EUROFAB Project:

A Clear Success for International Transport of Plutonium and MOX Fuels

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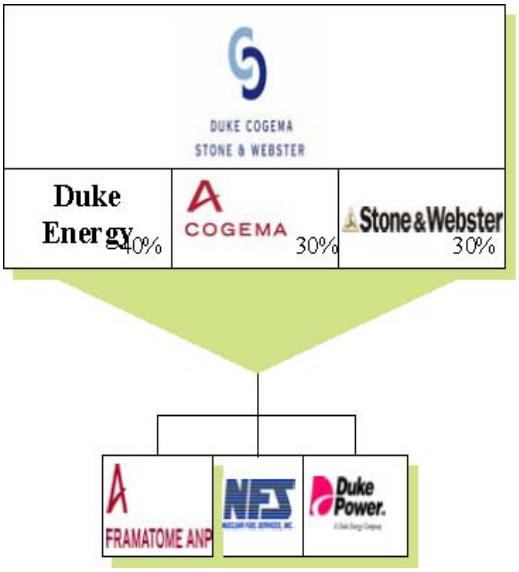
ABSTRACT

An Agreement between the United States and Russia to eliminate 68 metric tons of surplus weapons-grade plutonium provided the basis for the United States government and its agency, the Department of Energy (DOE), to enter into contracts with industry leaders to fabricate mixed oxide (MOX) fuels (a blend of uranium oxide and plutonium oxide) for use in existing domestic commercial reactors.



DOE contracted with Duke, COGEMA, Stone and Webster (DCS), a limited liability company comprised of Duke Energy, COGEMA Inc. and Stone & Webster to design a Mixed Oxide Fuel Fabrication Facility (MFFF) which would be built and operated at the DOE Savannah River Site (SRS) near Aiken, South Carolina. During this same timeframe, DOE commissioned fabrication and irradiation of lead test assemblies in one of the Mission Reactors to assist in obtaining NRC approval for batch implementation of MOX fuel prior to the operations phase of the MFFF facility. On February 2001, DOE directed DCS to initiate a predecisional investigation to determine means to obtain lead assemblies including all international options for manufacturing MOX fuels. This lead to implementation of the EUROFAB project and work was initiated in earnest on EUROFAB by DCS on November 7th, 2003.

DESCRIPTION

EUROFAB project consisted of the following major tasks:

1. Polishing and packaging 140 kg of weapons grade plutonium oxide at LANL.
2. Shipment of the PuO2 from LANL to Charleston, South Carolina using security vehicles.
3. Transatlantic shipment of the PuO2 powder to France via Pacific Nuclear Transport Limited (PNTL) armed convoy,
4. Shipment of the PuO2 powder from Cherbourg, France through COGEMA La Hague reprocessing plant to COGEMA Cadarache plant.
5. Fabrication of pellets and rods at Cadarache and fabrication of four MOX fuel assemblies (Lead Assemblies-LAs) at COGEMA MELOX.
6. Shipment of completed MOX fuel assemblies, archives and excess fuel rods from COGEMA MELOX through COGEMA La Hague reprocessing plant to Cherbourg.
7. Transatlantic shipment via PNTL of completed fuel assemblies, archives and excess fuel rods to Charleston, South Carolina.
8. Shipment of the Lead Assemblies via road to Catawba 1 and shipment of the archive and excess fuel rods to LANL.

