

INTERNATIONAL SEMINAR ON NUCLEAR FUEL CYCLE

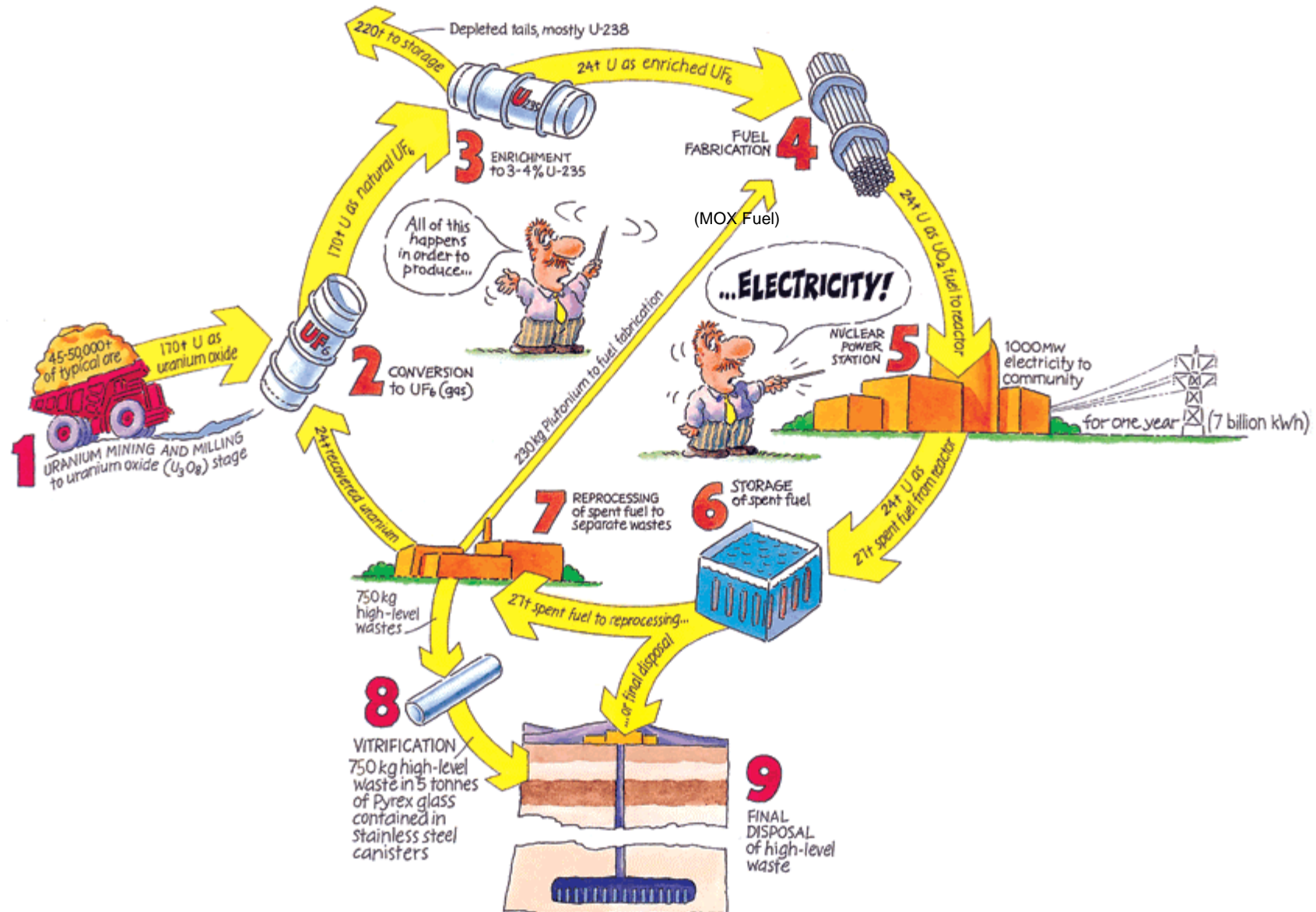


France
November 29th
December 10th, 2004



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NUCLEAR FUEL CYCLE



Mining Extraction / Concentration, Conversion, Enrichment



-  Mining sites undergoing reclamation
-  Enrichment and uranium chemistry



Mining Extraction/ Concentration

- No more production in France (foreign origin)

