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Publications

- Accueil
- La revue Contrôle
- Les dossiers de Contrôle
- La sûreté nucléaire et la radioprotection en France
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- Autres publications

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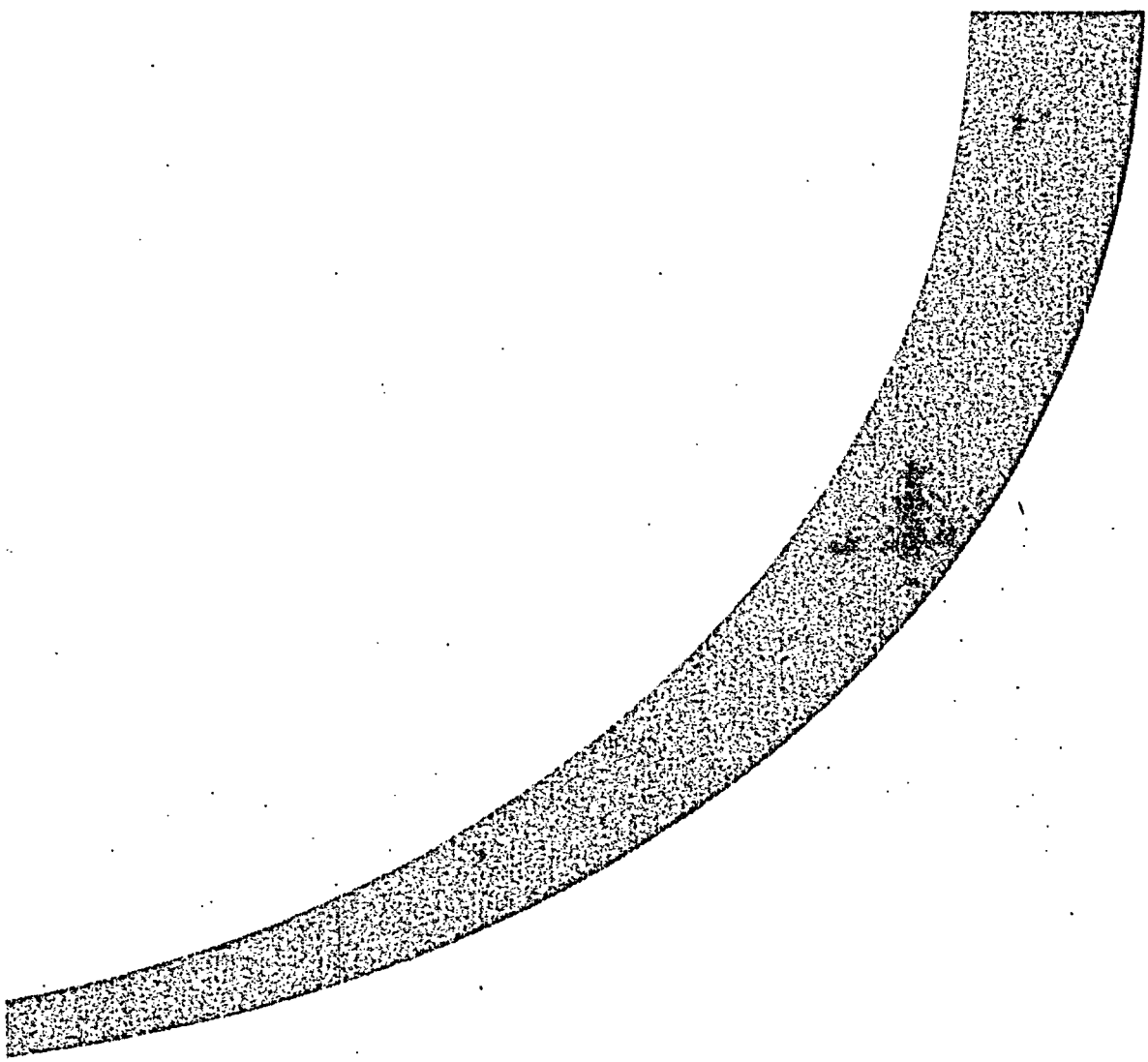
AUTORITE DE SURETE NUCLEAIRE

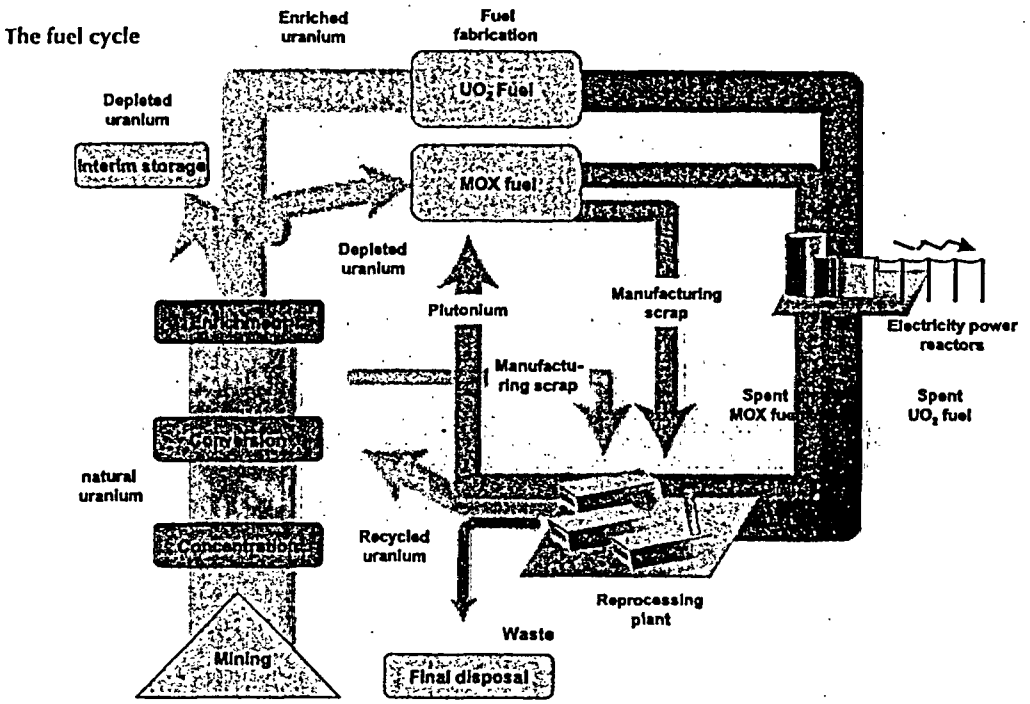
Directorate General
for Nuclear Safety
and Radiation Protection

