Fuel Cycle Information Exchange 2009

International Experience in Reprocessing

The French approach for the regulation of the recycling activities

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- ✓ The French regulatory framework
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Introduction

- ✓ The ASN ensures supervision and regulation of an important pool of major nuclear facilities (BNI)
- ✓ 164 major nuclear installations : 58 PWR (EDF) and an entire fuel cycle
  - 42 research facilities on 5 major research centers (CEA)
  - 12 fuel cycle industry facilities (AREVA)
  - the vast majority of the plants in the fuel cycle belong to the AREVA group

Introduction

- **After 3 to 5 years , the spent fuel is removed from the reactor and cooled first in a pool, first on the reactor site then in the reprocessing plant in La Hague**
- **The uranium and plutonium from the spent fuels are separated from the fission products and the other actinides**
- **The uranium and plutonium are packaged for interim storage before subsequent use (no Pu stock pile but technical buffer)**
- **The radioactive waste is placed in surface repository if low level or in interim storage pending an appropriate disposal solution**
- **The plutonium produced by reprocessing is used to make MOX fuel used in French 900 MWe PWRs**

✓ To upgrade the performances of reactor in service, EDF implements new fuel management systems

Management of Spent Fuel Policy and Practices

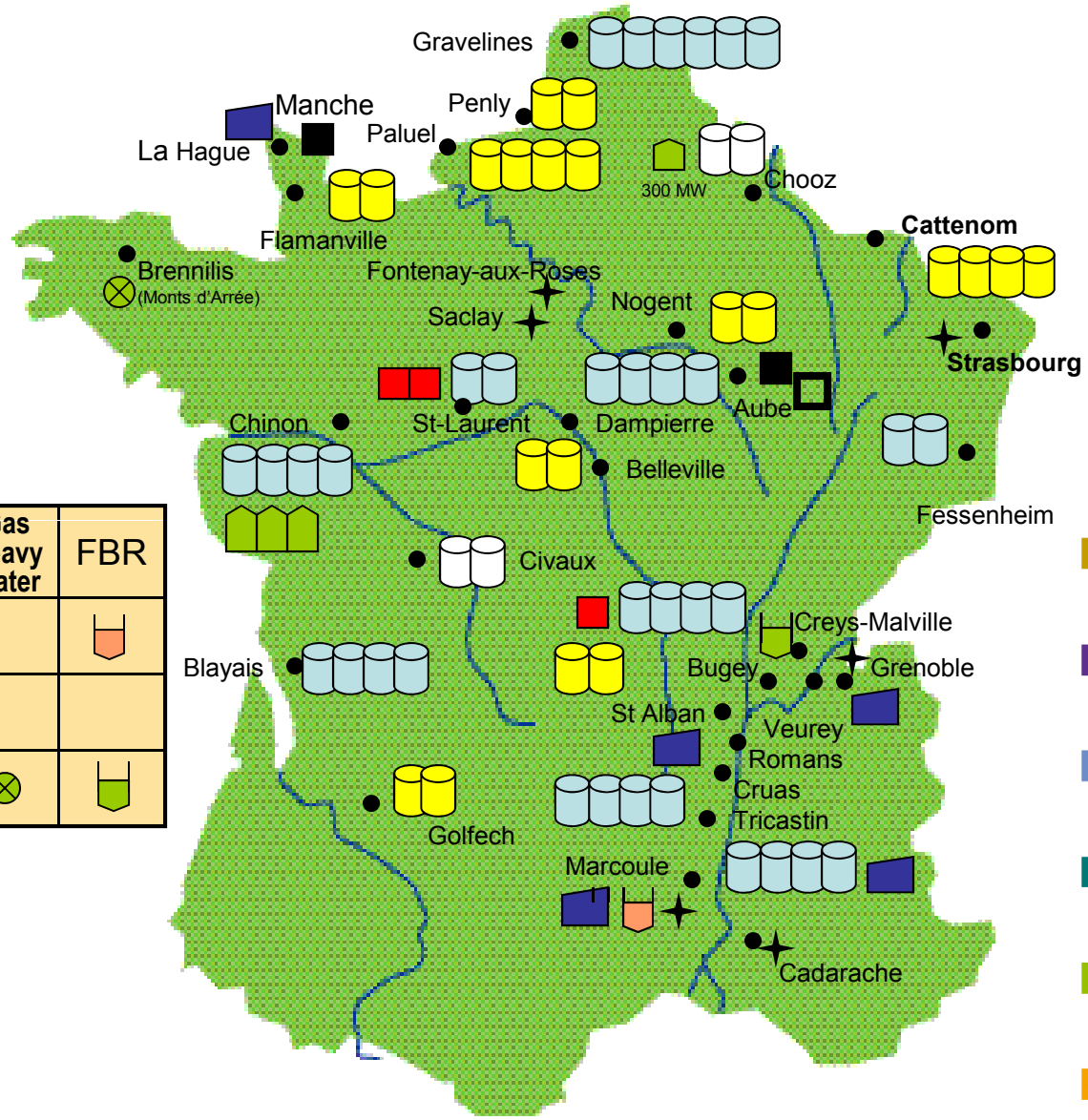
✓ ASN supervises the fuel cycle consistency

