UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

November 3, 1999

MEMORANDUM TO: Robert C. Pierson, Chief
Special Projects Branch, NMSS

THRU: Melanie A. Galloway, Chief
Enrichment Section
Special Projects Branch, NMSS

Melanie A. Galloway

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SUBJECT: TRIP REPORT - MEETINGS WITH DSIN AND COGEMA AND SITE VISITS TO MELOX AND LA HAGUE

SUMMARY

On September 20-24, 1999, the Office of Nuclear Material Safety and Safeguards (NMSS) staff (M. Galloway, A. Persinko, C. Tripp, and A. Murray), met with the Direction de la Surete des Installations Nucleaires (Nuclear Installation Safety Directorate) (DSIN), the French nuclear regulatory agency, and Cogema to discuss technical aspects of mixed oxide (MOX) fuel processing and the design of the Melox and La Hague facilities in France. A consortium, Duke, Cogema, Stone & Webster, funded by the Department of Energy, is expected to submit an application to NRC in late 2000 to construct and operate a MOX facility in the U.S. to dispose of weapons-grade plutonium. Many of the processes in the U.S. MOX facility will be based on the Melox and La Hague designs. Discussion topics included operating history of Melox and La Hague, nuclear criticality safety, fire protection, natural phenomena, confinement ventilation, electrical, and the "Americanization" of the French MOX designs for use in the U.S. MOX facility. The "Americanization" consists of transferring the technology to the U.S. and adapting the French MOX technology to comply with U.S. standards/requirements and U.S. preferences. The NMSS staff also conducted site visits at the Melox and La Hague facilities. The meetings and site visits were conducted in Paris, Marcoule (Melox site), and Cherbourg (La Hague site), France. Slides used in our discussions are attached.

NRC FILE CENTER COPY

DISCUSSION

General Information

The La Hague facility began operations in 1966 recycling spent fuel from French reactors and purifying Pu. In 1989, foreign spent fuel began to be reprocessed. There are various plants within the La Hague facility denoted as follows:

Plant	Description
UP2 400	Started in the 1970's; Pu finishing line for reactor-grade Pu.

NF05
~~DF03~~

UP3	Started in 1989 to reprocess spent fuel; includes activities denoted as T0 (fuel unloading), T1 (dissolution), T2 (U, Pu product separation), T3 (U finishing line), T4 (Pu finishing line for reactor-grade Pu), T7 (vitrification).
UP2 800	Not completely constructed yet; includes activities denoted as R1 (dissolution), R2 (U, Pu product separation), R4 (Pu finishing line for reactor-grade Pu; construction not completed).

The major MOX-related processes at La Hague consist of unloading and interim storage of spent fuel, shearing the fuel assemblies, dissolving the sheared fuel in a nitrate solution, removing impurities and extracting the Pu by mixer-settlers, centrifugal extractors or pulsed columns. Conversion to PuO_2 is performed by oxalate precipitation and calcination. Wastes from the process are vitrified. Improvements have been made to La Hague since its initial operation to improve efficiency. DSIN also required safety improvements as part of Cogema's expansion. During the site visit, NRC personnel observed the dry fuel unloading area, the interim spent fuel storage pool, the dissolvers, the waste vitrification furnaces and other associated components, and the interim storage area in the vitrification facility.

The Melox facility began fuel production in 1995, with full scale operations starting in 1998. An additional line was added in 1999 for producing boiling water reactor MOX fuel for foreign utilities. The processes are referred to as the MIMAS and the A-MIMAS processes (or the Melox and the advanced Melox processes). They consist of blending PuO_2 with UO_2 homogenizing the mix, forming and sintering the pellets, grinding and sorting the pellets, and assembling the completed fuel rods. Melox is licensed to process 100 metric tons of heavy metal (MTHM)/year. During the site visit, NRC personnel observed blending, grinding, and homogenizing operations. NRC staff also observed the pelletizing operation, where the MOX/PuO_2 powder is pressed to form cylindrical pellets, the furnaces used in the sintering process, and subsequent grinding. Assembled fuel rod inspection and storage areas, and fuel bundle storage areas, were also viewed by the staff.

During the site visits, NRC personnel observed that both facilities are highly automated and that both facilities have numerous International Atomic Energy Agency (IAEA) cameras for international safeguards.

DSIN Meeting

On September 20, 1999, we met with the DSIN and discussed the nuclear licensing procedure in France, operating history of Melox and La Hague, safety philosophy, and the designs of the Melox and La Hague facilities, emphasizing the safety systems and features.

Some of the topics discussed are as follows:

1. The DSIN is divided into four main departments consisting of fuel cycle and transport, power reactors, research, waste dismantling, and pressurized water reactor (PWR) main primary and secondary systems. Engineering support is provided to the DSIN by the Institute de Protection et de Surete Nucleaire (Institute of Protection and Nuclear Safety)

(IPSN). We spoke with representatives of the DSIN fuel cycle department and the IPSN. The licensing of fuel cycle facilities in France is a two-step procedure. The DSIN first approves construction and later, an operating license. The operating license is considered a provisional license and does not become final until after 5-10 years of experience is gained by the facility. As in the U.S., the regulation of nuclear facilities consists of a pyramid of requirements with laws at the top level, followed by decrees which are written based on recommendations from advisory committees, and followed by 40 basic safety rules on topics such as ventilation systems, electrical systems, external events, and gas discharges. The DSIN monitors construction and performs inspections. Approximately 60 inspections per year are performed at La Hague, some of which are unannounced. Each inspection lasts one day. There are no DSIN resident inspectors.

2. DSIN stated that there have been no major safety incidents at La Hague (in plant areas UP2/800 and UP3) or Melox since they began operating. There have been no major fires, no accidental criticalities, and average annual exposure is approximately 0.3 mSv, with a maximum of approximately 5 mSv. The French regulations specify that worker exposures must be less than 50 mSv/year, and soon, this will be changed to 20 mSv/year (1 mSv = 100 mrem). The Melox facility experienced approximately two glove ruptures per month. To improve the reliability, the glove material was changed to one that has higher resistance to breaking while still allowing manual dexterity.

3. The analyses and designs of the facilities are deterministic, supplemented in some cases by probabilistic assessments. The analyses assume specific design basis conditions.

4. Fire analyses are a classical approach based on performing fire hazards analyses and dividing the facility into different fire zones. Most walls are rated for two hours. Special analyses are done for filters and ventilation systems. The fire protection depends on early detection, controlling fire loadings, and automatic suppression systems that mostly use carbon dioxide, although halon is used in certain instances. The DSIN also indicated that water may also be used in some cases, if there is no criticality risk. Cogema later indicated that water is not used where fissile materials are present. The fire protection also uses defense-in-depth, relying on manual (e.g., fire brigade) as well as automatic actions. To protect ventilation system filters in a fire zone in case of fire, hot and cold air are mixed to maintain temperatures below that which would damage any filters.

5. Ventilation systems are divided into zones with each zone creating a sequentially larger vacuum to retain Pu. Each zone relies on high efficiency particulate air (HEPA) filters to purify the air. Glovebox ventilation consists of a nitrogen blanket to prevent fuel powder interactions and potential fires.

6. Design for earthquakes and floods is based on a historical review of past events during the millennium, with a safety factor added. High winds are not believed to be an issue, so wind designs are based on wind loads for normal buildings. In most cases, earthquake loads envelope wind loads. The facilities are designed for potential external explosions, which may originate from boats on adjacent bodies of water.

7. The criticality safety codes used in France are different than those used in the U.S. Both the DSIN and Cogema use the same criticality codes. As in the U.S., double contingency is

relied upon to prevent accidental criticalities. Criticality accident detection networks, measuring gamma, are employed at Melox and La Hague.

8. The normal electrical system employs two independent and redundant sources (diesel generators) for emergency power. The emergency power ensures glovebox and room ventilation and the cooling of Pu storage areas, among other functions, in the event of loss of offsite power.

Cogema Meetings

Following the DSIN meeting in Paris, we visited the Melox site in Marcoule on September 21, 1999, and met with Cogema and their engineering support group, the SGN, on September 21-22, 1999. We subsequently visited the La Hague site on September 23, 1999, and met with Cogema for further discussions on September 24, 1999. Much of what we observed on the site visits and the discussions with Cogema reinforced what the DSIN had previously stated about the licensing process and the design of the Melox and La Hague systems. Design information was discussed with Cogema at a more plant specific level, than it was with the DSIN. We also discussed what is referred to as the "Americanization" of the MOX process.

DCS Project Team

The DCS project team is composed of a process design team, composed mostly of Cogema personnel located in France, and the facilities design team, composed mostly of Duke, Stone, & Webster personnel located in the U.S. Initially, the process design team is focusing on process-related issues such as establishing basic flows and material throughputs, developing equipment concepts and facility layouts based on the French technology, establishing preliminary functional requirements using existing safety analyses, and updating or creating preliminary design documents which will be provided to the facility design team. The facility design team is initially developing design criteria based on U.S. requirements and preferences, establishing functional classification schemes and quality requirements, and developing site-specific facility requirements. Upon receiving the preliminary design documents from the process design team, the facility design team will develop detailed equipment design documents and procurement specifications, which will be reviewed and approved by the process design team. Subsequently, the facility design team will verify the design bases and issue construction level documents. The design is less than 10 percent complete. Although each team is proceeding with specific assignments, DCS indicated that there is constant communication between the two teams as the facility design team learns and assumes complete responsibility for the project.

Americanization

"Americanization" of the MOX fuel fabrication technology refers to the process by which the MOX fuel fabrication technology in France is adapted to comply with U.S. requirements or incorporate U.S. preferences. U.S. requirements refer to requirements in the areas of contracts, regulatory matters, quality, design codes and standards, site and utility interface, security, and safety practices and principles. U.S. preferences refer to differences in the U.S. MOX design compared to the French design based on the needs and desires in the U.S. The differences include different throughputs and differences resulting from the origin of the Pu (i.e., recycling commercial spent fuel vs. weapons-grade Pu), such as Pu isotopics. Differences due to U.S. preferences also includes component selection, maintenance and operation, project execution. Although the U.S. MOX facility will be based on proven technology in France, the specifics of the U.S. design will be different in some cases, and to varying degrees, from the French designs to accommodate the U.S. preferences. For example, the Melox process is licensed to process 100 MTHM per year; the advanced Melox process processes approximately 40 MTHM/year; and the U.S. MOX facility, which uses designs and components from both the Melox and advanced Melox processes, will process approximately 70 MTHM/year. DCS has identified U.S. designs as Types I, II, and III, depending on the degree of difference from the French design/process. Type I designates a duplicate of the French design, Type II indicates a minor change from the French design/process, and Type III denotes a significant difference from the French design. However, the Type I, II, and III design difference designations do not convey the complete information regarding differences from French design/process since they do not refer to the same French design/process baseline. The fuel fabrication process at Melox consists of the Melox process, the advanced Melox process and a process line still under construction--the U.S. MOX facility will borrow from all three processes. Therefore, there can be Type I, II, and III design differences from each of the three process. For example, preliminary design indicates that the PuO_2 can opening process will be a Type III design difference (i.e., significant difference from French design/process), blending will be a Type I design difference (no change from French design/process) from the Melox process, pelletizing and sintering will be a Type I design difference (no change from French design/ process) from the advanced Melox process, grinding will be a Type II design difference (minor change from French design/process) from the advanced Melox process, and assembly mounting and inspection will be Type I design differences (no change from the French design/process) from the process line still under construction. The aqueous processing portion of the U.S. MOX will draw upon two plants--UP3 and UP2 800--from the La Hague facility and from the UP1 plant located at Marcoule.

Technical Safety and Design Information

The global safety objectives guiding the design of the Melox and La Hague facilities are that there shall be no contamination in working areas during normal operation and that the number of operators receiving 5 mSv/year must be near zero. The safety functions that must be satisfied are to confine the radioactive materials, to protect the operators against radiation, and to avoid criticalities. Analyses are performed of possible failures of items performing the safety functions. These analyses include a French adaption of a Failure Modes and Effects Analysis (FMEA), HAZOP analyses, and fault trees. The analyses are qualitative except for large impact events where detailed quantitative analyses are performed. Individual scenarios are analyzed instead of using bounding scenarios (i.e., grouping of events). Prevention, mitigation, and detection measures are determined based on an analysis of nuclear and non-nuclear risks that include fire, criticality, fall of heavy loads, radiolysis, earthquakes, dispersion of radioactive materials, flooding (external and internal), corrosion, chemical handling, explosion (internal and external), aircraft crash, and loss of utilities. The overall safety analysis process starts with the global safety objectives (e.g., limit spread of contamination), defining the specific functional requirements (e.g., specifying pressure differentials and leakrates), analyzing possible failures of items performing the safety functions, defining the prevention, detection, and mitigation measures, establishing the operational domain, and establishing design and operational requirements.

Nuclear criticality control is based on double contingency. The steps in assuring criticality safety consists of: 1) determining the specifics of the fissile medium; 2) choosing criticality control modes which establish the parameters to be controlled; 3) performing criticality calculations to provide the limiting values of the parameters being controlled; 4) determining the specifications of any interlocks; 5) establishing the instrumentation and control (I&C) needs. Cogema uses a Criticality Control Flow Diagram (CCFD) to diagram the criticality controls being employed throughout each process. The CCFD is a flow diagram showing the piping, equipment, and tanks in each process. Each component is marked to denote the criticality controls being employed, such as geometry and mass. The CCFDs appeared to be a very simple and useful tool to assist in documenting and controlling the criticality controls. The CCFDs are submitted to the DSIN. French developed criticality computer codes are used to perform the criticality calculations. The U.S. facility will use the SCALE computer code in its design. A sample of criticality calculations will be performed using both the French codes and SCALE to assure that both codes provide the same results. If the results are sufficiently close, then only SCALE will be used for the balance of the criticality calculations. In France, only one validation of the criticality design code is performed whereas in the U.S., each user must validate the code; however, in France, there are fewer users. Because of the automated nature of the process, the NRC staff questioned the configuration management of the controlling software and associated controls. The process is controlled by redundant programmable logic controllers (PLCs) and the process is examined for common-mode failures. In addition to being highly automated, which reduces the likelihood of human error, most of the processing equipment at La Hague and Melox incorporates favorable geometry. The result is that both facilities rely heavily on passive engineered controls. Primary criticality controls are geometry, moderation, mass, and isotopics. Because credit is taken for the plutonium isotopic composition in sizing process equipment, there is the possibility that the equipment in the U.S. MOX facility would have reduced throughput and/or dimensions, due to the use of weapons-grade, rather than reactor-grade, plutonium. This difference will also require re-validation of the criticality safety computer codes.

