FROM AMI* CHINON TO LIDEC** NUCLEAR FACILITIES

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*Irradiated Materials Workshop

**EDF integrated laboratories facilities for examinations
History of AMI

- Built from 1960 up to 1963
- End of 1963: official start up and French decree publication (INB n°94)
- First metallurgical examinations from 1964:
  - Graphite/gas fuel element examination of Chinon A1 in hot cells,
  - Bolts examination from internals for corrosion aspect,
  - Corrosion and vibration phenomena on exchangers of Chinon A1 and Brennilis
History of AMI (cont’d)

- 1967 : beginning of Pressure Vessel Surveillance Program (PVSP) for Chooz A,
- In the eighties, hot cells are modified to receive fuel elements coming from PWR power plants (activity definitively transferred to CEA in 2000),
- From the beginning of eighties, 2 main missions :
  - follow up surveillance program on different components (PVSP, cast elbows from main primary circuit)
    - objective : life assessment
  - and also, AMI in support to PWR power plants in the field of materials and more recently, in the field of fluids and effluents characterization
    - objectives : availability, safety, maintenance policies optimization
- More recently (2004) :
  - examinations on equipments coming from conventional islands,
  - prescription for chemical and radio-chemical analysis methods are proposed in the field of process, effluents, wastes and environment in the objective to harmonize methods for all NPP
The PVSP allows to verify the conservatism of the ageing formulae defined to calculate the $RT_{NDT}$ shift due to neutron bombardment,

The PVSP is applied to each reactor vessel in operation in France (plus 2 in South Africa) and allows to monitor periodically the irradiation induced material embrittlement. The results obtained represent the shell state after approximatively 10, 20, 30 and 40 years of operation.
In-service toughness follow up of the PWR vessels under irradiation

Charpy-V specimen

Shell

Surveillance capsule

Température (°C)

Résilience (daJ/cm²)

Shift = ΔT<sub>CV</sub> = ΔR<sub>ndt</sub>

Unirradiated material

Irradiated material
AMI in support to PWR and fossil power plants

- in the fields of materials, fluids and effluents characterization
- About 150 metallurgical examinations by year

Materials concerned

Equipments concerned

<table>
<thead>
<tr>
<th>Equipments</th>
<th>Nuclear island 36%</th>
<th>Secondary circuits + Turbine hall 30%</th>
<th>Feedwater plant 14%</th>
<th>Others equipments 20%</th>
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<table>
<thead>
<tr>
<th>Materials</th>
<th>(150 expertises)</th>
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<tbody>
<tr>
<td>Low alloy steels 13%</td>
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</tr>
<tr>
<td>Austenitic stainless steels 30%</td>
<td>Martensitic stainless steel 5%</td>
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<tr>
<td>Martensitic stainless steel 5%</td>
<td>Carbon steels 24%</td>
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<tr>
<td>Austenitic stainless steels 30%</td>
<td>Nickel alloys 8%</td>
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<tr>
<td>Nickel alloys 8%</td>
<td>Copper alloys 9%</td>
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<tr>
<td>Carbon steels 24%</td>
<td>Mid alloy steels 7%</td>
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<tr>
<td>Martensitic stainless steel 5%</td>
<td>Coatings 3%</td>
</tr>
<tr>
<td>Austenitic stainless steels 30%</td>
<td>Hard deposits 2%</td>
</tr>
<tr>
<td>Nickel alloys 8%</td>
<td>Silver 1%</td>
</tr>
<tr>
<td>Copper alloys 9%</td>
<td>Ceramic 1%</td>
</tr>
<tr>
<td>Mid alloy steels 7%</td>
<td>Cast iron 1%</td>
</tr>
<tr>
<td>Coatings 3%</td>
<td>Hard deposits 2%</td>
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From AMI to LIDEC

Since 1994, several projects have been proposed to define AMI nuclear facilities future. Decision has been taken at the end of 2001:

- to definitively stop examinations on fuel,
- to significantly reduce radiological inventory (complete fuel evacuation and cleansing of storage holes)

New safety evaluation studied by EDF, combined with the French safety authorities position have led to take the decision in the 1st of June 2006:

- confirm the renunciation on fuel examinations,
- AMI Chinon decommissioning before 2015,
- building new nuclear facilities called LIDEC, located on NPP of Chinon close to chemical and radiochemical facilities in the field of effluents and environment, commissioned before end of 2011

Fuel examinations renunciation combined with a strict following of radiological inventory for metallurgical examinations will enable to define a new status for LIDEC nuclear facilities.
Prescriptive field: localization of new facilities
Prescriptive field (cont’d)

- Civil works lifespan (shielded hot cells included) : 50 years

- Maximum radiological inventory : 35 TBq $^{60}$Co (no fuel examination) ⇒ downgrade administrative status / AMI (Nuclear Installation)

- Radiological Cleanliness : to protect staff against contamination in each situation ⇒ best solution for the containment of equipments ⇒ over clothes in normal situation

- Dosimetry : workers as often as possible in low dose rates zones (< 0,25 µSv/h); zero internal contamination.