- **Through a** study carried out by ANDRA, Areva and EdF, **ASN ensures that the following topic is checked :**
  - **safety-related and regulatory consistency of the industrial choices for the next 10 years,**
- **The main goals are to anticipate and hence avoid :**
  - **saturation of storage capacity,**
  - **inconsistency between fuel cycle facilities and foreseen fuel management evolutions.**
- **An overall revision of this study transmitted to ASN in 2008 and will be submitted to ASN's advisory committee in 2010.**

Major Nuclear Installations in France

- Fuel cycle Facilities (enrichment, fabrication, reprocessing)
- Waste Repository
- Research Centres
- Power Reactors
- Morvilliers repository (ICPE)

Power Reactors	PWRs			Gas Graphite	Gas Heavy Water	FBR
	900MWe	1300 MWe	1450MWe			
In operation						
Shut Down						
Dismantling						



Overview of the French Fuel cycle Facilities

✓ AREVA fuel cycle throughput in 2008

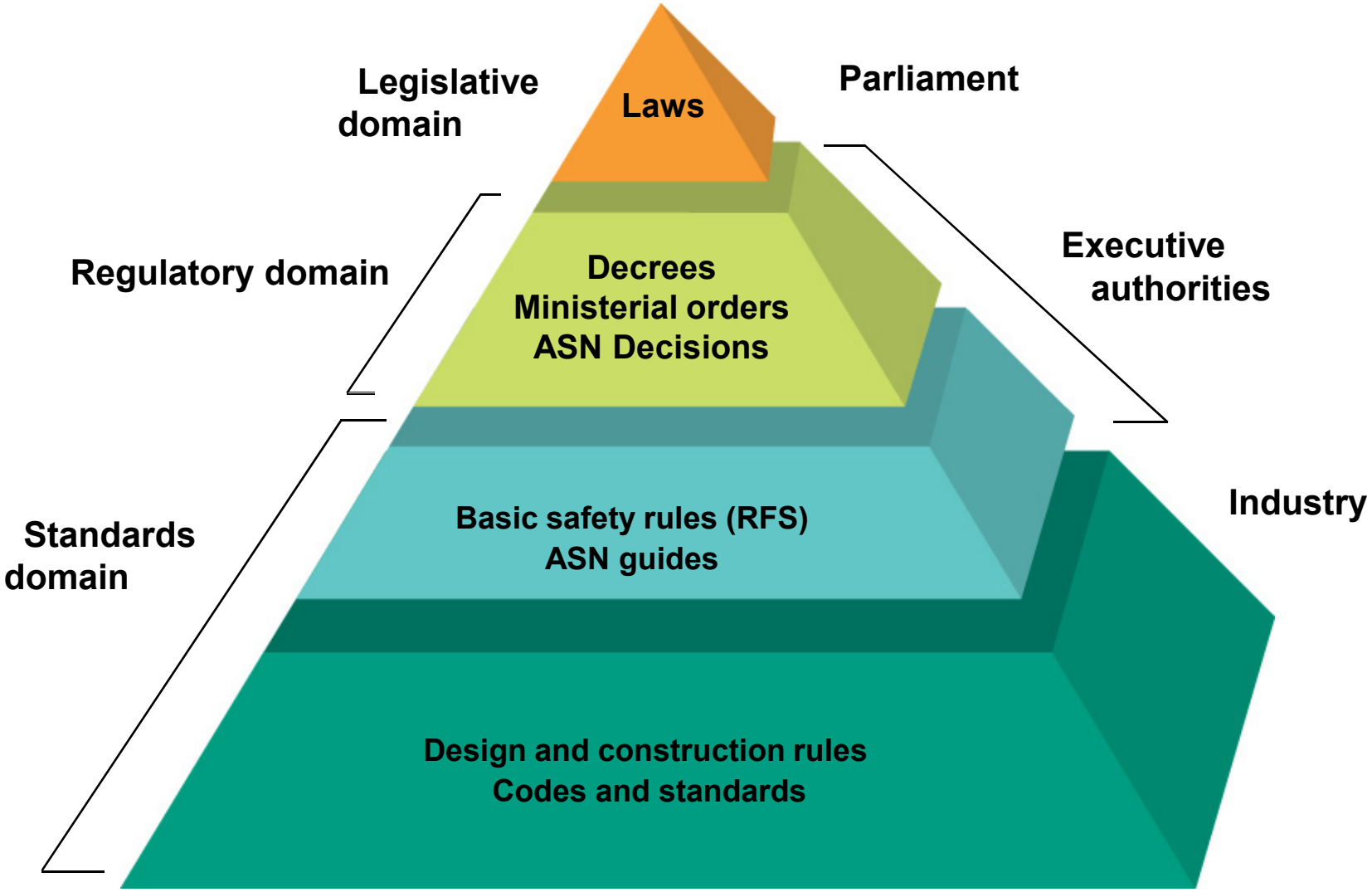
Facilities	Material processed	Product obtained
Comhurex Pierrelatte	**Uranyl nitrate** reprocessed uranium	**U3O8 storage 6.2t**
AREVA NC Pie TU5 W	**Uranyl nitrate** **UF6** (depleted U)	**U3O8 storage 12,889 t**
Eurodif Pierrelatte	**UF6** (naturel U)	**UF6** depleted **16,975t** **UF6** enriched **2232t**