Fire analyses are based on a classical approach of dividing the facility into different sectors and performing fire hazards analyses. Most firewalls are rated for 2 hours. The fire protection depends on early detection, controlling fire loadings, and a carbon dioxide, water or halon suppression system, depending on the specifics of the particular location and hazards. Manual fire protection actions are relied on as well as automatic actions. The effects of fire on ventilation systems were discussed. Fire zones are specified, depending on the fire loading and the presence, or absence, of fissile materials.

Ventilation system filters are protected from fires via different means, depending on the particular fire zone. Gloveboxes are considered a fire and confinement zone and are inerted using a nitrogen ventilation system to prevent glovebox fires. In the case of a fire in a glovebox, glovebox entry and exit dampers are manually controlled by firefighters, depending on the particulars of the situation since gloveboxes are serving a confinement function. If a fire were to occur in a fire zone, such as a room which is not considered a fire and confinement zone, the inlet damper closes automatically and hot and cold air are mixed to maintain temperatures below that which would damage any filters. If, however, the exhaust temperature reaches 70 degrees Celsius, then the exhaust damper will close automatically to protect the HEPA filter.

Docket: 70-3098

Attachment: Slides

cc: P. Hastings, DCS

DOCUMENTATION RELATED TO SAFETY AND REQUIRED FOR CONSTRUCTION AND OPERATION LICENSES IN FRANCE

❑ CONTENTS

- ADMINISTRATIVE ORGANIZATION OF SAFETY IN FRANCE
- MAIN PROCEDURES FOR LICENSING
- DOCUMENTS FOR A LICENSE TO BUILD A FACILITY
- DOCUMENTS IN THE COURSE OF THE DETAILED DESIGN AND CONSTRUCTION PHASE
- DOCUMENTS FOR THE COMMISSIONING LICENSE PROCEDURE

COGEMA

ADMINSTRATIVE ORGANIZATION OF SAFETY IN FRANCE

☐ BASIC PRINCIPLE

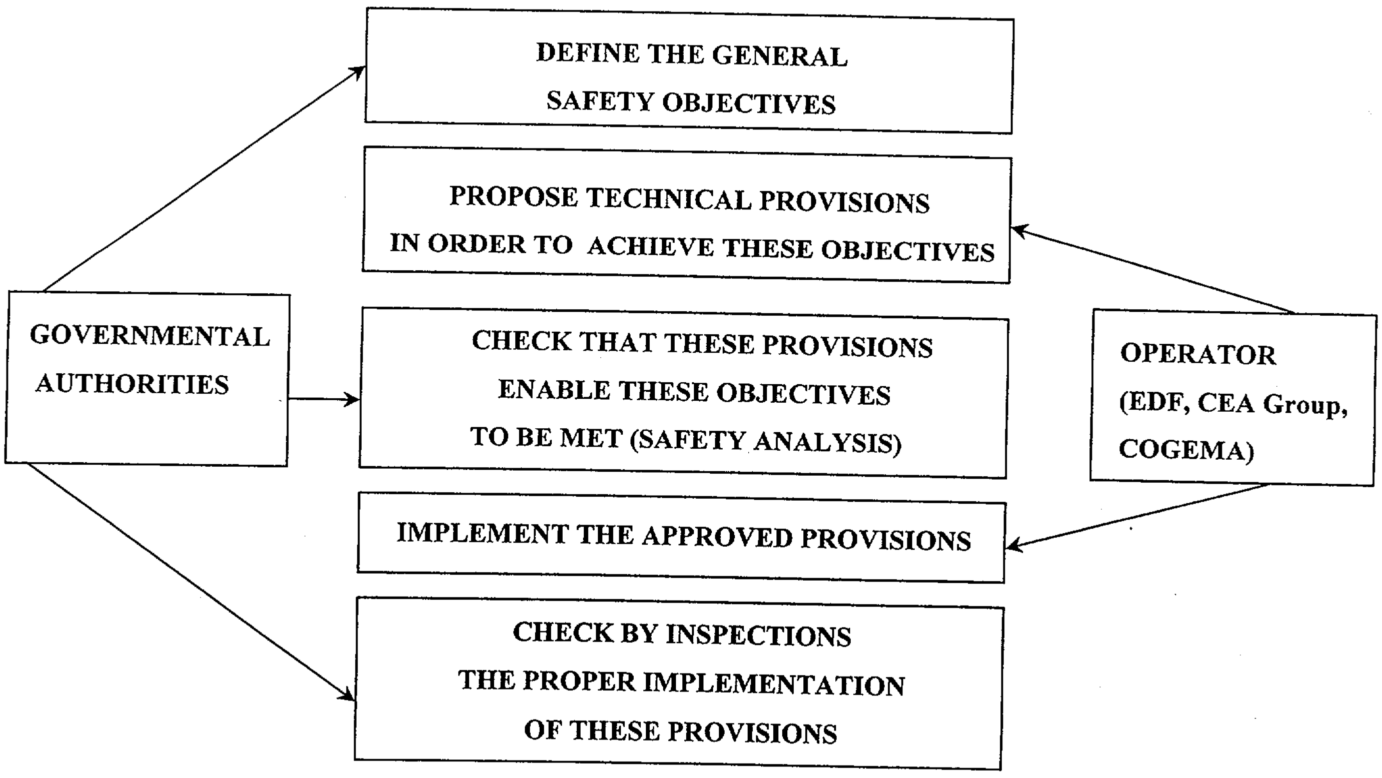
The plant Operator has the complete responsability for safety

- from the first stage of design
- to the plant operation

The safety assessment is mainly performed indepentently from the Operators and depends on a central commission.

ADMINSTRATIVE ORGANIZATION OF SAFETY IN FRANCE

Who is Responsible ?



GOVERNMENTAL AUTHORITIES

DEFINE THE GENERAL SAFETY OBJECTIVES

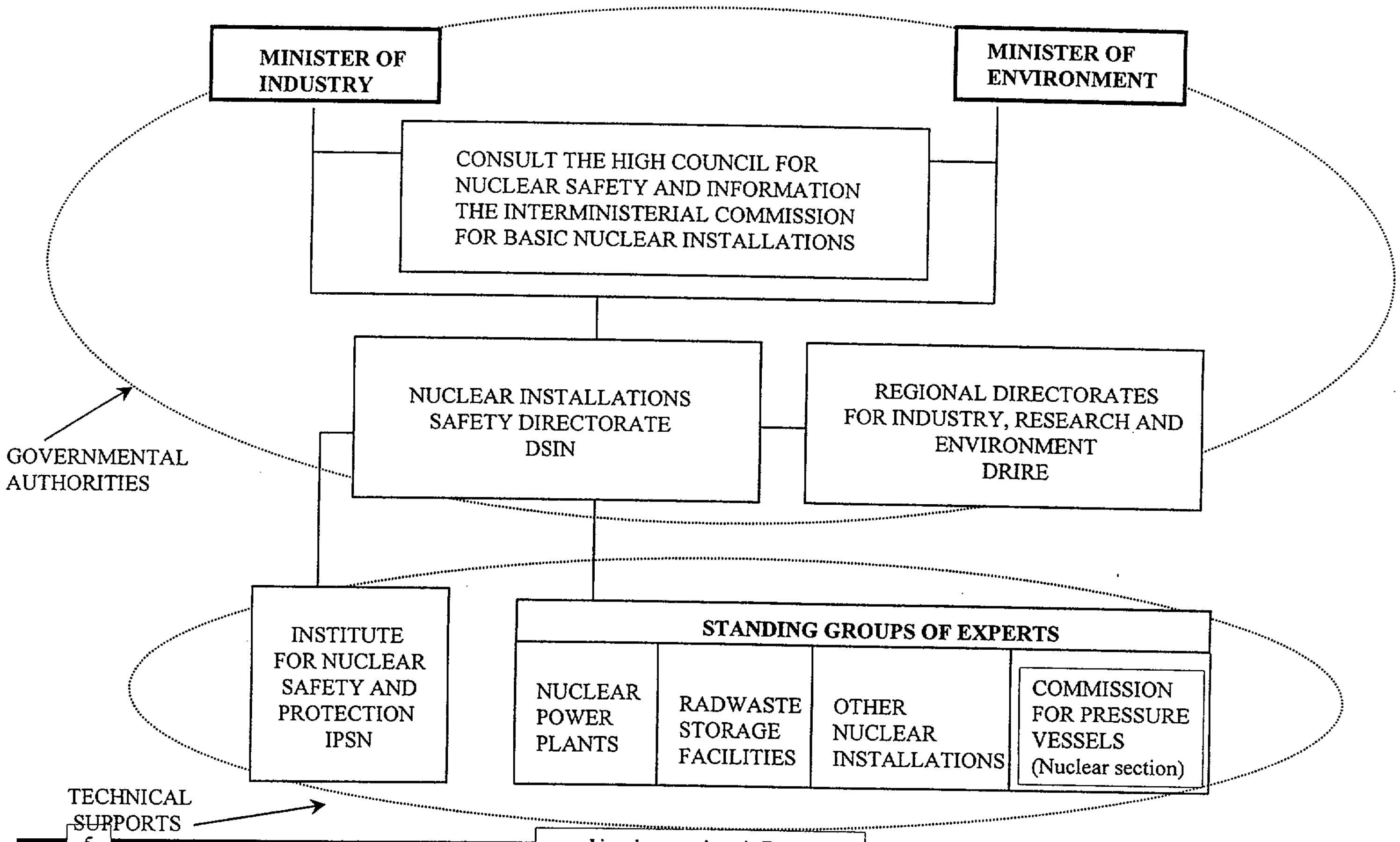
PROPOSE TECHNICAL PROVISIONS IN ORDER TO ACHIEVE THESE OBJECTIVES

CHECK THAT THESE PROVISIONS ENABLE THESE OBJECTIVES TO BE MET (SAFETY ANALYSIS)

IMPLEMENT THE APPROVED PROVISIONS

CHECK BY INSPECTIONS THE PROPER IMPLEMENTATION OF THESE PROVISIONS

OPERATOR (EDF, CEA Group, COGEMA)



MINISTER OF INDUSTRY

MINISTER OF ENVIRONMENT

CONSULT THE HIGH COUNCIL FOR NUCLEAR SAFETY AND INFORMATION THE INTERMINISTERIAL COMMISSION FOR BASIC NUCLEAR INSTALLATIONS

NUCLEAR INSTALLATIONS SAFETY DIRECTORATE
DSIN

REGIONAL DIRECTORATES FOR INDUSTRY, RESEARCH AND ENVIRONMENT
DRIRE

GOVERNMENTAL AUTHORITIES

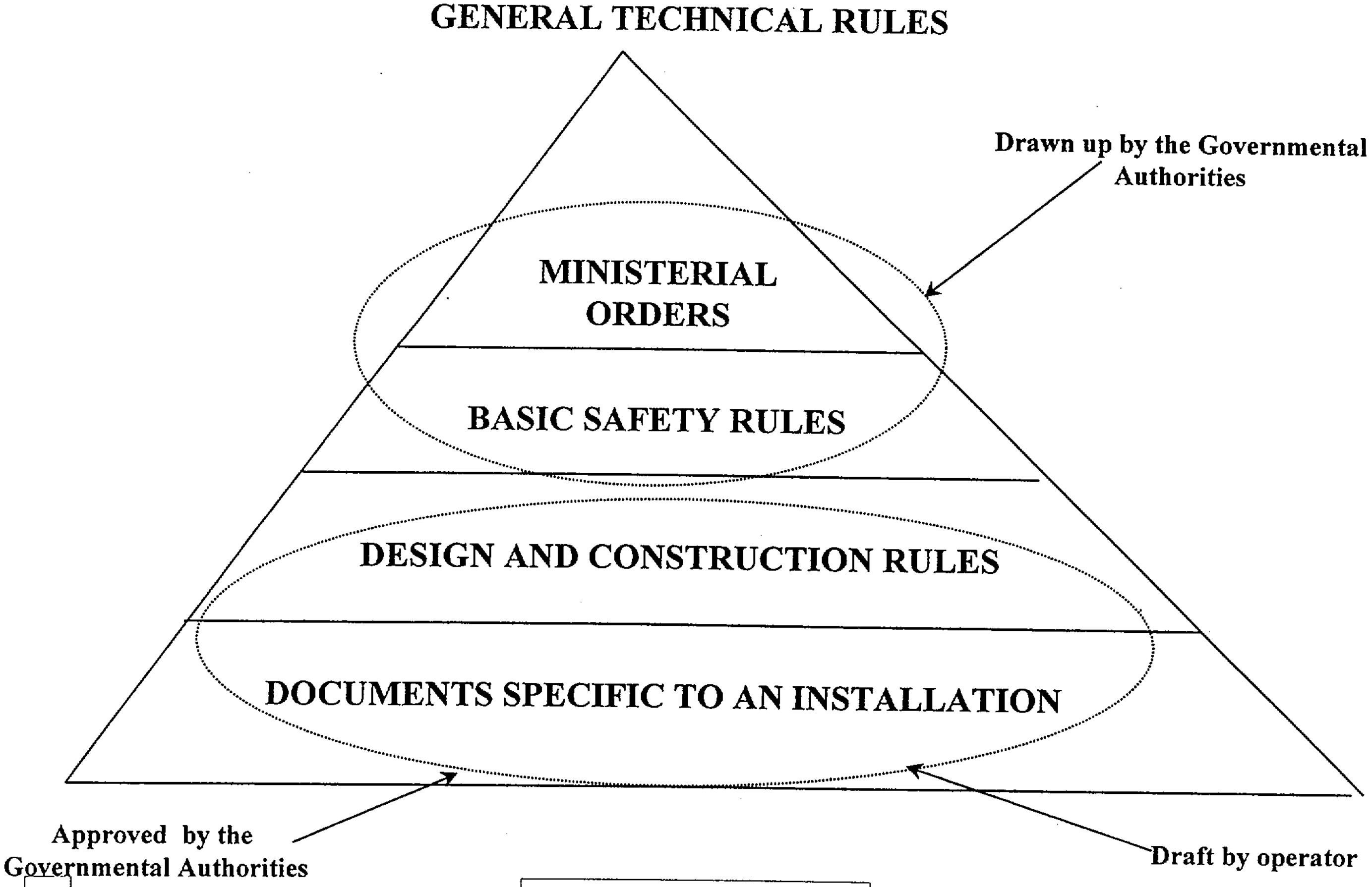
INSTITUTE FOR NUCLEAR SAFETY AND PROTECTION
IPSN

STANDING GROUPS OF EXPERTS

- NUCLEAR POWER PLANTS
- RADWASTE STORAGE FACILITIES
- OTHER NUCLEAR INSTALLATIONS
- COMMISSION FOR PRESSURE VESSELS (Nuclear section)

TECHNICAL SUPPORTS

ADMINSTRATIVE ORGANIZATION OF SAFETY IN FRANCE



ADMINSTRATIVE ORGANIZATION OF SAFETY IN FRANCE

❑ As a summary, we can say that :

1. **Laws and decrees give :**

- **limits of radiation dose for the workers**
  for the public
- **limits of environmental impacts for gaseous liquid or solid wastes**

that means all the main objectives for the safety.