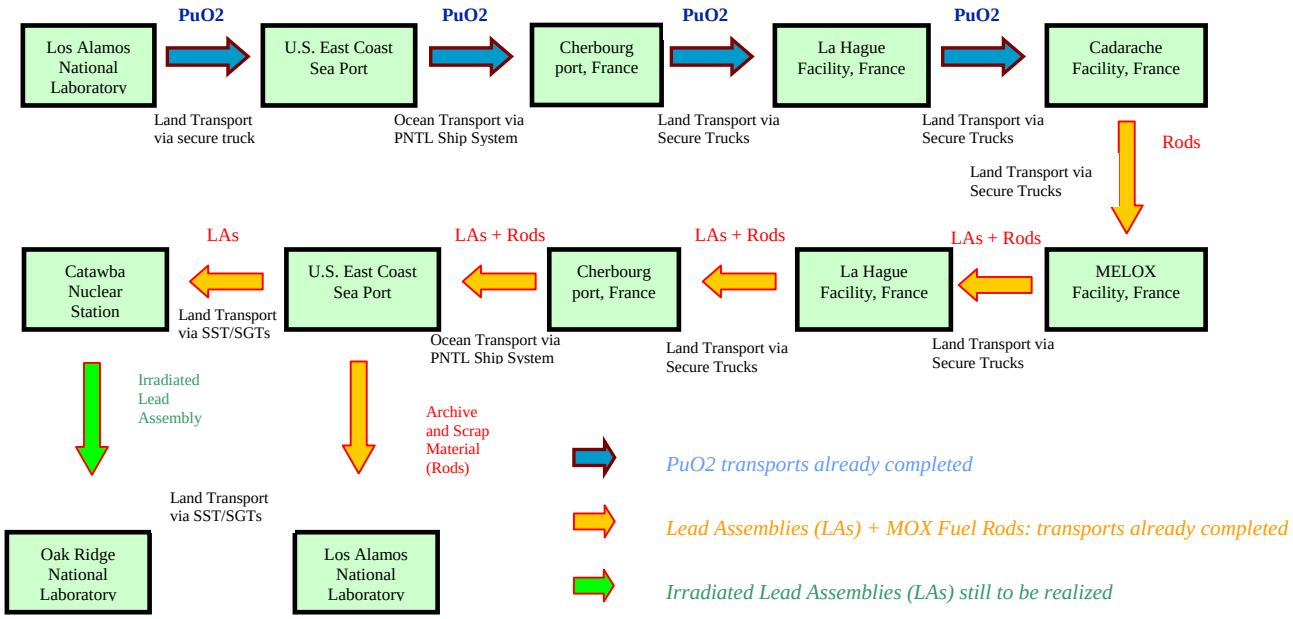


Fig. 1. EUROFAB Project Major Tasks

TECHNICAL

The decision to fabricate the lead assemblies (LAs) in Europe was, in a large part, determined because of the extensive fabrication experience in France, the proven shipping casks for both PuO2 and lead assemblies and the proven maritime transport capability. The technical approach was, therefore, to use the existing and proven infrastructures and equipment in so far as possible and adapt them for application for

providing lead assemblies in the U.S.

With this approach, the technical issues were minimal while the significant issues included: interfacing different regulatory regimes, interfacing different governments and policies, different security requirements, different work laws, contracts, different engineering units and coordination of a large number of different groups from different cultures and backgrounds in various locations.

Throughout the spectrum of EUROFAB functions, regardless of country, the respective experts took responsibility for their functions (functions which they had performed in the past for other like work scopes) and performed them well. The EUROFAB management team respected the expertise of the different groups. In addition, the team also provided program direction and managed the interface between performers.

EUROFAB also included the translation of all necessary technical requirements between two languages - English and French, conversion of the U. S. fuel design and tooling requirements to metric units, complying with both English and French law as appropriate, flowing down appropriate DOE contract clause requirements to foreign suppliers, obtaining a U.S. export license, obtaining both French and U.S. licenses for both shipping packages, meeting all associated French, British, and U.S. security requirements and obtaining licensing extensions for U.S. weapons grade plutonium at Cadarache, Melox and La Hague facilities.

LEAD ASSEMBLY FABRICATION

Fabrication involved the interface and efforts of several entities including Duke Power, Framatome Lynchburg, DCS, Cadarache and Melox. Deliverables required by contracts between DCS and COGEMA and between DCS and Duke Power were completed on time and provided to the appropriate recipients.

Completion of EUROFAB included the following major tasks: minor modifications to the Cadarache and Melox plants to allow fabrication of the Mark-BW/MOXI (FRA-ANP Advanced Fuel Assembly design), qualification of Cadarache and Melox plant processes and personnel, supplying appropriate plant hardware and fuel assembly hardware by DCS, and qualification of the fabrication plants quality assurance programs to the Framatome ANP (FANP) QA program which is approved by the NRC.

