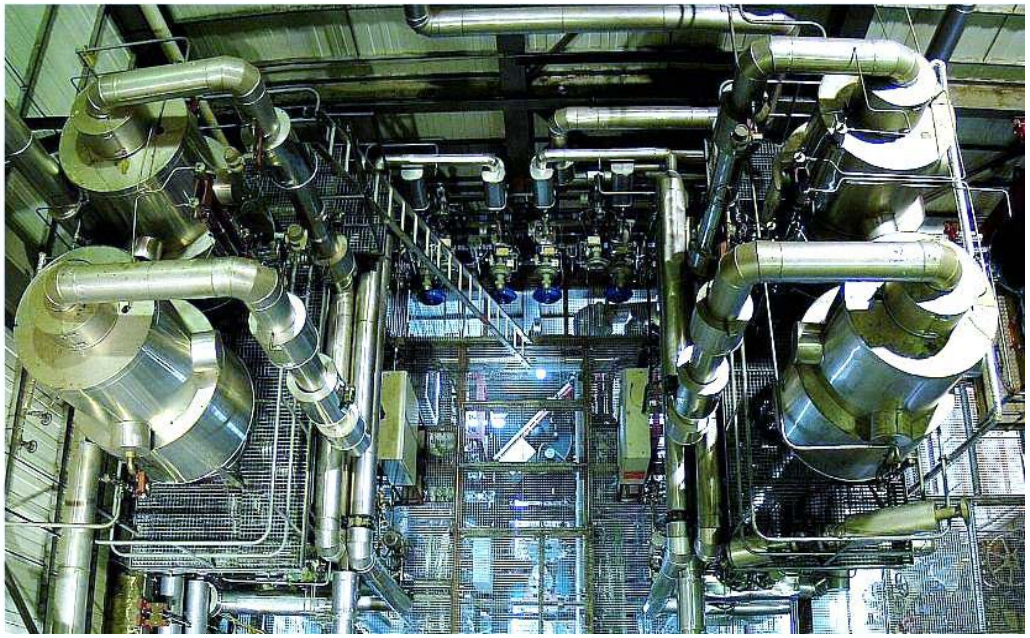
Key Features

- 4-loop configuration
- All primary and secondary-side operational and safety systems
- Extensive instrumentation (> 1500 measurement positions)

PKL Project
Test Facility

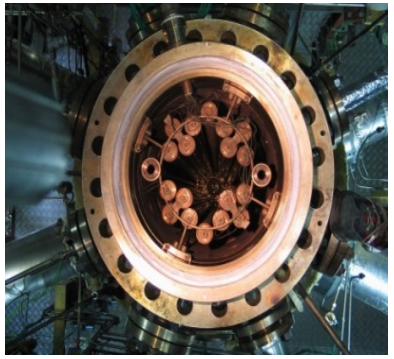


SGs, top view



More than 200 integral tests since 1977 at AREVA GmbH in Erlangen

- PWR thermo-hydraulic system behaviour under accident conditions
- Effectiveness of measures for accident control
- Data base for code validation
- Demonstration of safety margins
- Training of PWR operating personnel
- Solving of PWR safety concerns
- Operated at AREVA in Erlangen, Germany



PKL control room

Only PWR model with 4 primary-side loops

OECD/PKL Phase 4 Program
Topics Overview

i1: Investigations on T/H phenomena related to two-phase flow
modelling of two-phase flow phenomena related to LB-LOCA (2 runs)

i2: LOCA-related parameter studies (IB- and SB-LOCA) - **2 options**

- i2.1: SB-LOCA- Impact of nitrogen on cool-down/heat removal
- i2.2: IB-LOCA, Counterpart Testing with LSTF/ATLAS)
- i2.2: IB/SB-LOCA- Influence of certain parameters on depressurization

i3: Studies on boron dilution - 2 options

- i3.1: Failure of RHRS, confirmation of conclusions on boron dilution for 3-loop plants
- i3.1: Parameter studies on boron dilution following SB-LOCA

i4: Investigations on cool-down procedures – 2 tests

- i4.1: **Upper head void formation** during cool down under loss of offsite power (complementary to test G6.1)
- i4.2: **ELAP** (extended loss of AC-power): cool-down with feed water from mobile pump after secondary side depressurization

i5: Concluding investigations on **boron precipitation (LB-LOCA) - 1 test**

i6 : Open test with topic to be defined during project progress

Access to AREVA NP Facilities

- **Who to contact:**

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- **Additional information can found at the AREVA Technical Center web page:**

  http://de.areva.com/EN/customer-3832/thermal-hydraulic-and-component-testing.html