2. **The plant designer or the plant operator has to define all the basic safety principles including the design and construction rules and the corresponding applications.**

ADMINSTRATIVE ORGANIZATION OF SAFETY IN FRANCE

3. Some guides called «Basic Safety Rules» give recommendations, intended to define technical safety aims to be achieved in different fields and the accepted practice deemed compatible with these aims.

   The basic safety rules are not regulatory documents. An operating organization may always decide not to adopt the provisions laid down in a Basic Safety Rule. In this case, it has to demonstrate that the technical safety aims underlying the rule can be achieved by alternative means, which it has to propose .

4. Safety Authorities (DSIN, supported by IPSN) give, case by case, an advice on the safety of the installation considering the real construction and finally, after the safety assessment, license is granted by Minister of Industry.

BASIC SAFETY RULES

- **Prepared by Technical Supports (IPSN) of Governmental Authorities (DSIN)**
- **Approved by standing groups of experts**
- **Emitted by Governmental Authorities as Recommandations to reach safety aims**
- **Not considered as regulatory documents**
- **Can be revised, if necessary**
- **Not applicable to previously authorized facilities**
- **If the operating organization adopts different provisions, it has to demonstrate that the safety aims are achieved**

BASIC SAFETY RULES FOR PWR

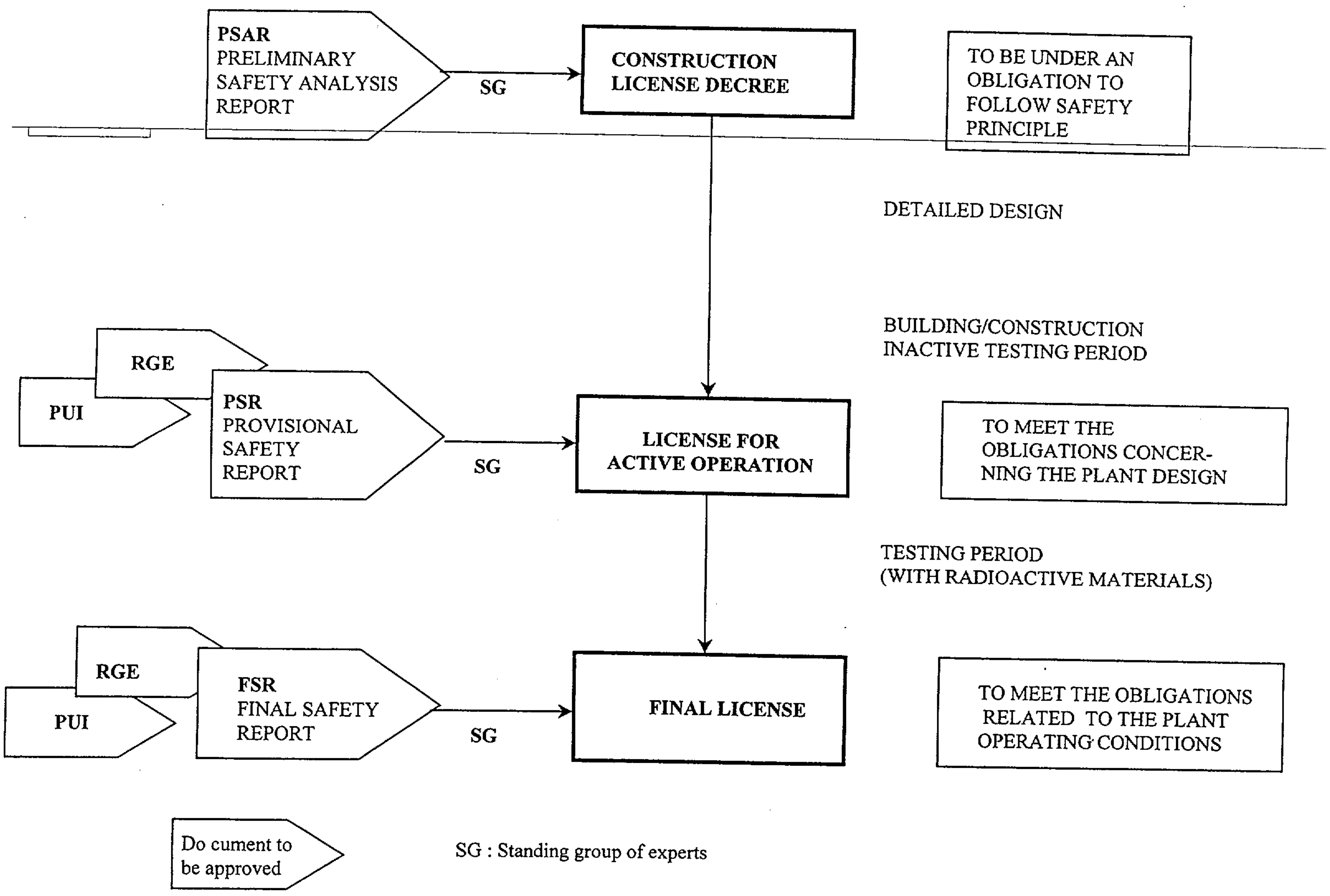
1980	Single Failure Criteria Air craft crash risk consideration Missiles from turbine
1981	Earthquake movements to consider Realization of civil engineering RCC.G Realization of mechanical equipments RCC.M
1982	Risks from neighbouring industries/roads Released activity from clad during accidents Meteorological instrumentation Fire protection - RCC.I Realization of electrical equipments RCC.E Realization of nuclear fuels RCC.C
1984	Flooding risk Seismic instrumentation Classification of mechanical, electrical systems and structures

BASIC SAFETY RULES FOR PWR

1984	Design rules for level 2-3 pressurized equipments safety classified Examination of PWR 900 process RCC.P
1985	Geological characteristics of soils Pressure suppression system for containment Design rules for electrical equipments safety classified Civil engineering seismic calculations
1986	Realization of mechanical equipments RCC-M (revision) Realization of electrical equipment RCC.E (Révision) Realization of nuclear fuels RCC.C (Revision 1) Realization of civil engineering RCC.G (Revision 1)
1988	Realization of civil engineering RCC.G (Revision 2) Fire protection of N4 NPPs'
1990	Secondary circuit design and operation Realization of nuclear fuels RCC.C (Revision 2)

BASIC SAFETY RULES FOR OTHER NUCLEAR FACILITIES

1982	General considerations for wastes from fuel reprocessing
	Particular considerations for vitrified wastes
1983	Meteorological instrumentation
1984	Particular considerations for bituminized wastes
	Solid waste surface disposal
	Criticality risk prevention
	General considerations for wastes from fuel reprocessing (Revision)
1985	Fire protection
	Particular considerations for cemented wastes
1986	Conditions for solid wastes for surface disposal
1991	Ventilation systems (not applicable to waste disposal)
	Conditions for solid wastes for deep disposal
1992	Earthquake movements to consider (not applicable to wastes disposal)
	Risks from neighbouring industries/roads (not applicable to wastes disposal)
	Air craft crash risk consideration (not applicable to wastes disposal)


PSAR
PRELIMINARY SAFETY ANALYSIS REPORT
SG
CONSTRUCTION LICENSE DECREE
TO BE UNDER AN OBLIGATION TO FOLLOW SAFETY PRINCIPLE
DETAILED DESIGN
BUILDING/CONSTRUCTION
INACTIVE TESTING PERIOD
RGE
PUI
PSR
PROVISIONAL SAFETY REPORT
SG
LICENSE FOR ACTIVE OPERATION
TO MEET THE OBLIGATIONS CONCERNING THE PLANT DESIGN
TESTING PERIOD
(WITH RADIOACTIVE MATERIALS)
RGE
PUI
FSR
FINAL SAFETY REPORT
SG
FINAL LICENSE
TO MEET THE OBLIGATIONS RELATED TO THE PLANT OPERATING CONDITIONS
Do cument to be approved
SG : Standing group of experts

DOCUMENTS FOR A LICENSE TO BUILD A FACILITY

PSAR

1. **The PRELIMINARY SAFETY ANALYSIS REPORT (PSAR) gives information on :**
    a) **The process, the plant**

    b) **The environmental aspects :**
      - **natural (flooding, seismicity, hydrogeology, meteorology...)**
      - **industrial (nearby industries, utility lines)**
      - **lines of communication (roads, rivers, air...)**
      - **human environment (population to be considered for design basis and for studying accident consequences)**

    c) **A first estimate of the Safety Principles proposed by the plant Designer**

    d) **The environmental impact of the plant :**
      - **in normal operating conditions**
      - **in accidental situations**

DOCUMENTS FOR A LICENCE TO BUILD A FACILITY

PSAR

2. **The PSAR shows :**

   - WHAT the designer is intending to do

   - not HOW

3. **The Safety Principles are given for each potential hazard.**

4. **The PSAR has to be approved by Safety Authorities in order to obtain the construction license decree**

COGEMA

INVENTORY OF POTENTIAL HAZARD

NUCLEAR HAZARDS	- DISPERSION OF RADIOACTIVE MATERIALS - RADIATION EXPOSURE - CRITICALITY - RADIOLYSIS - THERMAL EFFECTS OF RADIATIONS
NON NUCLEAR HAZARDS	- FIRE (INTERNAL AND EXTERNAL) - HANDLING OF CHEMICALS - CORROSION - OVER PRESSURE IN VESSEL/EQUIPMENT - EXPLOSION (INTERNAL AND EXTERNAL) - HAZARD DUE TO EQUIPMENT HANDLING (FALL OF HEAVY LOAD) - EARTHQUAKE - FLOODING (INTERNAL AND EXTERNAL) - AIRCRAFT CRASH - LOSS OF UTILITIES (WATER, COMPRESSED AIR, POWER...)

DOCUMENTS FOR THE COMMISSIONING LICENCE PROCEDURE

PSR	PROVISIONAL SAFETY REPORT → CONSTRUCTION
RGE	REGLES GENERALES D'EXPLOITATION (GENERAL OPERATING RULES) → OPERATING PROCEDURES
PUI	PLAN D'URGENCE INTERNE (ON SITE EMERGENCY PLAN) → INTERNAL EMERGENCY PROCEDURES

PSR

1. Document «PROVISIONAL SAFETY REPORT» (PSR) gives detailed information on :

   a) The process, the building, the control system, the utilities... (items necessary for the safety analysis)

   b) The results of the safety analysis showing the application of the safety principles given in the PSAR and in the construction license decree

2. THE PSR :

   - shows HOW the safety principles are applied for the design and the construction of the plant
   - provides proof of the safety

3. The PSR is the first key document on which the advice by the Safety Authorities is required for obtaining the license for active start-up with radioactive materials

DOCUMENTS IN THE COMMISSIONING LICENCE PROCEDURE

RGE

1. **Document «REGLES GENERALES D'EXPLOITATION» (General Operating Rules) :**

   It defines the operating range licensed by the Safety Authorities in normal and upset conditions

2. **THE RGE'show :**

   HOW the safety principles are applied in operation

3. **The RGE's are the second key document required for obtaining the license for active start-up.**

RGE

OBJECTIVES OF THE RGE'S :

- **Specify the OPERATING RANGE of the facility (the acceptability of wich is proved in the PSR)**
- **Specify the OPERATING ORGANIZATION regarding :**

  - operation

  - safety
- **Specify the IN SERVICE QUALITY ORGANIZATION (presenting the Quality Assurance Manuals, plans...)**
- **Specify the CONDITIONS OF CONTROL of :**

  - operation

  - safety by means of instructions (criticality, health physics...)
- **Specify**

  - the periodic tests and checks

  - the operation in upset situations

PUI

1. **Document «PLAN d'URGENCE INTERNE» (On Site Emergency Plan) is an operating document provided to manage an on-site emergency situation**

2. **The PUI completes the PSR and RGE's**

   It shows

   HOW the safety principles have to be followed in case of emergency situation

3. **THE PUI has to be approved by the Safety Authorities**

PUI

- **A set of rules laid down by the Management of the plant in case of an accident in order to :**
  - **PROTECT the staff and the surrounding people by placing the damaged facility in a state acceptable from the point of view of the internal and external radiation exposure,**
  - **MITIGATE the consequences by implementing emergency procedures,**
  - **ARRANGE for the transmission of suitable information to the responsible civil authorities (prefet)**
- CONTENT
  - **List of human and physical ressources to be implemented,**
  - **Tasks and responsabilities,**
  - **Description of the specific management system implemented in the context of the PUI,**
  - **Reflex sheets enabling mobilization and implementation of the ressources,**
  - **Means and methods of reporting on the accident**

CONTROL DURING CONSTRUCTION AND INSTALLATION

1. OBJECTIVES

To make sure that :

- the regulatory provisions are complied with by the operating organizations
- the installations are CONSTRUCTED and OPERATED in accordance with the Safety Reports and in the General Operating Rules.