REGULATORY

There were several regulatory actions required to accomplish the EUROFAB mission. These regulatory actions included:

- Export License (Pu02 to France)
- FS47 - Cask used to transport Pu02 to France
- FS65 - Cask used to transport leadassemblies to U.S.

The following French facilities required license extensions to handle U.S. weapons grade Pu:

- Cadarache: pellet /rod fabrication plant
- Melox: fuel bundle fabrication plant
- La Hague: French transport safe haven to change security containers

FS47 type package to transport PuO2

FS65 type package to transport LAs and Rods

Fig. 2. FS47 and FS65 package types

The regulatory actions by both countries were completed on time to support the EUROFAB schedule.

INSTITUTIONAL ISSUES

NEPA

The DOE was responsible for the NEPA analysis and the ROD (record of decision) regarding EUROFAB. DOE was also faced with two other NEPA actions that affected the MFFF project during this same time period (cancellation of immobilization and incorporation of alternate feed stock). All of these NEPA actions required coordination by DOE in order of importance and timing which affected the issue date of the EUROFAB NEPA.

On November 7, 2003, DOE issued supplemental analysis and an amended ROD for fabrication of lead assemblies in Europe (EUROFAB).

The practical effect on EUROFAB was that, in general, prior to the supplemental analysis of environmental Record of Decision (ROD) on November 7, 2003, only studies, plans and evaluations could be carried out. Irreversible actions such as equipment procurement and plant modifications could not be initiated.

Because of the NEPA actions and constraints, DCS effectively performed all support equipment procurements and fabrications, regulatory actions, PuO_2 shipment, lead assembly fabrication and return shipment in an eighteen month period between November 2003 and May 2005. The long pre-planning efforts yielded positive results in that the resulting plan was effective and carried out on time and within budget.

Interfaces and other Government Agencies

The interfaces required to carry out EUROFAB between governments, different U.S. government agencies and DCS companies and subcontractors were complex and further complicated by the individual laws, the regulatory requirements and the security requirements of each country. DOE managed all government and inter-governmental agency issues and actions. DCS managed all contractors' issues and performance. The DCS EUROFAB manager obtained both a DOE security clearance as well as a French security clearance to facilitate communication and resolution of cross cutting issues.

In general, the work scope split was such that entities from the U.S. were responsible for the overall EUROFAB program under DOE direction, land transport within the U.S., and U.S. port and U.S. regulatory interfaces. The British were responsible for the maritime shipment and the French were responsible for the French port, land transport within France and lead assembly fabrication with technical guidance and requirements provided by DCS.

Other U.S. agencies involved in the successful completion of EUROFAB were U.S. Coast Guard, Charleston Naval Weapons Station - U.S. Department of Navy and Public Works, South Carolina State Police and local law enforcement agencies, Federal Bureau of Investigation and the DOE Office of Safety Transport. Other institutional bodies and Government Agencies such as Nuclear Regulatory Commission (NRC), Department of Transportation, Department of Public Work, SLED (local law enforcement agencies), Department of States, Border Protection Services (Agriculture, Immigrations, Customs), Department of Justice (NEPA), and the Los Alamos National Laboratory within the Department of Energy have contributed to EUROFAB project. A like list of agencies could be added to this list for the work in France and England. LANL under contract to DOE polished and packaged the plutonium with DCS QA oversight and plutonium expertise assistance. DCS provided shipping packages, support equipment, training and procedures. DOE entered into a memorandum of agreement with the Department of Navy for use of the Charleston port and equipment. The DOE Savannah River Site Radiation Control team provided support for the shipments at the Charleston port, and a team from LANL provided the OST/SGT truck loading/unloading functions at the Charleston port. DCS entered into a contract with FANP for the EUROFAB lead assembly design responsibility and QA oversight to assure compliance with NRC regulations. Duke Power entered into a contract with DCS for acceptance and irradiation of the lead assemblies in their mission reactor.