FBFC Romans	**UF6**(depleted U) **UF6**(enriched U)	**UO2 powder 305t** **Fuel elements 470t**
Melox Marcoule	**UO2** (depleted U) **PuO2**	**MOX** **Fuel elements 123t**
AREVA NC La Hague	**Spent fuel elements** **UP3 639t UP2800 299t**	**Vitrified waste 793 p** **Uranyl nitrate 852.8 t** **PUO2 12.6t**

The Act on Transparency and Security in Nuclear Field

- ✓ Until 2006 the legislative basis for supervising the safety of the major nuclear installations were based on the decree of 11 December 1963

- ✓ The act of 13 June 2006 (TSN act) is a major step in strengthening the regulation of nuclear safety and radiation protection in France
  - **It creates ASN as an Independent Administrative Authority**
  - **It confirms the fundamental principles of Nuclear Safety (Convention of Nuclear Safety)**
    - Broadened definition of nuclear safety covering accident prevention but also the protection of the environment and human health
    - Prime responsibility of the licensee
    - The licensee must conduct periodic safety reviews
  - **It gives ASN the responsibility for licensing and inspections**
    - in case of licensee shortcomings, administrative sanctions and criminal penalties
  - **It guarantees the right of the public to reliable and accessible information on Nuclear Security**