2. COMPLIANCE WITH THE

- regulatory provisions
- requirements imposed or approved by the Safety Authorities such as :

  * construction license decree

  * Preliminary Safety Analysis Report

→ Examination by inspectors of technical specifications prepared by the designer

DOCUMENTS FOR THE COMMISSIONING LICENCE PROCEDURE

FSR

1. **Document «FINAL SAFETY REPORT» (FSR) is an updating of the PSR taking into account :**

   - modifications since the active start-up with the related safety analyses

   - operating experience and results

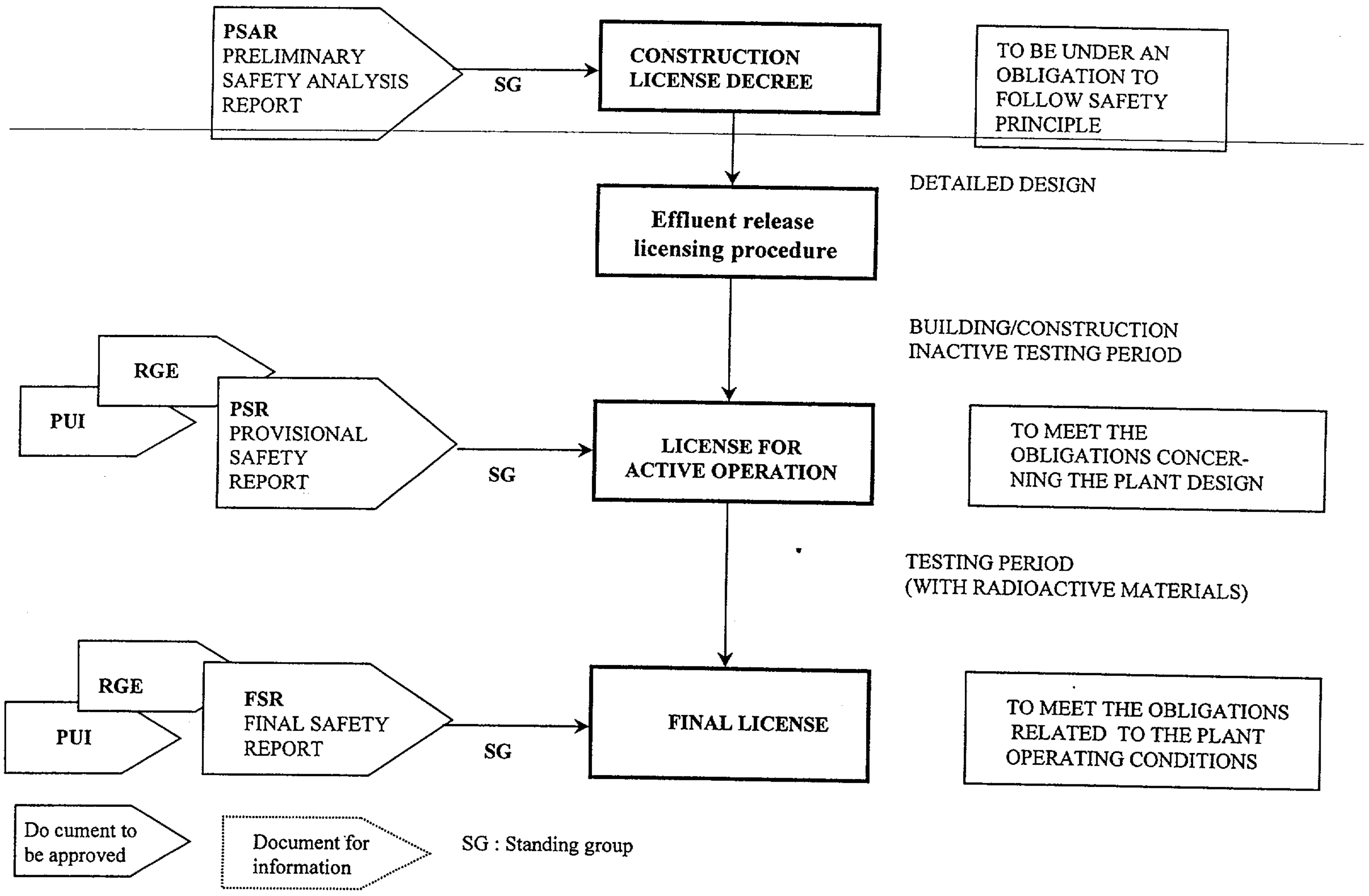
2. **The FSR shows**

   HOW the safety principles have been applied for the design and the construction of the plant (as in the PSR) and also HOW the safety is insured in active operating conditions.

3. **Prepared after a testing period with radioactive materials, the FSR is required to obtain the final license.**

DOCUMENTATION RELATED TO RELEASE AUTHORIZATIONS

IN FRANCE


PSAR
PRELIMINARY SAFETY ANALYSIS REPORT
SG
CONSTRUCTION LICENSE DECREE
TO BE UNDER AN OBLIGATION TO FOLLOW SAFETY PRINCIPLE
DETAILED DESIGN
Effluent release licensing procedure
BUILDING/CONSTRUCTION
INACTIVE TESTING PERIOD
RGE
PUI
PSR
PROVISIONAL SAFETY REPORT
SG
LICENSE FOR ACTIVE OPERATION
TO MEET THE OBLIGATIONS CONCERNING THE PLANT DESIGN
TESTING PERIOD
(WITH RADIOACTIVE MATERIALS)
RGE
PUI
FSR
FINAL SAFETY REPORT
SG
FINAL LICENSE
TO MEET THE OBLIGATIONS RELATED TO THE PLANT OPERATING CONDITIONS
Document to be approved
Document for information
SG : Standing group

EFFLUENT RELEASE LICENSING PROCEDURE

☐ Procedure defined in decree 95-540
(replacing previous decrees 74-945, 1181 and 85-449)

☐ Application by operator

- Impact study

☐ Advices of ministers (Industry, Environnement, Health)

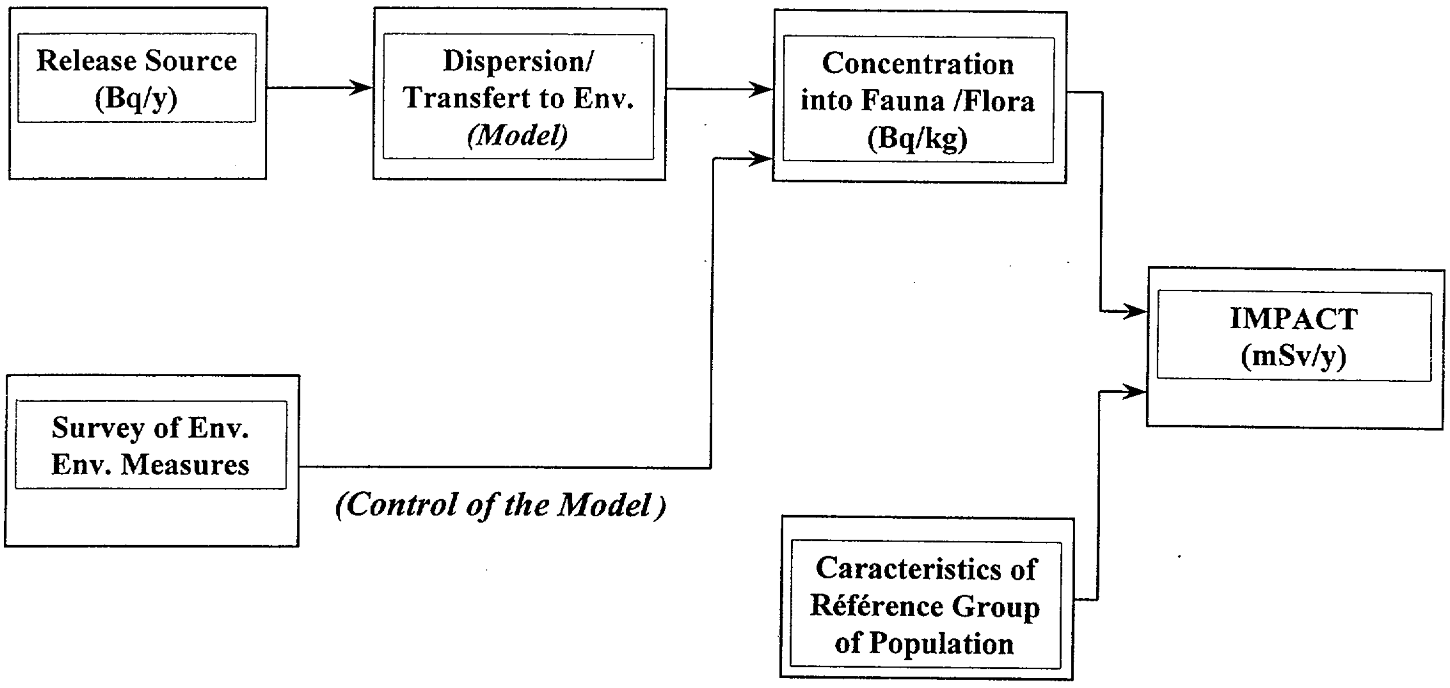
☐ Transmission to to the local prefect

- Administrative conference (between administraticve services concerned)
- Public Inquiry

☐ Interministerial Order (Industry, Environnement, Health)

- Limits of releases
- Conditions of Control measures
- Conditions of Survey of the environnement
- Indications on Administrative reporting
- Indications on Public Information

RADIOACTIVE RELEASES - IMPACT STUDY



Release Source (Bq/y)

Dispersion/ Transfert to Env. *(Model)*

Concentration into Fauna /Flora (Bq/kg)

IMPACT (mSv/y)

Survey of Env. Env. Measures

(Control of the Model)

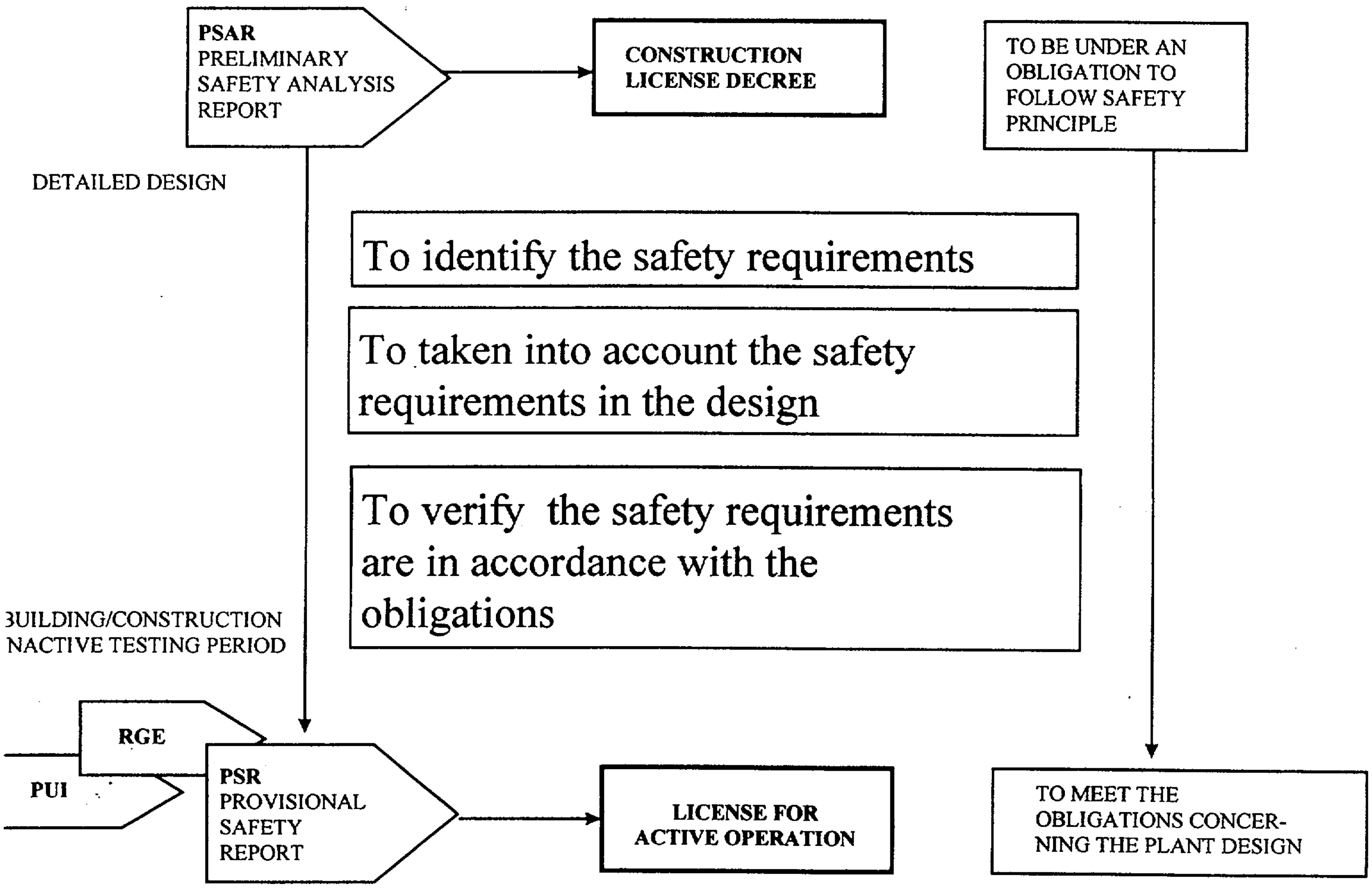
Caracteristics of Référence Group of Population

MELOX

	Gaseous releases				Liquid releases			
	Allowed level (July 94 Order)		Actual values* (1997)		Allowed level (July 94 Order)		Actual values* (1997)	
	MBq/y	mCi/y	MBq/y	mCi/y	MBq/y	mCi/y	MBq/y	mCi/y
Alpha	74	2	< 0,37	< 0,01	120	3,2	< 3,7	< 0,1
Total	1900	54	< 9,6	< 0,26	3300	89	< 74	< 2
Calculated impact	1,7µSv/y		-		2,4E-5 µSv/y		-	

* Corresponds to measurement threshold

SAFETY ANALYSES


PSAR
PRELIMINARY
SAFETY ANALYSIS
REPORT
CONSTRUCTION
LICENSE DECREE
TO BE UNDER AN
OBLIGATION TO
FOLLOW SAFETY
PRINCIPLE
DETAILED DESIGN
To identify the safety requirements
To taken into account the safety
requirements in the design
To verify the safety requirements
are in accordance with the
obligations
3UILDING/CONSTRUCTION
NACTIVE TESTING PERIOD
RGE
PUI
PSR
PROVISIONAL
SAFETY
REPORT
LICENSE FOR
ACTIVE OPERATION
TO MEET THE
OBLIGATIONS CONCER-
NING THE PLANT DESIGN

Lists of hazards to be considered

- NUCLEAR RISKS
  - DISPERSION OF RADIOACTIVE MATERIALS
  - RADIATION EXPOSURE
  - CRITICALITY
  - RADIOLYSIS
  - THERMAL EFFECTS OF RADIATIONS
- NON NUCLEAR RISKS
  - FIRE (INTERNAL and EXTERNAL)
  - HANDLING OF CHEMICALS
  - CORROSION
  - OVERPRESSURE IN VESSEL/EQUIPMENT
  - EXPLOSION (INTERNAL AND EXTERNAL)
  - HAZARD DUE TO EQUIPMENT HANDLING (Fall of heavy loads)
  - EATHQUAKE
  - FLOODING
  - AIRCRAFT CRASH
  - METEOROLOGICAL EFFECTS (Low or High temperatures, Wind...)
  - LOSS OF UTILITIES Water, compressed air, power...)