This brief interface discussion illustrates the vast number of entities involved in the successful completion of EUROFAB. Not discussed or shown are the identical infrastructures in France and England between the commercial companies and their corresponding government interfaces which enabled successful EUROFAB performance.

SCHEDULE

In April 2001, a resource loaded primavera baseline schedule was developed for EUROFAB. It was an optimistic schedule with a target delivery date of four lead assemblies at the mission reactor by October 2003.

This baseline schedule had four parallel critical paths: 1) polishing of the PU02 at LANL, 2) fabrication of the shipping packages and support equipment, 3) French and U.S. licensing of the shipping packages, and 4) the issuance of a mission reactor license amendment. The latter three depended upon issuance of appropriate NEPA documentation before significant work could be started.

With the March 6, 2002 issuance of the intent to prepare supplemental EUROFAB NEPA Analysis, DOE authorized submittal of the FS47 and FS65 shipping package request for certificates of approval in France thereby alleviating one of the critical path bottlenecks.

With the delay in issuance of the EUROFAB supplemental analysis and amended ROD until November 7, 2003, it was also necessary to move the target delivery date for the four lead assemblies to April - May 2005. The resource loaded primavera baseline schedule was adjusted to this delivery schedule and the revised EUROFAB cost and schedule baseline was submitted to DOE on November 10, 2003.

The lead assemblies were delivered on April 28, 2005 according to schedule.

TRANSPORTATION

EUROFAB transportation was carried out by the following entities:

1) the DOE Office of Transportation safely transported all nuclear materials within the U.S. Commercial carriers were used to stage support equipment within the U.S.
2) PNTL (Pacific Nuclear Transport Limited), in conjunction with the appropriate British security forces provided maritime transport services
3) Cogema Logistics, in conjunction with French security forces, provided French land transport services. Because of the classified nature of the shipping dates and numerous security support agencies, many integration meetings were required to confirm interfaces and protect classified shipping dates.

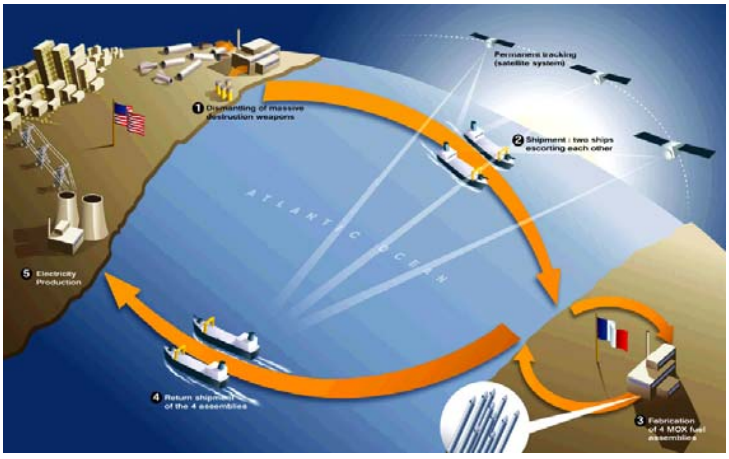


Fig. 3. Transportion

Specific security measures are classified information but it is recognized that the French government and the British government exceeded all expectation in their support and protection of the material for the U.S. One of the main reasons for success in all transport activities was that before each transport occurred, the following were performed: 1) support equipment was fabricated, 2) operational, handling and maintenance procedures were written, and 3) a complete dry run using the equipment and procedures was performed with the people who would be performing the actual work to verify that the equipment performed properly, the procedures were correct and that the people were trained. Everything was tested and people were trained before the actual transports occurred.

Cogema Logistics provided rental use of the FS47s, procurement and fabrication of the FS65s including support equipment and French land transport and supporting services. PacTec provided loading interface equipment for the packages and the OST trucks as well as a simulated OST truck bed for training and testing purposes. Both Cogema Logistics and PacTec provided training, testing and procedures for all equipment used by all entities handling the packages.