Conversion - COMURHEX

- Malvesi (from yellow cake to UF_4)
- Pierrelatte (from UF_4 to UF_6)

Conversion - COGEMA

- TU5 (from reprocessed $UO_2(NO_3)_2$ to U_3O_8) (Pierrelatte)

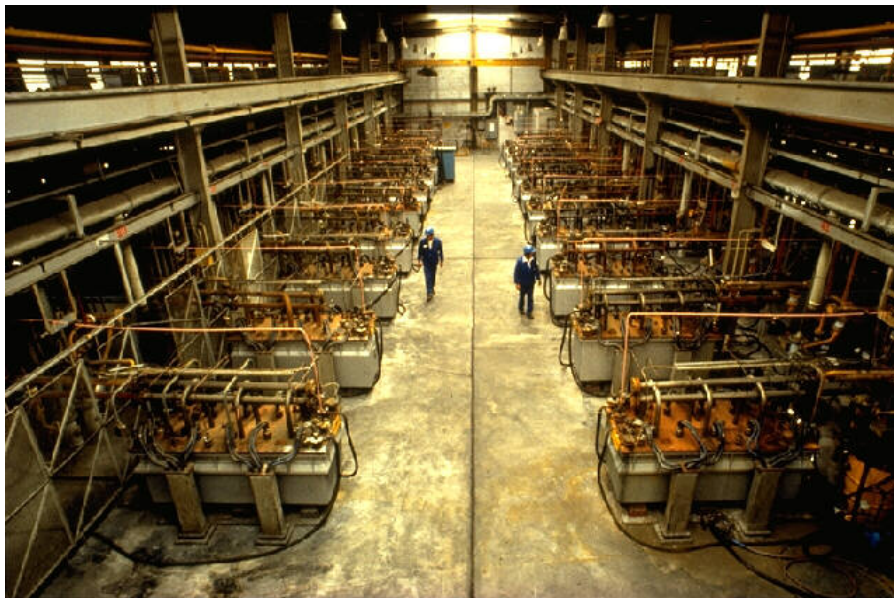
Enrichment - EURODIF

- Pierrelatte

Conversion – COMURHEX (Thursday December 9th)



Plant for conversion of
 UF_4 into UF_6
(Pierrelatte)



Fluorine electrolysis cells

Conversion – COGEMA (Friday December 10th)



The TU5 uranyl nitrate conversion facility (Pierrelatte)