COGEMA

Definition of the safety objectives

❑ Defense-in-depth principle

❑ Safety objectives are graded depending on the likelihood of the situation

In MELOX :

Operational situation	Functional requirement
Normal operation	**Guarantee of product manufacturing, in addition to the requirements below**
Incidents	**Guarantee that there is no large production loss, in addition to the requirements below**
Accidents **which may affect safety or plant integrity**	**Guarantee of personnel security and of the plant integrity in addition to the requirements below**
Hypothetical accidents: **very rare situations that may have a large impact on safety**	**Guarantee of safety i.e. of limited radiologiacal impact on the environment and the public**
Beyond Design basis events	**None**

APPROACH USED FOR EACH RISK

- GLOBAL SAFETY OBJECTIVES
  - **No contamination in working place, in normal operating conditions**
  - **The number of operators receiving 5 mSv/y must be quite near zero**
- SAFETY FUNCTIONS
  - **To confine the radioactive materials**
  - **To protect the operators against radiations**
  - **To avoid criticality**
- ANALYSIS OF POSSIBLE FAILURES OF ITEMS PERFORMING THE SAFETY FUNCTIONS
  - ***Using FMEA***

APPROACH USED FOR EACH RISK

- DEFINITION OF PREVENTION, DETECTION , MITIGATION MEASURES
  - ***Analysis of Fire Risk:***
    - *Design of fire resistant walls, doors...*
    - *Lay out of fire detectors...*
    - ...
  - ***Analysis of criticality safety:***
    - *Sizing of geometrically safe equipments*
    - *Sizing of neutron shields*
    - *Equipment lay out (neutron interaction..)*
    - ...
  - ***Analysis of fall of heavy loads:***
    - *Reliability of handling equipment*
    - *Sizing of concrete floor to resist to fall out*
  - **Calculations of biological shieldings**
    - *Nature and size of shieldings*
    - *Limitation of stay time...*
    -

APPROACH USED FOR EACH RISK

- DEFINITION OF PREVENTION, DETECTION , MITIGATION MEASURES
  - ***Analysis of radiolysis***
    - *Reliability of the hydrogen dilution systems*
    - *Number of redundant systems*
    - ...
  - ***Analysis of earthquake effects***
    - *Aseismic design of vessels, equipments*
    - *Operating procedure after earthquake...*
    - ...
  - **Analysis of dispersion of radioactive materials**
    - *Efficiency of filtration systems*
    - *Lay out of monitoring equipment for local contamination control...*
    - ...
  - ***Analysis of flooding conditions***
    - *Minimum level for equipment installation*
    - *Conditions for water raising up...*

Example of application: confinement

Global safety objectives	e.g. Limit contamination spreading to rooms and the environment to admissible values
Specific functional requirements	e.g. Specified leakrates and pressure differentials
Analysis of possible failures of items performing the safety functions	e.g. risk of pressure or temperature exceeding design values
Definition of prevention, detection, mitigation measures	e.g. valves against over/under pressure, pressure monitoring & control systems

Allowed operational domain	e.g. glovebox -300 to -500 Pa / room
Design requirements	e.g. glovebox desig for +1500 Pa to 25
Operation requirements	e.g. safety valve s to -1000 Pa

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CONTENT OF THE SAFETY ANALYSIS REPORT

☐ **VOLUME A: DESCRIPTION**

With a specific emphasis on the safety-related features

☐ **VOLUME B: SAFETY ANALYSIS**

For each risk, demonstration that it has been correctly taken into account

- Presentation of the risk: why should the risk be considered, what are the specificities of the facility in that respect
- Prevention measures
- Detection measures
- Mitigation measures
- Analysis of the risk

☐ **VOLUME C: RESULTS OF START TESTING and OPERATING EXPERIENCE**

CONTENT OF THE SAFETY ANALYSIS REPORT

- **Typically, the PSR represents several files**
  - MELOX
    - **VOLUME A: 7 files**
    - **VOLUME B: 4 files**
    - **Drawing Files: 2**
    - **DETAILED CALCULATIONS OR ANALYSES ARE APPENDED**

The FSR has 3 volumes:

- **VOLUME A: 7 files**
- **VOLUME B: 4 files**
- **Drawing Files: 2**
- **VOLUME C: 1 file**

CRITICALITY SAFETY DESIGN APPROACH

☐ Design approach

- Choise of criticality control modes ⇒ parameters to be controlled
- Calcultaion of allowable parameters ⇒ limit value for the parameters

COGEMA

CRITICALITY CONTROL FLOW DIAGRAM (CCFD)

Methodology for Criticality Safety Design Applied to Nuclear Fuel Cycle Plants

CCFD - Introduction

❑ Main points

- complex process
- different people involved
- long periods of time

➪ Definition of an outline document

- easy to understand
- with adequate information for criticality safety analysis

➪ the Criticality Control Flow Diagram (CCFD)

COGEMA

CCFD Implementation

☐ The different steps

- specification of fissile medium
- definition of control modes
- specific criticality calculations
- specification of locking devices
- specification of instrumentation and control

CCFD - Specification of fissile medium

☐ Knowledge of the process

- fissile materials present
- physical/chemical form
- isotopic conditions
- normal/accident process conditions

⇘ selection of the most severe conditions

☐ This information (isotopic vector, fissile material, physical-chemical form) is codified and indicated on the CCFD

CCFD - Definition of control modes

☐ Specification of an appropriate control mode for each equipment item or unit

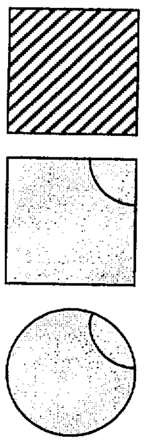
☐ One or more of the following parameters
  - fissile material mass
  - geometry of the equipment
  - fissile material concentration
  - moderation ratio for dry products
  - neutron absorbing material

CCFD - Definition of control modes

☐ This information (mass, geometry, concentration, moderation ratio) is codified and indicated on the CCFD

☐ Codification is based on difference between geometry control mode and other control modes

- geometry only
- geometry and another control mode
- other than geometry



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CCFD - Specific calculation results

❑ Criticality calculations
  - single equipment
  - multi-equipment

❑ Results
  - on CCFD (mass, concentration, moderation)
  - on appended note (geometry)

CCFD - Specification of locking devices

☐ Prevent unsafe transfer

- between vessels with different media
- between vessels with different control modes

☐ Prevent plutonium precipitation

- with decontamination solution Specific calculation results

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CCFD - Specification of instrumentation and control

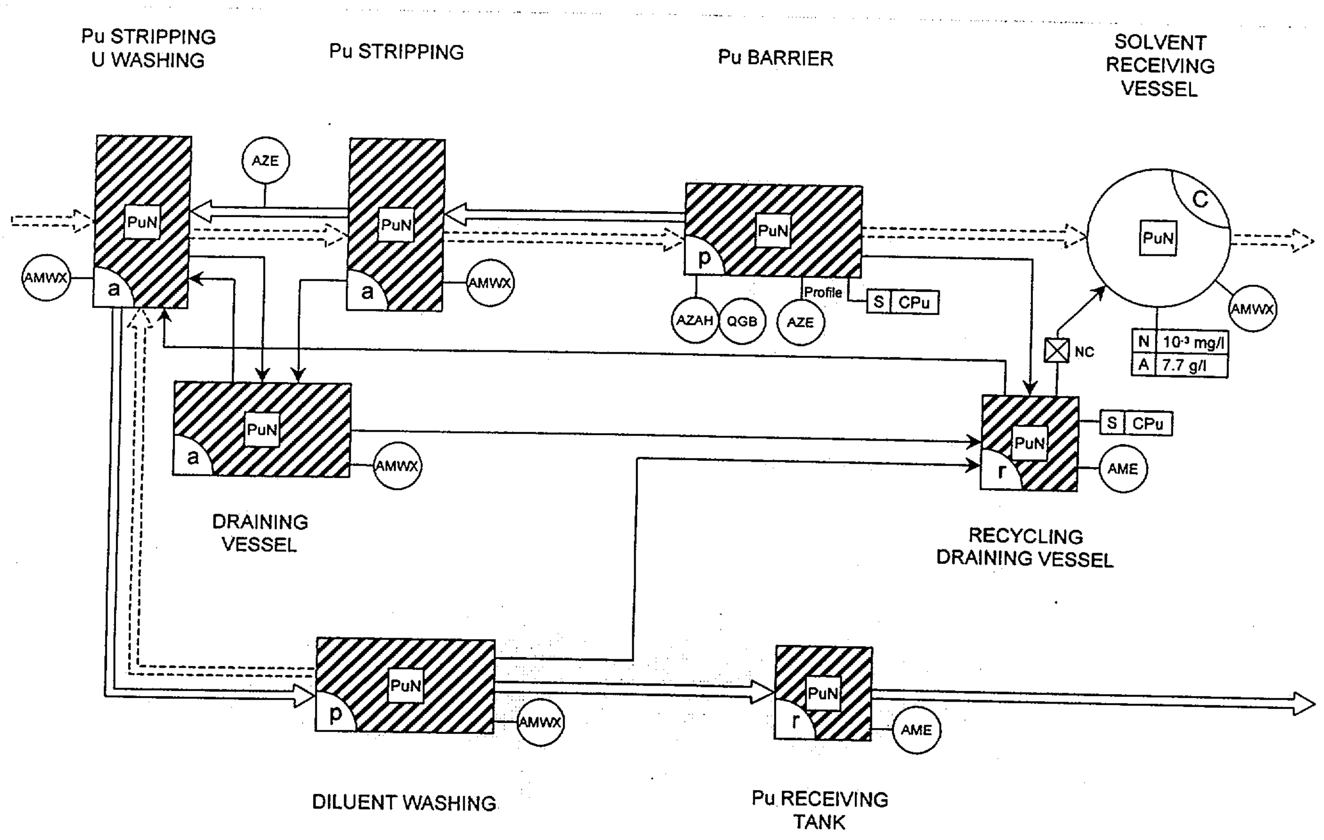
☐ Verification of hypothesis used for criticality analysis
  - sampling for isotopic determination

☐ Verification of values used for criticality analysis
  - accurate accounting of fissile material (control with mass)
  - sampling before unlocking

☐ Alarm values for process transients
  - density measurement for concentration control
  - neutronic counting for concentration or mass control

☐ Periodically checking during inter-compaign

Criticality Control Flow Diagram (CCFD)



DEFINITION OF REFERENCE FISSILE MEDIA - « DILUTION LAWS »

Criticality calculation need as input data densities of fissile materials

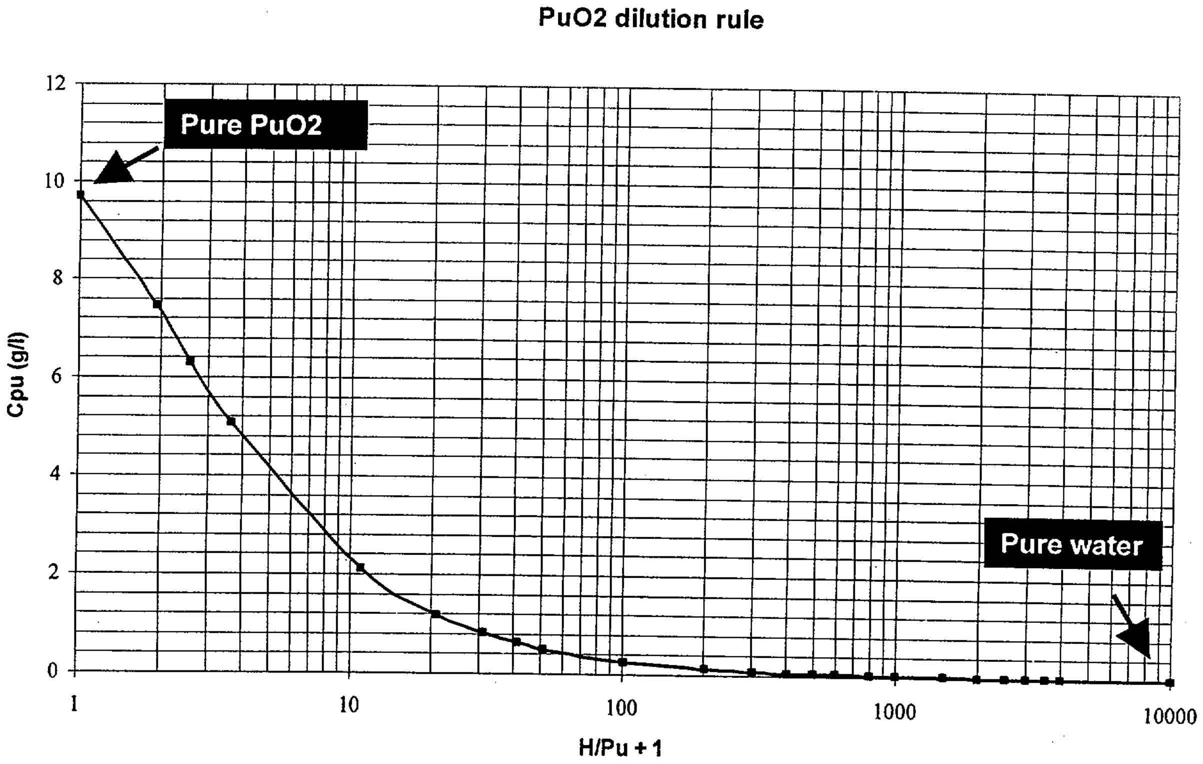
⇓

Dilution laws

$$C(\text{U or / and Pu}) = f\left(\frac{\text{H}}{\text{U or/and Pu}}\right)$$

gPu/cm^3 atomic ratio = $\frac{\text{nbr of H atoms}}{\text{nbr of Pu atoms}}$

DEFINITION OF REFERENCE FISSILE MEDIA - « DILUTION LAWS »



DEFINITION OF REFERENCE FISSILE MEDIA - « DILUTION LAWS »

Two categories :

☐ **Theoretical laws :**

- **theoritical mixture homogeneous**
- **based on the addition of individual volumes and masses (AIVM)**

☐ **Experimental laws :**

- **polynomyal expressions fitted on experimental density mesurement**
- **generally extended beyond the data range**

DEFINITION OF REFERENCE FISSILE MEDIA - « DILUTION LAWS »

Examples :

Theorical laws :