The French Regulatory Framework



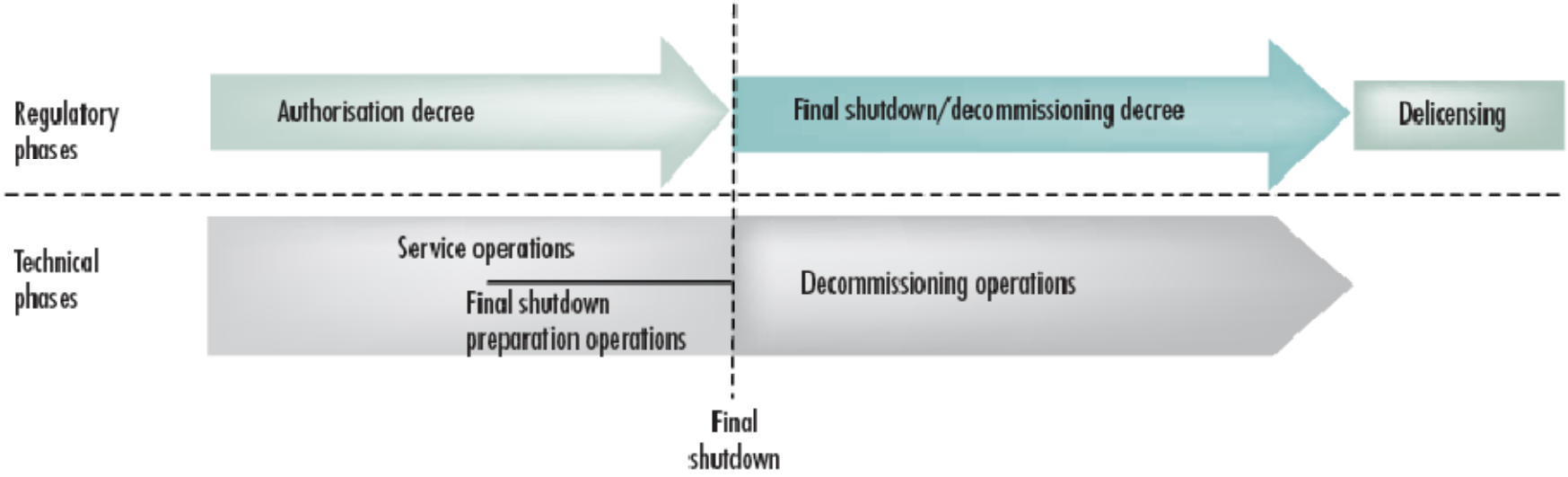
The French Regulatory Framework

Commissioning procedure

- Transmission by the operating organization of the authorization dossier to the ministers and ASN
- Public enquiry
- Consultation of the ministers (environment, health, …)
- Examination of the Preliminary Safety Report by IRSN (Institute for Radioprotection and Nuclear Safety) and the Standing Group of Experts for FCF and research laboratories
- Draft of the authorization decree by ASN
- Examination of the decree by CIINB (inter ministerial commission for BNI)
- Examination by the ASN College of Commissioners
- License (decree)

The French Regulatory Framework

Decommissioning procedure



- **Guides :**
  - **Guide related to shutdown, decommissioning and declassification of BNIs**