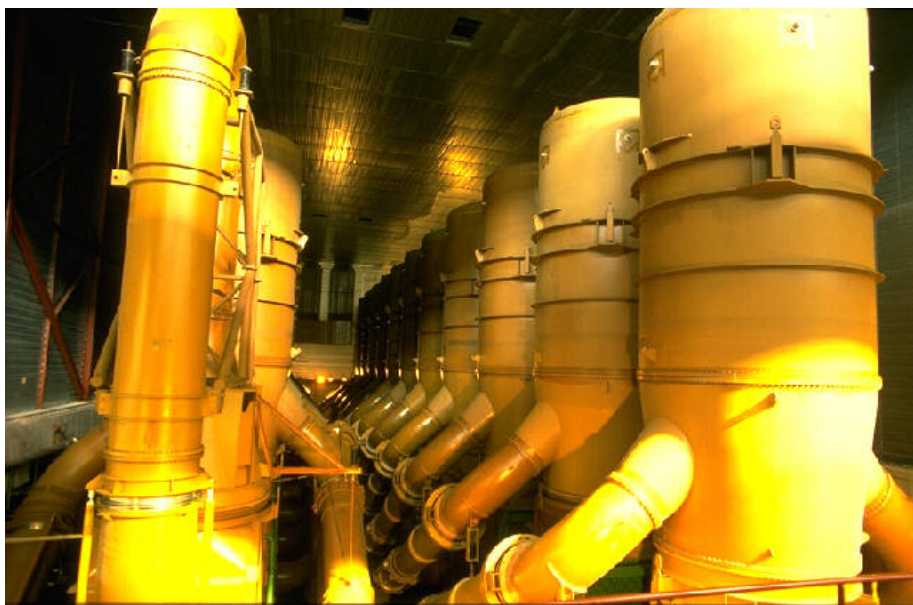
Drying concentrates on belt filter



Thermal containers of uranyl nitrate

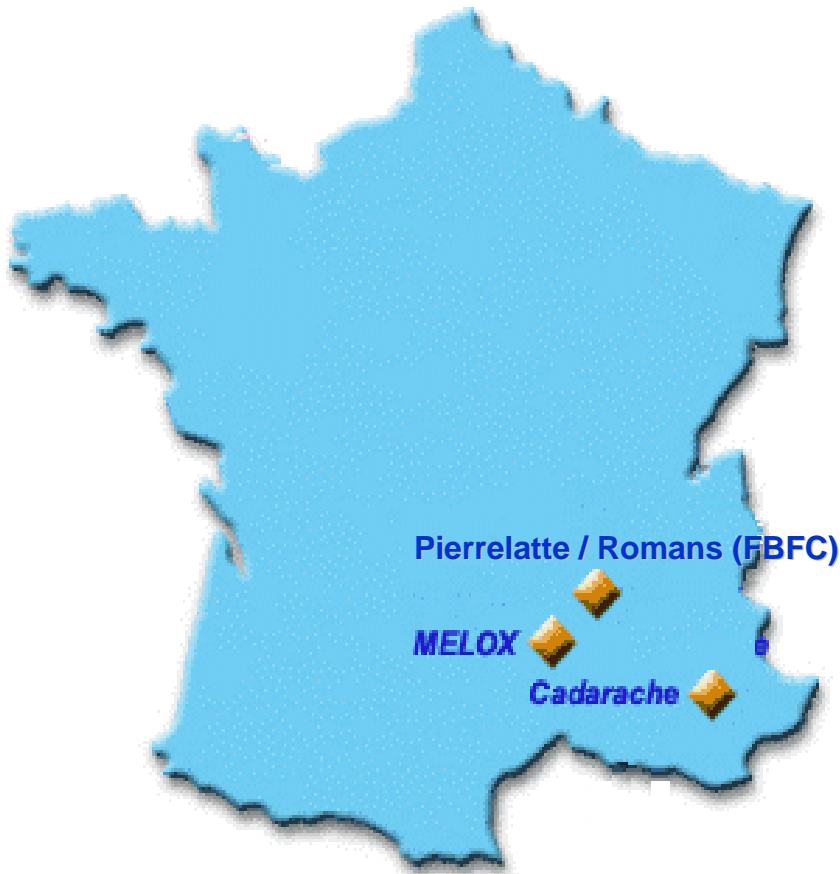


The Georges Besse gaseous diffusion enrichment plant (Pierrelatte)



Diffuser stages

Fuel Fabrication – Fuel Assembly



1) Standard Fuel (enriched U in ^{235}U) FBFC

- Romans
- Dessel / Belgium (from UO_2 powder)
- Pierrelatte (skeletons of fuel assembly)

2) MOX Fuel (mixed U and Pu) MELOX

- Marcoule
- Dessel / Belgium
- Cadarache (closed)

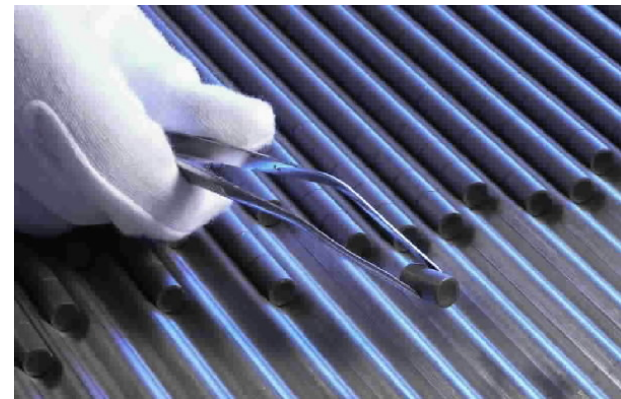
Fuel Fabrication – FBFC (Wednesday December 8th)