NUCLEAR SAFETY IN FRANCE IN 2002



NUCLEAR FUEL CYCLE INSTALLATIONS

CHAPTER 12



Manufacture of the fuel and its subsequent reprocessing after it has passed through the nuclear reactors constitute the fuel cycle. The cycle begins with the extraction of uranium ore and ends with storage of a variety of radioactive waste originating from the irradiated fuel or from the industrial operations involved and utilising radioactive materials.

The uranium ore is mined, purified and concentrated into yellow-cake on the mining site. The installations involved use natural uranium, where the uranium 235 content is about 0.7%. They are not subject to BNI regulations.

Most of the world's reactors use uranium which is slightly enriched with uranium 235. For example, the PWR series requires uranium enriched to between 3 and 4%. Prior to enrichment, the solid yellow-cake is converted into uranium hexafluoride gas during the conversion operation. This is done in the Comurhex facilities in Malvési (Aude department) and Pierrelatte (Drôme department).

In the Eurodif plant at Tricastin, the uranium hexafluoride is separated into two streams using a gaseous diffusion process, one relatively rich in uranium 235 and the other depleted.

The enriched uranium hexafluoride is then converted into uranium oxide to allow manufacture of fuel assemblies in the FBFC plants at Romans-sur-Isère. The assemblies are then placed in the reactor core where they release power by fission of the uranium 235 nuclei.

After about three years, the spent fuel is removed from the reactor and cooled in a pit, first of all on the plant site and then in the COGEMA reprocessing plant at La Hague.

In this plant, 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 reuse. The radioactive waste is placed in a surface repository if low-level, or in interim storage pending an appropriate disposal solution.

The plutonium produced by reprocessing can be used to make fuel for fast neutron reactors (as was the case in the ATPu at Cadarache), or MOX fuel (uranium and plutonium mixed oxide), used in French 900 MWe PWRs, in the ATPu shop or in the Marcoule MELOX plant.

The vast majority of the plants in the cycle belong to the COGEMA group. It should however be noted that the uranium-based fuel manufacturing plants are operated by FBFC, a wholly-owned subsidiary of Framatome-ANP. The COGEMA group is a subsidiary of AREVA. Its organisation comprises an executive committee, four activity areas (Mines-chemistry, Enrichment, Processing-recycling-engineering, Services) grouping 11 business units (operational result centres), corporate functions and an operational committee. Fuel cycle BNIs depend on the business units covering Chemistry (Comurhex, TU5, W, COGEMA Miramas), Enrichment (Eurodif), Processing (COGEMA La Hague), Recycling (ATPu, MELOX), Mechanical engineering (SICN).

Fuel cycle industry throughput

Facility	Material processed	Product obtained
Comurhex Pierrelatte	Uranyl nitrate (reprocessed uranium)	UF_4: 0 ton UF_6: 0 ton U_3O_8: 497 tons
COGEMA Pierrelatte TU5 shop W plant	Uranyl nitrate (reprocessed uranium UF_6 (depleted uranium)	U_3O_8: 1496 tons U_3O_8: 15058 tons Total U_3O_8 on-site interim storage U_3O_8: 115,461 tons
Eurodif Pierrelatte	UF_6 (natural uranium): 21,366 tons	UF_6 (depleted uranium): 19,320 tons UF_6 (enriched uranium): 2438 tons
FBFC Romans	UF_6 (enriched uranium): 1747 tons UF_6 (enriched reprocessed uranium): 27 tons	UO_2 (powder): 1200 tons including 356 shipped UO_2 (fuel elements): 785 tons UO_2 (reprocessed uranium fuel elements): 24 tons
ATPu Cadarache	UO_2 (depleted uranium): 43.7 tons PuO_2: 3.3 tons	MOX (fuel rods): 44.1tons
MELOX Marcoule	UO_2 (depleted uranium): 103.48 tons PuO_2: 7.49 tons	MOX (fuel rods): 100.53tons
COGEMA La Hague	Spent fuel elements Quantities processed: UP3: 509.9 tons UP2 800: 550.7 tons UP2 400: 0 ton Spent fuel elements offloaded into the spent fuel pits: 1348.6 tons	Vitrified waste packages produced UP3: 291 containers UP2 800: 321 containers UN produced: 1086 tons PuO_2 produced: 10.4 tons