A EUROFAB shipment plan outlining the equipment staging, equipment movement and the timing was also written and followed to minimize cost and to insure transportation success. More than 40 subcontracts were place by DCS and carried through to completion to accomplish EUROFAB. The following is a summary of those subcontracts:

Consent Packages

Prior to the transport equipment fabrication, numerous consent packages have been approved by DCS and DOE. Cogema Logistics followed-up the supply and fabrication of over 20 transport equipment such as 1) Secured Communications, 2) Armored Closet, 3) FS47 Technical Test Assistance, 4) Monilogs, 5) Dummy Rods, 6) AA227 Opening / Closing Machine, 7) IP Caisson & Transfer Frame & Tilting Device, 8) FS65 Unloading Skid, 9) FS65 Bodies, 10) Pouring Resin, 11) FS65 Tooling, 12) Forged Parts for AA431 Basket, 13) Boronated Aluminum Plates, 14) Vibration Measurements for FS65, 15) FS65 Clamping System, 16) Maritime Caisson Physical Protection, 17) FS65 Testing Facility and Tech Assistance, 18) FS65 Baskets, 19) Grating Floors for FS65, 20) FS47 Tooling, 21) AA433 Rod Boxes, 22) Excess Storage Carts, 23) FS47 Repair. For PACTEC: 1) Transportation Services, 2) Simulated SGT, 3) Floor Assembly FS47/65 skids & air pallets & tables.

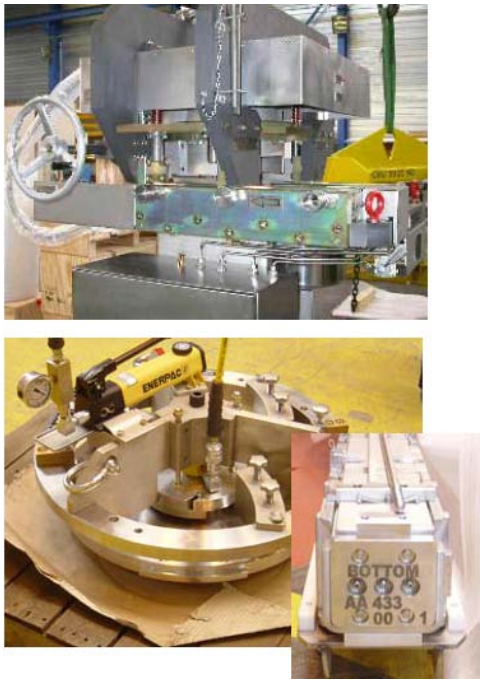


Fig. 4. Example of equipment manufactured

Numerous subcontractors have taken part in Europe to the major procurement efforts such as Thales, Optim, Socitec, Valorel, Sarrazin, Reel, Pole de Plasturgie, Mecachimie, Forges de la Loire, Eagle Picher, Sopemea, Cybernetix, Mecagest, Reel, Cimat, Sarrazin/Cybernetix, PACTEC: Reel Tri-State, PACTEC: Olympic, PACTEC: Ideal.

U.S. REQUIREMENTS VERSUS FOREIGN PERFORMANCE

A large majority of the EUROFAB work was performed outside of U.S. territorial waters under DCS's contract and resolution of several compatibility issues were made.

Examples include: 1) Flowdown of DOE orders for lead assembly fabrication in France - DCS's contract with DOE required adherence to the requirements of a large list of DOE orders. Many of theses orders have no applicability outside the United States. DCS put together a small team with legal help and reviewed the DCS applicable orders for applicability in France. A large percentage of the orders were eliminated through this review. DOE Chicago, in turn, performed a review of the resultant list; adjustments were made and the fabrication contract was awarded with a significantly reduced meaningful list for application to production operations in France. 2) Law - All contracts were written such that laws in the country in which the work was being performed were the laws applicable to the work of that contract. 3) Nuclear indemnification insurance - Price Anderson nuclear indemnification insurance was invoked by the DOE in the DCS contract for all activities; however, French law mandated that Paris Convention indemnification insurance be provided in France and on the high seas.