    Includes the typical content of a decommissioning plan

    the topics to be included in the review process

  - **Guide related to cleanup**

    Includes the typical content of a cleanup report

The French Regulatory Framework

Definition and classification of radioactive waste

Status of long-term management solutions for each waste category

<table>
<tr><th>Half-life / Activity</th><th>Very short half-life
(< 100 days)</th><th>Short half-life
(≤ 31 years)</th><th>Long half-life
(> 31 years)</th></tr>
<tr><td>Very low level (VLL)</td><td rowspan="4">Management by radioactive decay</td><td colspan="2">Surface disposal (CSTFA)
Recycling systems</td></tr>
<tr><td>Low level (LL)</td><td rowspan="2">Surface disposal
(CSFMA)
except some tritiated waste and some sealed sources</td><td>Dedicated shallow facility under study</td></tr>
<tr><td>Intermediate level (IL)</td><td rowspan="2">Ongoing studies
pursuant to
2006 Planning Act</td></tr>
<tr><td>High level (HL)</td><td></td></tr>
</table>

Examples of Radioactive Waste packages

VLLW

ILW-LL

Compacted hulls and end caps

LILW-SL

Metallic drum

Concrete container

HLW

Vitrified waste

The French Regulatory Framework

✓ The French regulatory framework is applicable to all nuclear facilities, including fuel cycle facilities

- **Graded approach but the same frame as NPP**
  - Deterministic safety assessment complemented by PSA as appropriate
  - Safety analysis applied to operating conditions
  - Use of design codes
  - Licensing Process is the same (PSR..)
- **FCF safety reference system**
  - Inter ministerial authorization decree
  - Technical prescriptions by ASN and technical specifications
  - Safety Analysis Report
  - General Operating Rules
  - On site emergency plan
  - Release authorization (ASN prescriptions)

The French Regulatory Framework

- ✓ **Specific regulation**
- ✓ Each facility is regulated as well through
  - Licensee's identity
  - Plant maximal capacity
  - Installations concerned
  - Main equipment important for safety

- **ASN decisions specifies its requirements**
- **Any modification of the installations has to be notified**
- **ASN requirements**
  - Appropriate siting
  - Robust design against any kind of aggression (defense in depth)
  - Adequate construction
  - Properly operated
  - Regular controls
  - Dismantling options

Operation feedback for FCF

- **Significant increase in reported events**
  - 2007 - 30 incidents, 2008 – 55 incidents
  - Not necessary linked to a degradation of the safety level
  - But linked to more transparency (most of them = level 0)
  - RP events scale, new criteria for safety events (environment)
  - Some are due to the ageing of installations (old facilities)
- **Cross analysis by IRSN (ASN TSO) presented to the Advisory Committee**
- **The importance of the human factors**

Periodic safety review and operation feedback

Ageing management

- **The French practice does not limit the life of a nuclear facility**
- **Numerous systems may be changed in FCF**
- **ASN implemented periodic safety reviews (every 10 years)**
  - to check the conformity of the facilities to the description of the safety reference system,
  - to reassess the design taking into account current knowledge , codes and standards and lessons learned from operational experience,
  - to examine the necessity to proceed to changes regarding to the outlooks of operating in the next years

Periodic safety review and operation feedback

Ageing of equipment

- Pipes, vessels, anti-seismic support, expansion bellows
- Causes (wear, corrosion, concrete cracking…

Facility modifications

- Evolution of process, activity or operating conditions
- Evolution of the nuclear material process
- Increase of the production capacity
- Building enlargement