- Modularity and extension possible :
  - 2 reserved locations for possible future hot cells in shielded cells,
  - a 300 m² area to enlarge the building, if necessary
Functional field

- 2 kinds of activities on materials or fluids:
  - foreseen and planned in EDF survey programs: Irradiation Vessel Survey, ageing of cast primary elbows,
  - fortuitous, often in urgency, answering a need of one particular EDF plant in relation with safety or availability of power plant

⇒ On Irradiated, contaminated or conventional materials

- Fuel is not included, but fluid coming from main primary circuit in a situation of fuel casing breakdown will be allowed

- Principal functions:
  - reception and radiological characterization of objects, parts, fluid, specimens…
  - prepare samples for examinations
  - perform the examinations (solid or fluid)
  - archive samples and material
  - evacuate wastes
Design options

Civil works:

- The LIDEC building is made of reinforced concrete, with an architectural external cladding and vegetal roof.

- On 3 levels:
  - Basement: technical galleries for liquid effluents collecting (4 tanks: 2x15 m³ for low activity effluents, 2x5 m³ for high activity effluents), solid contaminated wastes sorting and storing,
  - Ground floor: reception, preparation and material assessment,
  - First floor: utilities and sample archiving,
Design options (cont’d)

On a surface of 3500m²:

- Metallurgy, chimistry and mechanical testing
- hot labs + hot workshops + reception area + archive samples and materials

Conventional lab
Materials reception

For radioactive materials, there are 3 paths inside the nuclear laboratory:

- 5 glove boxes connected together to receive the low activity materials in air proof containers (90% of materials flow) and to perform characterization, visual inspection, decontamination and cutting.

- Exceptional working zone (> 20 Kg or > 550 x 340 mm)
Shielded hot cells

- Transport cask (R48, TN106, Padirac or specific flask) accessible to the reception cell

- Concrete thickness between 70 and 110 cm,

- Stainless steel containment box to assure the static containment,

- A filtered ventilation to assure the dynamic containment,

- Cells equipped with remote manipulator systems and windows for vision.
Shielded hot cells (cont’d)

Transfer between cells:

- by direct transfer between 2 party wall cells, via lateral shielded doors and motorized conveyor belt between the cells,
- with a Padirac cask for equipped cells,
- with an airproof container connected directly to the containment box for low activity materials
- by pneumatic transfer for small parts (diameter max 72 mm)
Handling equipments and utilities

- Main handling equipments:
  - 2 travelling cranes (20 t), one in reception hall and one in the rear zone of shielded cells (for casks handling),
  - 4 monorails, 3 (1 t) in the front zone of shielded cells to extract remote manipulator systems, and 1 (2 t) in the exceptional working area

- 2 ventilation systems used:
  - Process ventilation: filtered ventilation for shielded cells and glove boxes,
  - Building ventilation: air conditioning, and filtered ventilation for nuclear laboratory including fume cupboards

- Electrical supply: LIDEC is powered by 2 sources of 5,5 kV

- Fluid supply and evacuation:
  - LIDEC is supplied with drinkable water, demineralised water and fire extinguishing water (under pressure),
  - A system assures the production of cold water from drinkable water, for the cooling of equipments
Work stations study

Analysis (for low irradiated specimens):

- Study based on a risk analysis approach: its goal is to identify causes and types of potential accidents and preventive measures to limit frequency and gravity.

- The analysis also integrates 40 years AMI experience and some known referential as CEA “practical guide Radio nuclides et radioprotections – EDP science”.

- Type of work station for integration of equipments is defined depending on radiological characteristics of specimen manipulated.

- For contaminated materials (depending on the contamination level), different types of containment will be used:
  - Glove box and shielded glove box
  - Pallet and pallet under air flux
  - Ventilated cabin
Cleanliness zoning

Objective: minimize nuclear wastes and facilitate access to each place:

- Cold laboratories, public zones, utilities premises are without risk of contamination, wastes are conventional zones (K),
- To minimize nuclear wastes (N), N wastes zones are limited (using confinements) to the very nearest zones around the contamination sources
**Radioprotection zoning**

**Objective**: a maximum of zones as “green” (< 25 µSv/h):

- Steps of reception, visual observation, machining, decontamination are regrouped in a dedicated room, in shielded glove boxes unit,

- In chemical laboratory, dose rates around some work stations are still high. So, to limit impact on neighbor, work stations have been separated by concrete wall.
Main steps of the project

A project in 4 years with main steps as follows:

- Preliminary studies: between June 2007 and August 2008
- Executive studies: from July to December 2009
- First concrete: December 2009 (optimized planning on 31 months)
- First conventional examination: before end of 2011
- Progressive transfer of hot activities: before end of 2012