QUALITY ASSURANCE

DCS was structured such that FANP had responsibility for the fuel assembly design and certification. Additionally, FANP's QA program had been audited and approved by the NRC. FANP is partially an AREVA-owned company who is also the parent of COGEMA. When the competitive procurement for lead assembly fabrication was issued, it was determined to make the fabrication contractor adhere to the requirements of 10CFR 50 Appendix B so unfair advantage would not be provided to either of the bidders. Once the contract was awarded, FANP audited the fabricators' QA program and the fabricator was accepted as a qualified supplier to FANP, an agent of DCS. Throughout the fabrication process, FANP QA also performed several surveillance audits to ensure compliance with the quality requirements.

FANP also performed an audit of the Cogema Logistics QA program and the LANL QA programs and also accepted them as qualified suppliers. Cogema Logistics was responsible for the shipping casks for the lead assemblies and LANL was responsible for polishing the U.S. origin material.

COMMUNICATION

Based on numerous experiences in shipping PuO_2 and MOX fuels within Europe and to Japan, French and British public communication teams were involved and used a pro-active approach. The U.S. approach was to host a series of public meetings to address plutonium disposition issues and to be responsive to media inquiries during the Eurofab process. This difference, in part, is caused by the fact that the intervener groups in France are much more active and militant than in the U.S. These two different methods caused adjustments during the performance of EUROFAB.

Fig. 5. Shipping

These adjustments were essentially mitigated and managed by DOE's establishment of a communications action group and a weekly communications conference that brought together public relations representatives from all relevant agencies and the review of all press releases and material before issuance and by DOE having input on content and timing of releases.

Because of the wide publicity of EUROFAB, a special communication plan was developed at the beginning of the project. A coordination group led by DOE Headquarters with membership from COGEMA, BNFL, Duke Power, and the DCS EUROFAB team worked together to handle all communication issues for EUROFAB. The Duke Power/EUROFAB representative served as second chair

in coordination the work of the group. White papers on various related topics and questions and answers were developed, reviewed and approved by DOE and used as a common data base by everyone as the need arose.

EXCESS MATERIAL STORAGE SITE

On June 4, 2004, LANL was designated by DOE as the site for storage of the excess EUROFAB material. Just placing the two FS65s in storage is rather simple but when considering either the extraction of a few rods for post irradiation examination or removal of the material to the MFFF facility, the issues become quite complex very fast. Planning, tooling, support equipment and procedures were developed for the more complex work scope since the excess material storage site was selected late in the program.

EQUIPMENT DISPOSITION

To accomplish the EUROFAB project, it was necessary to buy or fabricate over 160 different pieces of equipment (casks, tooling, lifting beams, etc). This equipment was entered into the government property list maintained by DCS as it was purchased or fabricated. At the completion of EUROFAB, most of the equipment was no longer needed and was located in many different places according to its last use including La Hague, Melox, Cadarache, LANL, Aiken, U.S. Port, Duke Power, etc. An equipment disposition plan was put together to manage the equipment in accordance with DOE requirements.

CONCLUSION

Polished U.S. weapons grade $Pu0_2$ was loaded onto ships at Charleston, SC on September 20, 2004 bound for France. Pellet fabrication was initiated on October 12, 2004 and fabrication of the lead assemblies was completed on March 4, 2005. The lead assemblies were delivered at the U.S. mission reactor on April 28, 2005.

AREVA Business Unit Logistics provided all necessary transport equipment and expertise to realize all shipments of PuO_2 powder and MOX fuel assemblies. Based on its vast experience of nearly 200 shipments every year of PuO_2 and MOX fuels, AREVA Business Unit Logistics has developed reliable and proven solutions to implement with optimum safety and security requirements all complex and sensitive shipments. This international effort including over 23 different subcontracts for Cogema Logistics and its AREVA Business Unit Logistics partners was completed on schedule and within the initial budget for the best satisfaction of DCS and DOE. EUROFAB project is a major step for disposing of surplus weapon-grade plutonium and is a proven example of international transport of plutonium and MOX fuels.

Fig. 6. PuO2 arrival at Cherbourg port