External modification

- Evolution of the natural and human environment

Operating feedback

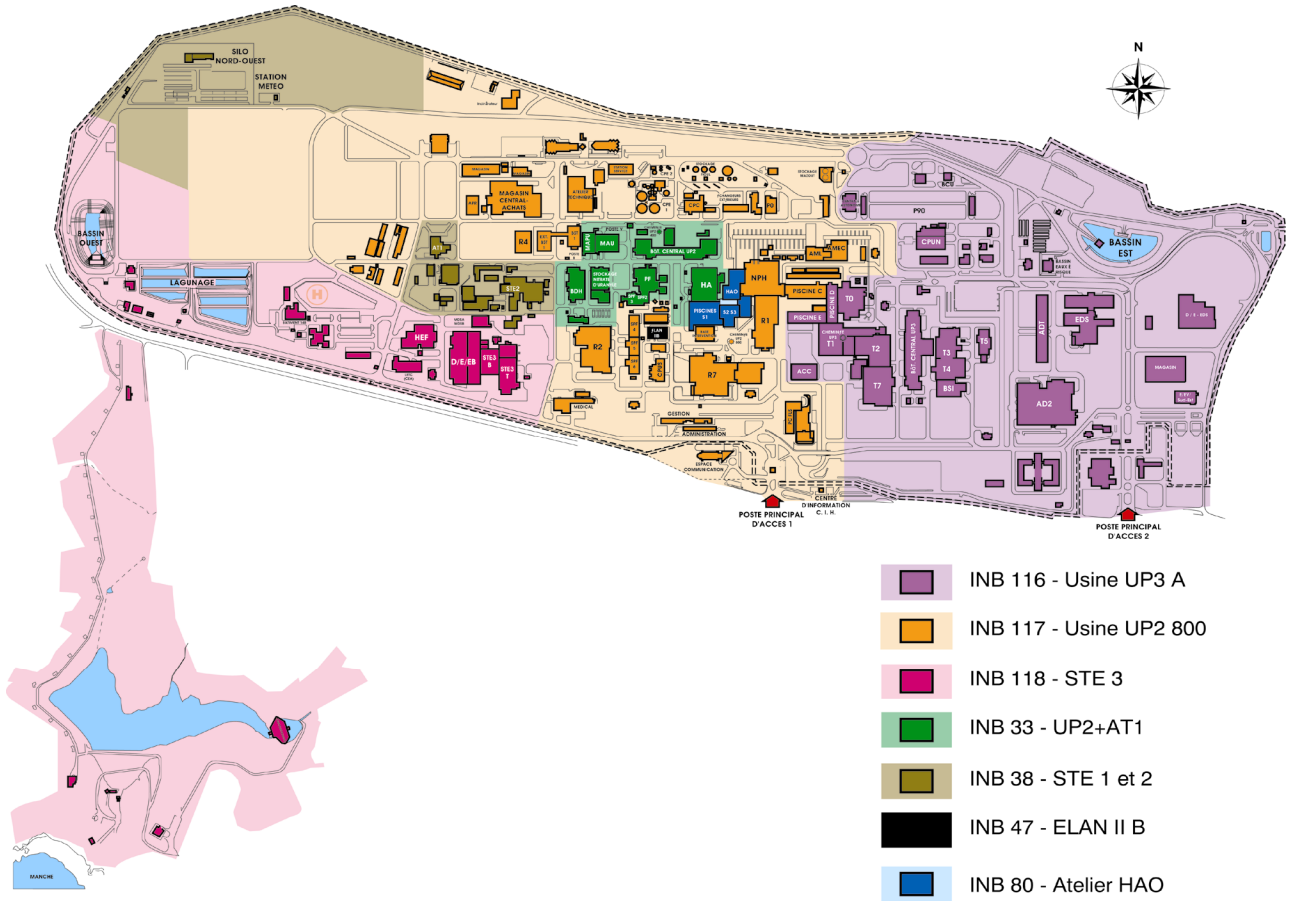
- Radiation protection issues
- Releases
- Waste production
- Anomalies, incidents
- Staff training
- Emergency exercise reports

Periodic safety review and operation feedback

Facility	Year	Main topics	Decision
ATPu BNI n°32	1995-2000	Seismic reinforcement Ageing	Radioactive material removal 2008 Decommissioning 2009
FBFC BNI n°98	2001-2003	Seismic Ageing, fire, OHF, Confinement, RP	General refurbishment, Optimisation of the industrial tool
FBFC BNI n°63	2004-2006	General Safety Analysis	Refurbishment Optimisation
MELOX NBI N°151	2000	Operation feedback General safety analysis (RP, criticality safety)	RP improvements