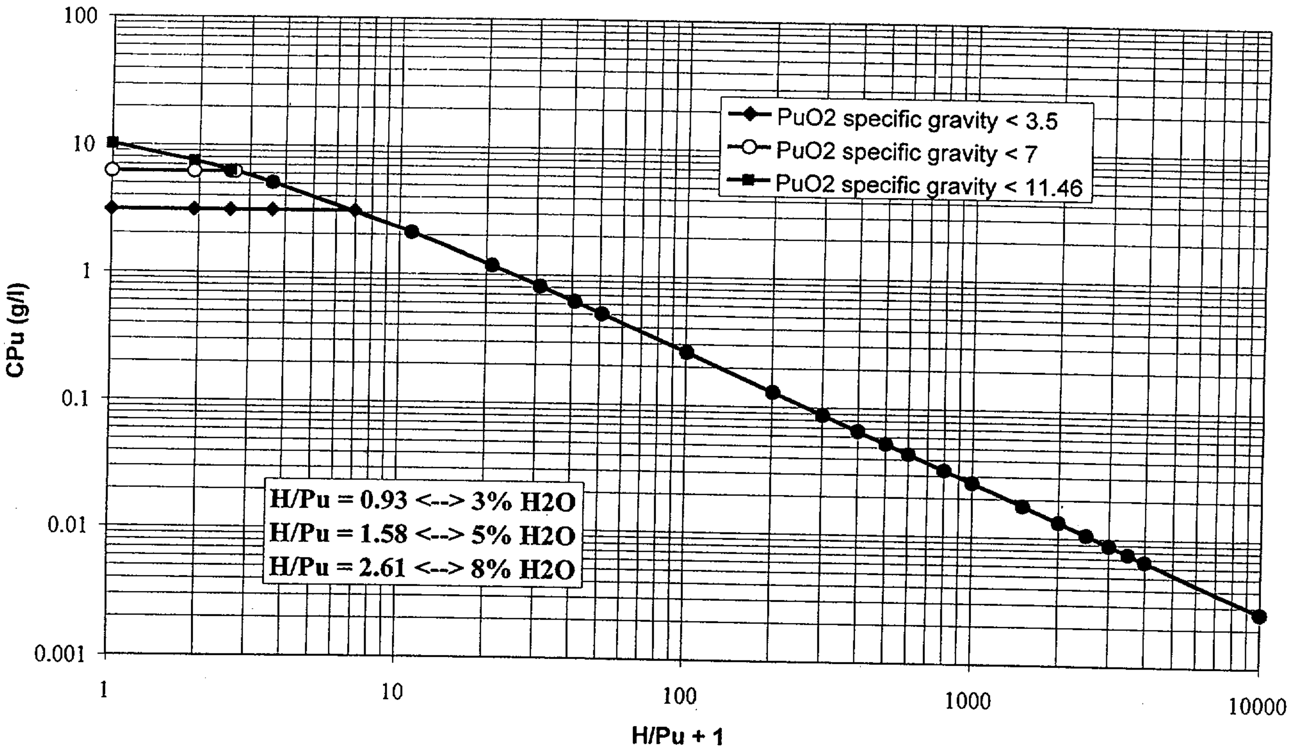
- **metallic Pu or U in water**
- **UO_2 and/or PuO_2 in water**
- **PuO_2F_2 and/or UO_2F_2 in water**

Experimental laws :

- **nitrate (U, Pu or UPu)**

DEFINITION OF REFERENCE FISSILE MEDIA - « DILUTION LAWS »

PuO2 dilution rule (IPSN/SEC)



CALCULATION CODES AND ACCEPTABILITY CRITERIA

☐ <u>In France</u> :

- criticality tools are developped by CEA and IPSN
- extend validation on benchmarks is made by CEA and IPSN
- a reduce set of 52 criticality benchmarks is used to verify and validate the installation of tools on users computers
- current french criticality package

APOLLO 1 - DTF IV - MORET III

- new package CRISTAL

APOLLO 2 - TRIPOLI 4 - MORET IV

CALCULATION CODES AND ACCEPTABILITY CRITERIA

❑ **US approach :**

Validation requirements concerning criticality safety in US are given in ANSI/ANS-8.1 1998 and ANSI/ANS-8.17 1984

ks ≤ kc - Δks -Δkc -Δkm with Δkm generally equal to 0.05

⇒ validation (validation made by code users for each situation) allow to define the area of applicability of codes and acceptability criteria

COGEMA

CRITICALITY CALULATIONS TOOLS AT SGN

US TOOLS FOR MOX FFF

☐ SCALE 4.4

→ verification accomplished

→ validation running with the 44 and 238 group cross sections library

☐ 238 group cross sections library will be selected because of large energy spectrum in MOX facility (very low moderation to full moderation)

FRENCH TOOLS FOR MELOX

☐ APOLLO 1- MORET III - DTF IV

with CEA86 99 groups cross sections library

Self shielding and collapsing into 16 HANSEN-ROACH structure group process by APOLLO 1

MORET III (Monte Carlo code) and DTF IV use APOLLO 1 condensed cross-sections

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SCALE 4.4 CRITICALITY VALIDATION

☐ **Nitrate plutonium system**

A lot of benchmarks available with low content of ^{240}Pu and various concentrations (PU-SOL-THERM001 to 004, 010, 014 to 017, 025 Cylinders, sphere, slabs ICSBEP)

☐ **UO_2+PuO_2 pellets and rods in water**

Benchmarks with MOX rods in water (MIX_COMP-THERM002, 003, EPRI, SAXTON programs)

☐ **Low moderated powder (few benchmarks)**

Plutonium metal benchmarks PU-MET-FAST... MIX-MET-FAST008
PuO_2-UO_2 mixture (MIX-COMP-INTER 001 to 003)
Low moderated UO_2 (MARACAS french experiment)

EXAMPLES OF CALCULATION

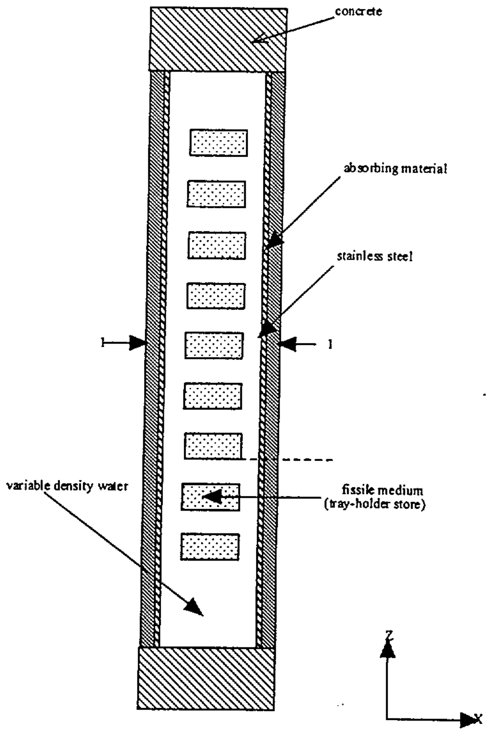
☐ PELLETS TRAY-BASKETS STORES

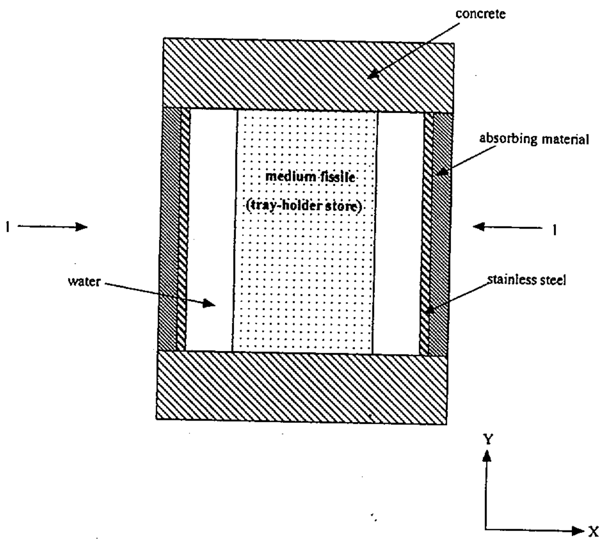
- parallel vertical stacks. Each stack features tray-baskets with a vertical pitch.

- Tray-baskets consist of trays. Each tray features grooves with a pitch.

- Stacks are separated by a neutron absorbing material lined with stainless steel layer.

EXAMPLES OF CALCULATION





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EXAMPLES OF CALCULATION

Fissile medium (tray-holder store) is simlated by an array of pins in water without cladding

- Pellet diameter is choosen to have the maximum reactivity,
- Pitch of pellets vary to have the maximum reactivity (Vmoderator/Voxyde variable), so called optimum of moderation in France,

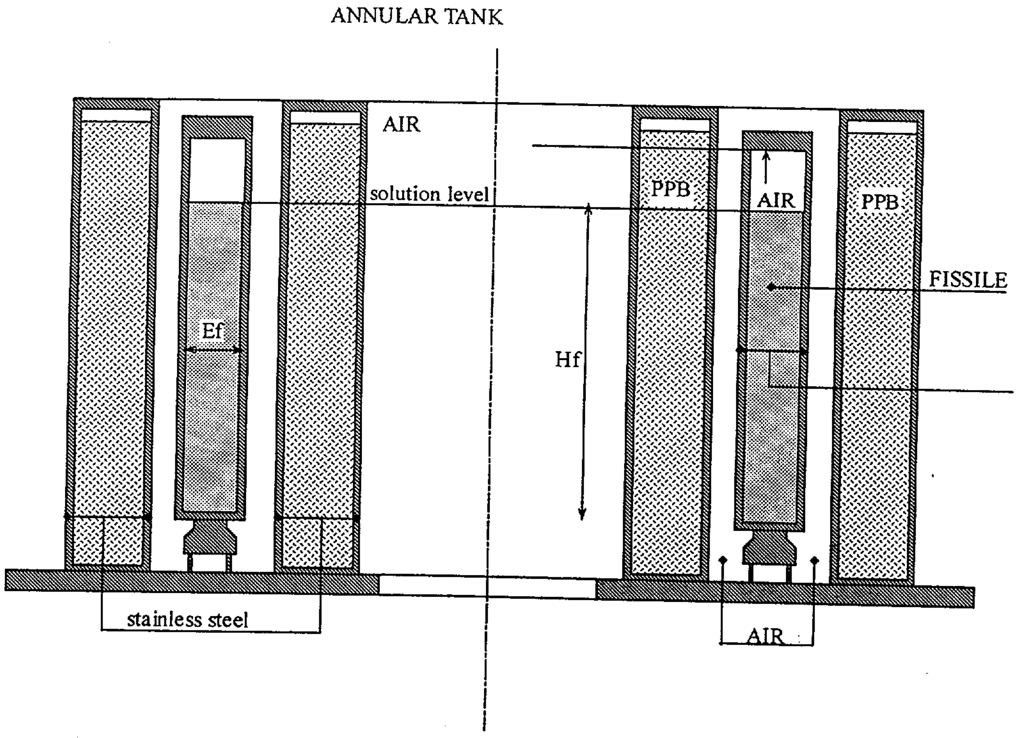
Store calculation take into account ingress of water in the store

- Water density around the pellets tray-baskets is variable

Dimensions used in calculations are minimum values for pitchs, and maximum values for fissile material

EXAMPLES OF CALCULATION

☐ NITRATE PLUTONIUM ANNULAR TANK



EXAMPLES OF CALCULATION

CALCULATION HYPOTHESIS :

- Optimum moderation (variable plutonium concentration)
- Tank is filled with fissile media
- Fissile thicknesses used in calculation are maximum values (take into account corrosion, manufacturing tolerances, ...)
- Minimum thicknesses for absorbing material (manufacturing tolerances)
- Conservative hypothesis in absorbing material composition

FIRE PROTECTION
In MELOX

Fire protection

DEFENSE IN DEPTH:

☐ **Prevention**

Design practices (e.g. choice of materials)

☐ **Detection & Alarm**

☐ **Mitigation**

- **Design measures:**
  - **Prevention of spreading (fire barriers)**
  - **Suppression**
- **Organization of fire fighting**

Fire protection in French Nuclear Cycle Facilities

French regulation: Basic Safety Rule I.4.a

- Deterministic method for assessing fire hazard

  The main criterion is the Fire Load Density (FLD)

- Sectorization (classification of rooms) according to the calculated Fire Load Density

  See figures on next slides

Typical examples and measures applied
for each type

Protected Zones (PZ)

FLD < 400 MJ/m²

but need to be protected from a fire coming from their surroundings

- Examples
  - Rooms / corridors needed for personnel evacuation or smoke&fire fighting
  - Staircases / elevators where vertical spreading of smoke&fire is a risk
  - Rooms containing significant amounts of Pu in sealed uncombustible envelope
- Measures taken:
  - 2 hours fire resistant* walls
  - 1 hour flame integrity* doors
  - Ventilation inlet by direct blowing (no transfer from other room)

* according to RFS I.4a

Typical examples and measures applied
for each type

Fire Zones (FZ)

FLD > 400 MJ/m^2

with no nuclear materials

- **Examples**
  - **Electrical ducts**
  - **Electrical rooms**
- **Measures taken:**
  - **2 hours fire resistant walls**
  - **2 hours fire resistant doors**
  - **Ventilation inlet by direct blowing (no transfer from other rooms)**
  - **Automatic fire detection**
  - **Fire damper on ventilation on inlet and exhaust**
  - **Fixed extinguishing means in some rooms (no easy access)**

COGEMA

Typical examples and measures applied
for each type

Fire and Confinement Zones (FCZ)

FLD > 400 MJ/m²

contain nuclear materials (Pu) that may be dispersed in case of a fire

One FCZ can include several Fire Zones, as well as Protected Zones or unclassified areas

- **Examples**

  Group of rooms constituting a volume capable of containing the radioactive products that may be released by a fire in the considered Fire Zone

- **Measures taken:**

  In addition to the measures concerning the Fire Zones:

  - **Building:**
    - Access airlock(s) with separated ventilation
    - Special fire dampers operable up to 400°C on inlet & exhaust
    - « HEPA » filters
    - Ventilation exhaust ducts resistant to heat (200°C - 400°C)
    - Dilution of exhaust gases to protect the final filtration stage (before stack)

Typical examples and measures applied
for each type

COGEMA

Fire and Confinement Zones (FCZ) (continued)

- **Measures taken (continued):**
  - **Glove boxes:**
    - Fire dampers on inlet & exhaust
    - « HEPA » filters
    - Fire detection inside gloveboxes
    - Fast connectors for CO_2 injection (enable gas injection while maintingconfinement)

N.B. For process reasons, most glove boxes are ventilated with nitrogen , which contributes to lower the fire risk.