FBFC standard fuel fabrication plant (Romans)



skeleton of
fuel assembly



Fuel
pellet

Fuel Fabrication – MELOX (Friday December 10th)



MELOX mixed fuel fabrication plant (Marcoule)

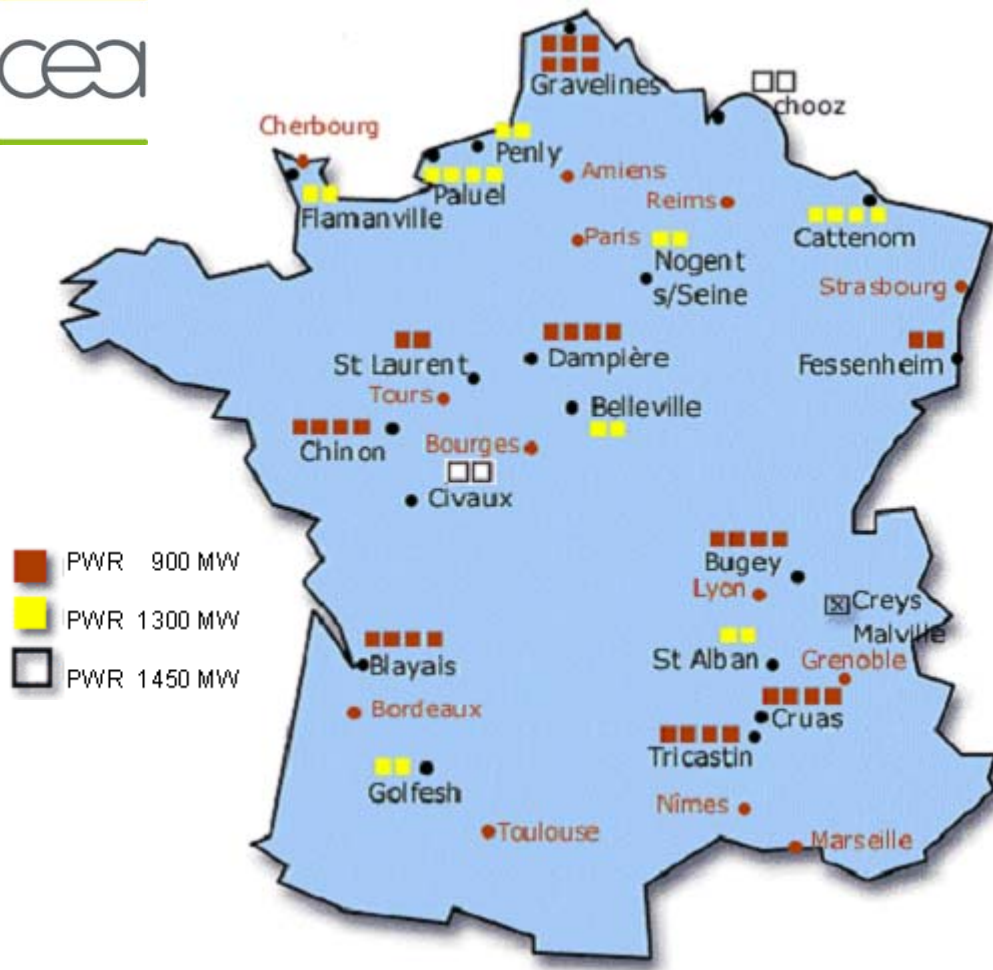
Storage and handling tunnel



Visual inspection of Mox fuel rods



Nuclear Power Plant – Pressurised Water Reactor (PWR)



**75% of the electricity produced
is from nuclear origin**

58 PWRs operating

34 units of 900 MW of an average
age of twenty one years old

20 units of 1300 MW of an average
age of fifteen years old

4 units of 1450 MW of an average
age of five years old

TRICASTIN nuclear power plant (Pierrelatte)



Waste Management - ANDRA



ANDRA (National Agency for the Management of radioactive Wastes)

Surface disposal

- **The Manche center**
- The Aube Center
- VLLW Center

Deep disposal

- The Meuse Underground Research Laboratory (under construction)



Radioactive Waste Classification

France's classification method is based on radioactivity levels and the half-life of radioactive elements contained in waste (referred to as short or long-lived). The cut-off point between short and long-lived waste is 30 years.