General view of la Hague

General view of la Hague



ASN experience with reprocessing at La Hague

1959 : creation of UP2 by the CEA, reprocessing of nuclear fuel UNGG (BNI 33) with shop AT1 for reprocessing of nuclear fuel RNR creation of the plant for processing the discharges: STE2 (BNI 38)

1974 : addition of a shop to process the nuclear fuel from the reactors based on the light water principle (HAO : BNI 80)

1981 : Creation of UP2-800 (BNI 117), UP3 (BNI 116) and STE3 (BNI 118)

Dec. 2003 : Notification of the end of processing nuclear fuel UP2-400 from January 1st, 2004

Jan 2003: New regulatory framework for UP2-800, UP3 and STE3

UP2-800, UP3, STE3 Regulatory framework

♦ Increases of the treatment capacity of the plants UP2-800 et UP3 to 1 000 tons per year, keeping the overall maximum retreatment capacity at 1700 tons per year;

♦ Increases of the pool storage capacity of the used nuclear fuel from 11 990 to 17 600 tons ;

♦ Extends the range of nuclear fuel to be treated (RTR, MOX, HTC, URE, RNR) ;

♦ Extends the provenance and the kind of **nuclear** materials and radioactive substances to be treated (effluents, and technologic wastes...)

UP2-800, UP3, STE3 Regulatory framework

Area opened by the 2003 décrees			A.I Dates	Authorized area	
UOX	75 GWj/t	< 5 %	01/16/04 01/16/04	< 4,5 %	60 GWj/t
MOX	65 GWj/t	< 12% Pu	04/26/04 03/22/04	< 8,65% Pu	55 GWj/t
URE	75 GWj/t	< 4,9 %	02/08/05 02/08/05	< 4,1 %	52 GWj/t
RNR	120 GWj/t	< 35% Pu			
RTR		< 95% U5	03/29/05 03/29/05	< 93,5 % U5	
Nuclear materials Radioactive substances			03/29/05 03/29/05	rejected MOX, powders … .	

General view of MELOX

MELOX plant evolution

The production capacity limit was increased in two steps:

- first from 115 tons of mixed oxide to 145 tons of heavy metal,
- then from 145 to 195 tons of heavy metal.

MELOX plant evolution

August 2004
Preliminary safety report

↓

Beginning of 2006
Public enquiry

↓

July 2006
IRSN's assessment
Advisory Committee

↓

April 2007
Decree modification

ASN experience with MELOX

- **2009**
  - **Total Productive maintenance (predictive maintenance) implemented on gloves boxes and automated equipment for reducing exposure during maintenance**
  - **Energetic value of recovered Pu decreauses when the used fuel burn up increases**
  - **Need for higher Pu content in fresh MOX fuel, resulting in higher gamma and neutron emission rate and higher occupational exposure**
- **ALARA studies needed**
- **Need to update criticality safety analysis**
- **PSR is planned (2010-2012)**

ASN opinion about the safety of La Hague and Melox

- **MELOX: about 10 inspections/year in MELOX – about 15 incidents/year**
- **La Hague: about 60 inspections/year in La Hague – about 30 incidents/year**

- **Robustly designed**
- **Operating improvements expected**
- **No major incidents**

CONCLUSION

- **FCF are of most importance for the French Nuclear Program**
  - Each of them is a particular case : a graded approach is implemented for safety
  - A safety approach more and more generic : major progress in safety
  - An ageing pool of FCFs : periodic reassessments are necessary
  - The importance of the human and organizational factors
- **“Renaissance” of the nuclear**
  - New projects to be instructed
  - GB II will replace Eurodif (gaseous diffusion enrichment plant)
- **The challenges for ASN**
  - FCF must remain at the top level for safety
  - New context with majors stakes
  - The TSN act

Thank you for your attention !

more information available at

www.asn.fr