Fire detection and alarm

☐ **Functions:**

- **Rapid detection of any abnormal situation**
- **Knowledge of the location of the detection point**
- **Triggering of alarm to enable rapid intervention of fire fighters**
- **Triggering of:**
  - **automatic suppression systems**
  - **active systems that prevent fire spreading (i.e. fire hatches & doors, some fire dampers)**

Fire suppression

☐ **Organization for fire fighting:**

- **In each operating team, some operators *(Equipiers de Première Intervention, EPI)* have a special fire fighting training**
- **MELOX plant has its own team of professional fire fighters *(Equipiers de Seconde Intervention, ESI)***
- **Fire fighting brigade *(Force Locale de Sécurité, FLS)* with all heavy fire-fighting equipments coming from the neighbouring nuclear plants**

☐ **Fire fighting systems:**

- **Portable extinguishers (CO_2, powder, water)**
- **Fixed extinguishing systems**
  - **CO_2 e.g. if criticality or accessibility constraints**
  - **Water**

AMERICANIZATION

AMERICANIZATION PROCESS

- Process by which proven MOX fuel fabrication technology is being adapted as required to comply with U.S. requirements or incorporate U.S. preferences
- Requirements - Contract, regulatory, quality, design codes and standards, site and utility interface, security, safety practices and principles
- Preferences - Component selection, maintenance and operation, project execution

AMERICANIZATION PROCESS

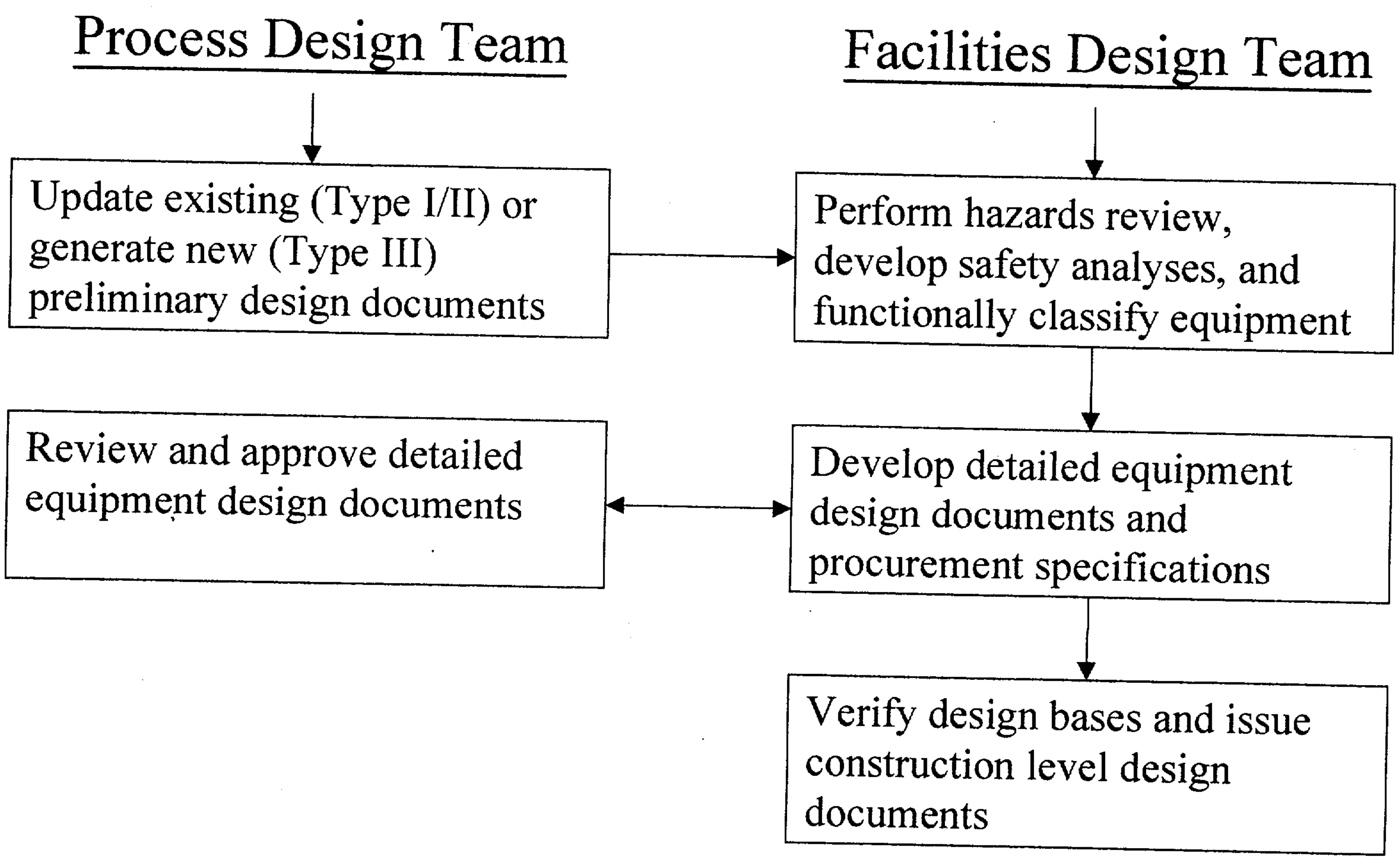
Process Design Team

- Establish basic process flows and material throughputs based on contract requirements
- Develop equipment concepts and facility layouts based on proven technology
- Establish preliminary functional requirements using existing safety analysis bases

Facilities Design Team

- Develop design criteria based on U.S. requirements and preferences
- Establish functional classification scheme and quality requirements
- Develop site specific facilities requirements - natural phenomena hazards

AMERICANIZATION PROCESS



Process Design Team

Update existing (Type I/II) or generate new (Type III) preliminary design documents

Review and approve detailed equipment design documents

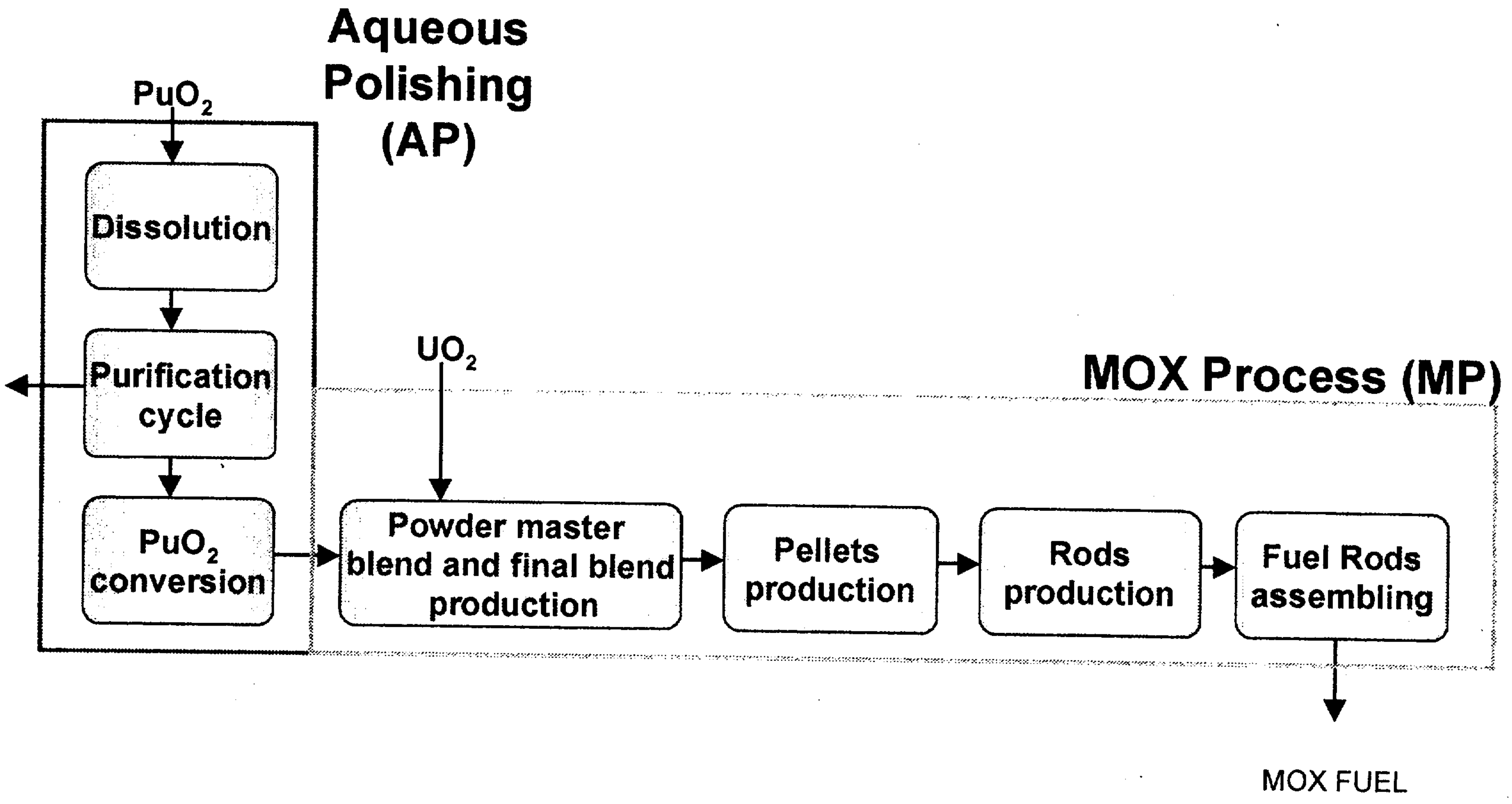
Facilities Design Team

Perform hazards review, develop safety analyses, and functionally classify equipment

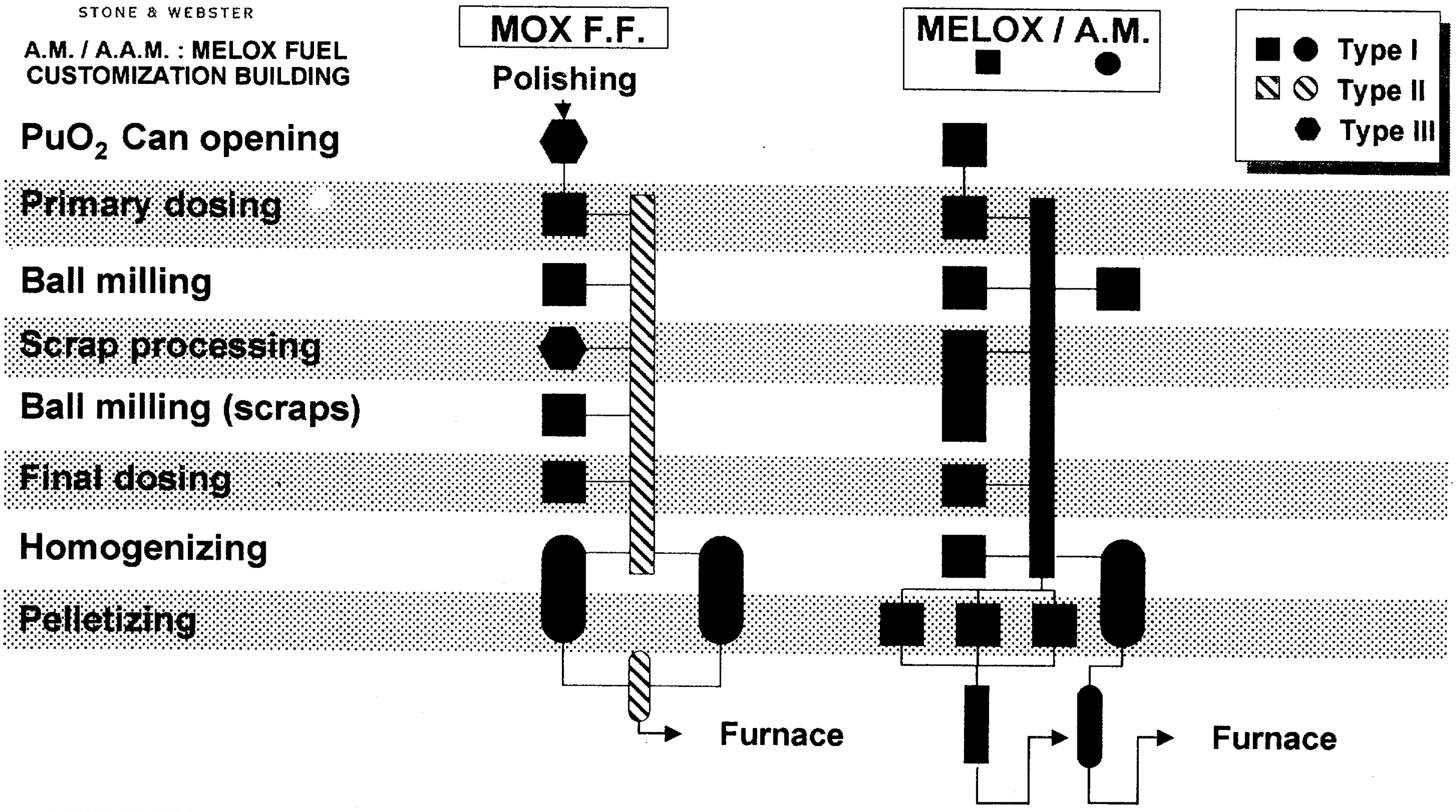
Develop detailed equipment design documents and procurement specifications

Verify design bases and issue construction level design documents

MOX Fuel Fabrication Facility



MOX PROCESS: 1/2



A.M. / A.A.M. : MELOX FUEL CUSTOMIZATION BUILDING

MOX F.F.