The following table is based on the above notions. The horizontal axis (radioactivity level) and vertical axis (half-life) define the various waste categories and their associated management solutions.

	Short-lived Half-life < 30 years	Long-lived Half-life > 30 years
Very-low level (VLL)	VLLW Disposal Facility	
Low level (LL)	<ul style="list-style-type: none">Centre de l'Aube Disposal FacilityOngoing studies for tritiated waste	Ongoing studies for graphite and radium-bearing waste
Intermediate level (IL)		
High level (HL)	Ongoing studies (Law of 30 December 1991)	

Radioactive waste classification.

The former classification into types A, B or C is now dying out.

Low Level Waste (LLW) and Intermediate Level Waste (ILW) is disposed of at the Aube Center. The global term LILW (Low and Intermediate Level Waste) is often used to describe this type of waste,

High Level (HLW) waste is always mixed with Long-Lived Intermediate Level Waste (ILWLL) : this type of waste is often referred to as HLW-LL (Long-Lived High Level Waste).



THE MANCHE CENTER

Low level and
middle level wastes
(Beaumont-Hague)



Visitors' centre

The manche center in
operation from 1969
to 1994, and today
under surveillance



Waste Management – ANDRA



The Very Low Level Wastes Center (Morvilliers)



The Meuse/Haute Marne
Underground Research
Laboratory (Bure)
(under construction)

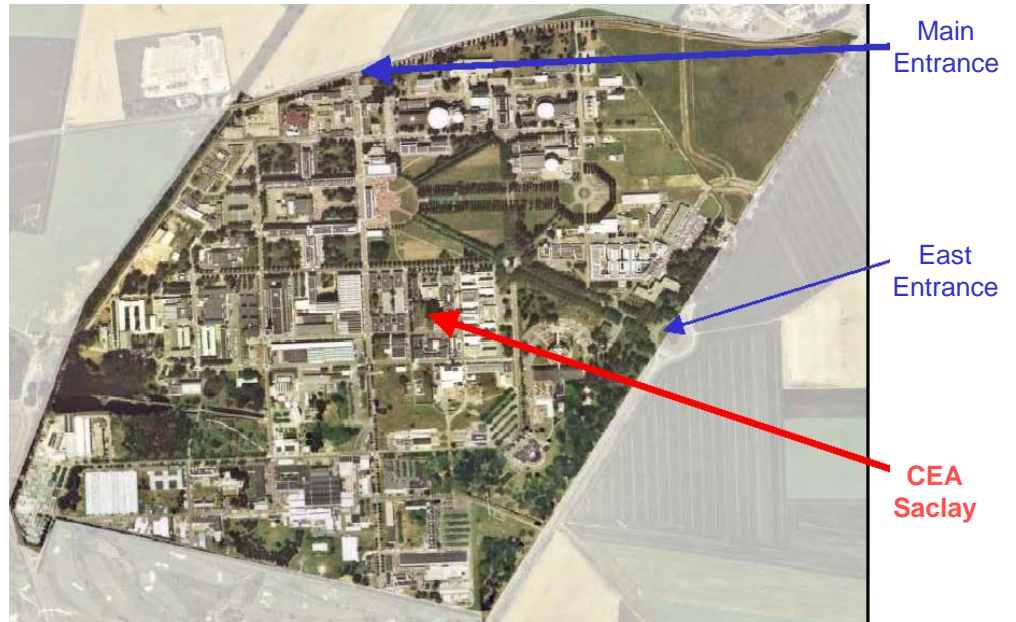


The Aube Center
(Soulaines)
(Low Level and
Middle Level Wastes)

Liquid Waste – CEA (Tuesday December 7th)



The Liquid waste treatment plant (Saclay)



Effluent tank



Effluent transport tank





Reprocessing - COGEMA

- La Hague reprocessing plant

Reprocessing – COGEMA (Thursday December 2nd)



La Hague reprocessing plant



Spent fuel storage pool



Lectures - INSTN

- concern all the steps of
the nuclear fuel cycle

given by nuclear industry experts

<http://www.enen-assoc.org>

<http://www-instn.cea.fr>