MELOX / A.M. ■ ●

■ ● Type I
▨ ⦸ Type II
⬢ Type III

Polishing

PuO_2 Can opening

Primary dosing

Ball milling

Scrap processing

Ball milling (scraps)

Final dosing

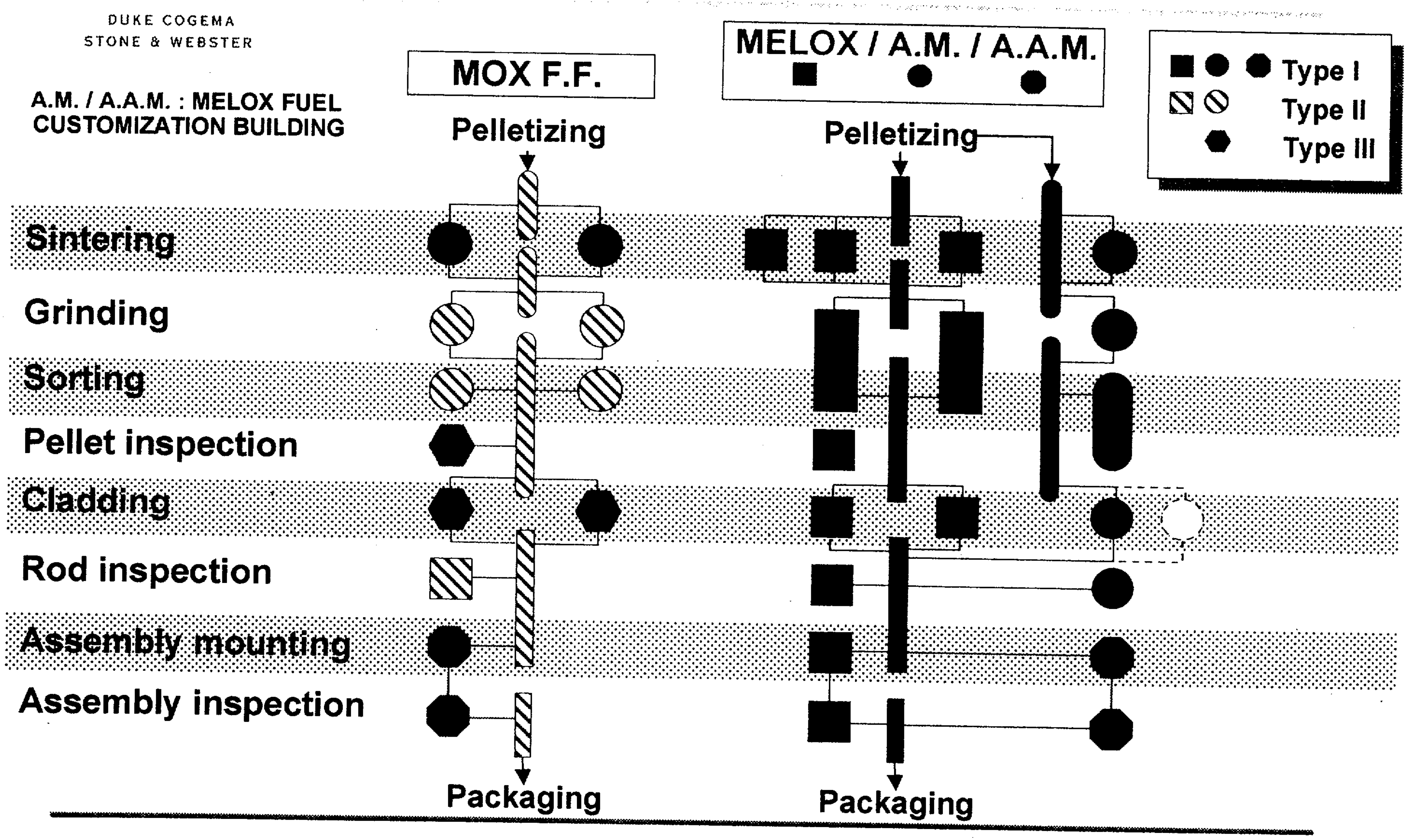
Homogenizing

Pelletizing

DUKE COGEMA
STONE & WEBSTER

MOX PROCESS: 2/2

A.M. / A.A.M. : MELOX FUEL CUSTOMIZATION BUILDING



MOX F.F.

MELOX / A.M. / A.A.M.
■ ● ⬣

■ ● ⬣ Type I
▨ ⊘ Type II
⬢ Type III

Pelletizing

Sintering

Grinding

Sorting

Pellet inspection

Cladding

Rod inspection

Assembly mounting

Assembly inspection

Packaging

POLISHING PROCESS

process step	Equipment	Reference	modifications
Dissolution			
Dissolution	Dissolver	U.R.P.	Criticality Throughput larger
Purification			
Pu extraction	pulsed columns	T4	Criticality Throughput lower
solvent regeneration	Mixer settlers	T4	Throughput lower Number of stages
acid recovery	Thermosiphon evaporators	T3 / R2	Throughput lower
Silver recovery	Electrolyzer	UCD	same equipment
Conversion			
Precipitation	Précipitators	R4	Criticality Throughput lower
Filtration	Filter	UP1	same equipment
Calcination	Furnace	R4 / T4 MAPu	Criticality Throughput lower
Homogeneisation	Tumbling mixer	R4	Criticality Throughput lower

EXAMPLES

CHANGES BASED ON REQUIREMENTS

Contract:	Weapons grade Pu vs. non Weapons grade Pu – Potential to eliminate glovebox forced cooling as a safety function
Regulatory:	Draft 10 CFR, Part 70 regulations
Quality:	Graded functional classification scheme – Risk based classifications vs. redundancy criteria 10 CFR Part 50, Appendix B. vs. ISO 9000

EXAMPLES

CHANGES BASED ON REQUIREMENTS

Design Codes: RCC-MR vs. AISC, ANSI, AWS, ASTM, IEEE
- Fillet weld allowable stress derating

Utility Interface: Electrical power
- 120VAC, 60 cycles vs. 220VAC, 50 cycles

Security: Integration of DOE Orders
- Tamper safe materials during transfers
- Receipt accountability measurements

Safety Practices: Occupation Safety and Health Act implications
- Machine tool guarding

EXAMPLES

CHANGES BASED ON PREFERENCES

Components: Glovebox auxiliary and utility items
- Gloves, drop-in lighting and other consumables
- HEPA filters where space permits

M&O Practices: In-situ testing provisions
- Glovebox overheat detector surveillance
- Glovebox hoist periodic testing

Execution: Engineering units in design documentation
- Metric dimensions, flows / U.S. stresses

Specifications for U.S. procurements

MOX PROCESS MECHANICAL UNITS

SYM	ORIG SYM	PLANT	TYPE	PROCESS UNIT	N° OF UNITS
RECEIVING		(*) ME: MELOX EXTENSION			
DRS			3	UO2 RECEIVING	1
DRS	DRS	MELOX	2	UO2 STORAGE	1
DDP	DDP	MELOX	2	UO2 DRUM EMPTYING	1
DCP	DCR	MELOX	3	PuO2 RECEIVING	1
DCM	DCM	MELOX	2	PuO2 3013 STORAGE	1
DCE			3	PuO2 BUFFER STORAGE	1
POWDER					
NDD	NDT	MELOX	3	PuO2 CONTAINER OPENING AND HANDLING	1
NDP	NDP	MELOX	1	PRIMARY DOSING	1
NBX, NBY	NBX	MELOX	1	BALL MILLING	2
NDS	NDS	MELOX	1	FINAL DOSING	1
NXR	NXN	MELOX	3	AUXILIARY POWDER	1
NCR	NCH	MELOX	3	SCRAPS PROCESSING	1
NTM	NTM	MELOX	2	JAR STORAGE AND TRANSFER	1
NPE, NPF	NPV	ME (*)	1	HOMOGENIZATION AND PELLETIZING	2
NCP	NCP	MELOX	1	POWDER CONTAINERS	1
PELLETS					
PFE, PFF	PFV	ME	1	SINTERING FURNACE	2
PRE, PRF	PRZ	ME	2	GRINDING	2
PTE, PTF	PTC	ME	2	PELLETS INSPECTION AND SORTING	2
PQE			3	QUALITY CONTROL AND MANUAL SORTING	1
PAD	PAD	ME	1	PELLETS REPACKAGING	1
PAR			3	SCRAPS BOX LOADING	1
PSE	PSA	ME	2	GREEN PELLET STORAGE	1
PSF	PSA	ME	2	SINTERED PELLET STORAGE	1
PSI	PSA	ME	2	SCRAPED PELLETS STORAGE	1
PSJ	PSB	ME	2	GROUND AND SORTED PELLETS STORAGE	1
PML	PMA	ME	2	PELLETS HANDLING	1
PCT	PCT	MELOX ME	1	PELLETS CONTAINERS	1

MOX PROCESS MECHANICAL UNITS

SYM	ORIG SYM	PLANT	TYPE	PROCESS UNIT	Nº OF UNITS
CLADDING AND ROD CONTROL					
GME F	GMZ	ME	3	ROD CLADDING AND DECONTAMINATION	2
	GMX	MELOX			
	GDY	MELOX			
GMK	GMK	MELOX	2	ROD HANDLING	2
GDR	GDC	MELOX	1	ROD DECLADDING	1
SXE	SXA	ME	2	X RAY TEST	1
SEK	SEK	MELOX	1	HELIUM LEAK TEST	1
SDK	SDK	MELOX	1	ROD INSPECTION AND SORTING	1
SCE, SCF	SCX	MELOX	3	GAMMA SCANNING TEST	2
STK	STK	MELOX	2	ROD STORAGE	1
SMK	SMK	MELOX	2	ROD HANDLING	1
GPD	GPD	MELOX	1	SMALL ROD COMPONENTS CLEANING	1
ASSEMBLY					
TGM	TGM	MELOX	2	ASSEMBLY MOCKUP LOADING	1
TGV	TGV	ME	1	ASSEMBLY MOUNTING EQUIPMENT	1
TAS	TAS	MELOX	2	ASSEMBLY HANDLING	1
TCK	TCK	ME	1	ASSEMBLY DRY CLEANING	1
TCP	TCP	ME	1	ASSEMBLY INSPECTION	1
TCL	TCL	ME	1	ASSEMBLY FINAL INSPECTION	1
TGJ	TGM		1	RESERVE PIT	1
TAS	TAS	MELOX	2	ASSEMBLY STORAGE	1
TXE			3	ASSEMBLY PACKAGING	1
MISCELLANEOUS					
NPP	NPP	MELOX	1	ADDITIVES PREPARATION	1
LTP	LTP	MELOX	2	PNEUMATIC TRANSFER (SAMPLES)	1
NTP		R4 LA HAGUE	2	PNEUMATIC TRANSFER (PuO2 CANS)	1

MOX PROCESS MECHANICAL UNITS

SYM	ORIG SYM	PLANT	TYPE	PROCESS UNIT	Nº OF UNITS
LABORATORY					
LAC	LAC	MELOX	1	CHEMICAL ANALYSIS (FLUORINE/CHLORINE)	1
LAN	LAN	MELOX	1	CHEMICAL ANALYSIS OXYDE/METAL RATIO	1
LAU	LAU	MELOX	1	AUTOCLAVE	1
LCE	LCE	MELOX	1	EFFLUENT CONTROL, TREATMENT,	1
LCP	LCP	MELOX	1	PHYSICAL CONTROL, CERAMOGRAPHIC TEST	1
LCT	LCT	MELOX	1	TEST LINE	1
LDS	LDS	MELOX	1	DENSITOMETRY	1
LEN	LEN	MELOX	1	SAMPLE STORAGE	1
LET	LET	MELOX	1	GAUGING	1
LGF	LGF	MELOX	1	IMPURITY MEASURMENT (ICP, GAMMA FX, SOLUBILITY TEST)	1
LLI	LLI	MELOX	1	INACTIVE PREPARATION	1
LME	LME	MELOX	1	METALLOGRAPHY	1
LPG	LPG	MELOX	1	GAZ PHYSICS	1
LPO	LPO	MELOX	1	PHOTO	1
LPS	LPS	MELOX	1	ISOTOPIC AND RADIO CHEMICAL ANALYSIS PREPARATION	1
LSG	LSG	MELOX	1	GAZ STORAGE	1
LSM	LSM	MELOX	1	INACTIVE STORAGE	1
LSP	LSP	MELOX	1	CHEMICAL PRODUCTS STORAGE	1
LSR	LSR	MELOX	1	MASS AND GAMMA SPECTROMETRY	1
LTP	LTP	MELOX	1	PNEUMATIC TRANSFER	1
LVE	LVE	MELOX	1	VENTILATION FILTRATION (INLET)	1
LVS	LVS	MELOX	1	VENTILATION FILTRATION (OUTLET)	1
LST				SOLID TREATMENT	1
XX				ANALYSIS FOR AQAEOUS POLISHING	
XX				" "	
XX				" "	
XX				" "	
XX				" "	
WASTES					
VDQ	VDQ	MELOX	2	WASTES STORAGE	1
VDT	VDT	MELOX	2	WASTES RAD MEASURMENT	1
VDR	VDR	MELOX	2	FILTERS DISMANTLING	1
VDU	VDU	MELOX	2	MECHANICAL DISMANTLING	1

Nuclear criticality control is based on double contingency. The steps in assuring criticality safety consists of: 1) determining the specifics of the fissile medium; 2) choosing criticality control modes which establish the parameters to be controlled; 3) performing criticality calculations to provide the limiting values of the parameters being controlled; 4) determining the specifications of any interlocks; 5) establishing the instrumentation and control (I&C) needs. Cogema uses a Criticality Control Flow Diagram (CCFD) to diagram the criticality controls being employed throughout each process. The CCFD is a flow diagram showing the piping, equipment, and tanks in each process. Each component is marked to denote the criticality controls being employed, such as geometry and mass. The CCFDs appeared to be a very simple and useful tool to assist in documenting and controlling the criticality controls. The CCFDs are submitted to the DSIN. French developed criticality computer codes are used to perform the criticality calculations. The U.S. facility will use the SCALE computer code in its design. A sample of criticality calculations will be performed using both the French codes and SCALE to assure that both codes provide the same results. If the results are sufficiently close, then only SCALE will be used for the balance of the criticality calculations. In France, only one validation of the criticality design code is performed whereas in the U.S., each user must validate the code; however, in France, there are fewer users. Because of the automated nature of the process, the NRC staff questioned the configuration management of the controlling software and associated controls. The process is controlled by redundant programmable logic controllers (PLCs) and the process is examined for common-mode failures. In addition to being highly automated, which reduces the likelihood of human error, most of the processing equipment at La Hague and Melox incorporates favorable geometry. The result is that both facilities rely heavily on passive engineered controls. Primary criticality controls are geometry, moderation, mass, and isotopics. Because credit is taken for the plutonium isotopic composition in sizing process equipment, there is the possibility that the equipment in the U.S. MOX facility would have reduced throughput and/or dimensions, due to the use of weapons-grade, rather than reactor-grade, plutonium. This difference will also require re-validation of the criticality safety computer codes.

Fire analyses are based on a classical approach of dividing the facility into different sectors and performing fire hazards analyses. Most firewalls are rated for 2 hours. The fire protection depends on early detection, controlling fire loadings, and a carbon dioxide, water or halon suppression system, depending on the specifics of the particular location and hazards. Manual fire protection actions are relied on as well as automatic actions. The effects of fire on ventilation systems were discussed. Fire zones are specified, depending on the fire loading and the presence, or absence, of fissile materials.

Ventilation system filters are protected from fires via different means, depending on the particular fire zone. Gloveboxes are considered a fire and confinement zone and are inerted using a nitrogen ventilation system to prevent glovebox fires. In the case of a fire in a glovebox, glovebox entry and exit dampers are manually controlled by firefighters, depending on the particulars of the situation since gloveboxes are serving a confinement function. If a fire were to occur in a fire zone, such as a room which is not considered a fire and confinement zone, the inlet damper closes automatically and hot and cold air are mixed to maintain temperatures below that which would damage any filters. If, however, the exhaust temperature reaches 70 degrees Celsius, then the exhaust damper will close automatically to protect the HEPA filter.

Docket: 70-3098
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OFC	SPB	E	SPB	E	SPB	E	SPB	E	SPB	E					
NAME	*DPersinko:al		*AMurray		*AHoadley		*MGalloway		*CTripp						
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