

LAGUNA VERDE STATION APPROACH TO NUCLEAR WASTE

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ABSTRACT

México's first Nuclear Station Laguna Verde, consists of two BWR units and is operated by the Nation's Utility, Comisión Federal de Electricidad (CFE). Currently, Laguna Verde has adequate facilities for temporary storage of low level waste and spent fuel.

The purpose of this paper is to review the present status of radwaste handling and to discuss the approach and alternatives being considered by CFE, to manage long term storage of radwaste taking into account experiences in other countries and their applicability in México.

In the area of low level waste, in addition to the Radwaste Building original design storage area, an On-Site Radioactive Waste Storage Facility is in operation. However, CFE is committed to provide a final disposal facility by 1995. The location and type of facility is being evaluated. The convenience of building such a facility at the site is highlighted, provided the site feasibility can be confirmed. The immediate steps being taken by CFE are described and as part of this strategy, considerations for waste management in connection with future plants are also analyzed.

In the high level waste area, when Unit 1 started commercial operation, the spent fuel pool had a storage capacity for 8 to 10 years of operation. CFE seeked alternatives to increase this capacity in a safe and economical manner and reracking was selected as the best option for the Laguna Verde Station. Reracking has been performed in both Units and provides a 37 year storage capacity plus full core reserve. Even though this condition establishes a good time frame for a decision on final disposition of high level waste, the options available in this field are being evaluated now by CFE in order to develop a long term strategy. In this decision, it is recognized the influence of the potential expansion of the Mexican Nuclear Program.

It is concluded that the permanent storage of low level waste can be achieved in the near future at the Laguna Verde Site. In the high level waste disposal cycle, immediate actions are not required, however, site characterization studies are recommended considering the future need of final repository facilities.

In both cases, CFE keeps track of the research and development in the field of waste management and its potential application in México. CFE acknowledges the responsibility of operating the first Nuclear Station in México and has committed to maintain as a goal in Laguna Verde, safety and protection to the public and environment in the operation as well as in nuclear waste management.

INTRODUCTION

México's first Nuclear Station, Laguna Verde, consists of two General Electric BWR Units. Unit 1 started commercial operation in July 1990 and is scheduled for its third outage in October 1993. Unit 2 is in the start-up phase, scheduled for commercial operation during 1994.

The Nation's utility, Comisión Federal de Electricidad (CFE), as the Station operator, recognizes the importance of waste management in the nuclear industry and is committed to maintain as a goal, protection to the public and the environment, both in the station operation as well as in the waste management process.

Currently, Laguna Verde has adequate facilities for storing low level waste and spent fuel.

This paper begins reviewing such facilities and continues with the analysis of the alternatives to achieve an integral waste management in the mid and long term. These alternatives are analyzed not only in terms of their feasibility and applicability to the Laguna Verde Station but also in connection with the different scenarios for future plants in México.

In the first part, low level waste management is presented. Low level waste includes dry active waste (paper, gloves, clothes, plastic) and solidified or dewatered waste (chemical concentrates, spent resins and sludges).

In the second part, the management of high level waste is discussed, considering the spent fuel and highly irradiated components such as control rods and core detectors.

LOW LEVEL WASTE MANAGEMENT

In the Laguna Verde Station design, the Radwaste Building is shared by both units. Low level waste is collected, treated and packed for disposition in this building. The storage capacity covers two years of operation for one of the units. Unit 2 has a building to collect radwaste that is eventually transferred to the Radwaste Building for its reprocessing.

Since Unit 1 started commercial operation in 1990, it was necessary to build during 1991 a temporary On-Site Radioactive Waste Storage Facility.

Figure 1 presents an architectonic view of this facility which provides 1800 cubic meters of storage capacity for 5 years of operation of both units. It has a storage area for 208 liters drums containing dry active or solidified waste in bitumen or cement and another area to store 4 cubic meters high integrity containers (HIC's) with dewatered resins and sludges.

The storage areas are equipped with a closed T.V. circuit and remote control crane operation. Proper shielding, radiation monitoring, HVAC, Fire Protection and Liquid drainage systems are also included. At this point, the facility stores already the first drums and high integrity containers.

From Unit 1 fuel load to January 1993, the status of waste generated is as follows:

- Drums (208 lt)
 - 1331 compacted dry-active waste.

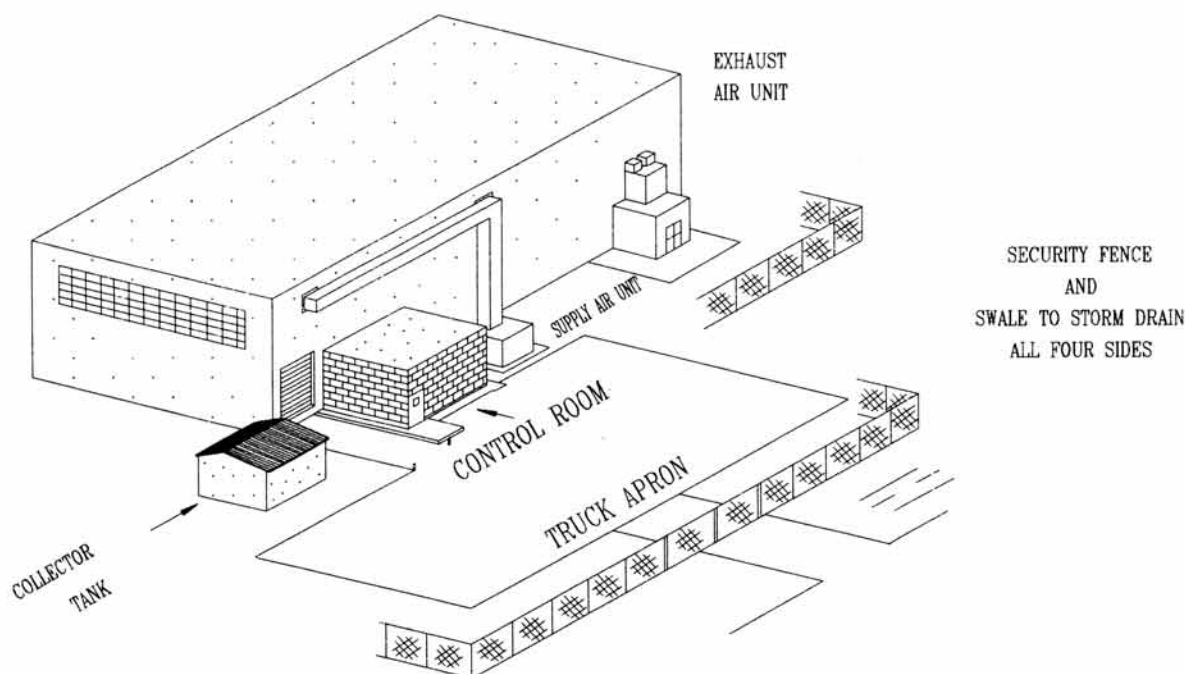


Fig. 1. On-site radioactive waste storage facility.

- 792 solidified waste in bitumen.
- 118 solidified waste in cement.
- High Integrity Containers (4 m³)
 - 36 dewatered sludges
 - 34 dewatered resins

Considering that Unit 2 is scheduled for commercial operation in 1994, this storage facility could be full by the year 1997. In addition, the Mexican Regulatory Body, Comisión Nacional de Seguridad Nuclear y Salvaguardias (CNSNS), has indicated that the temporary storage of low level waste must not exceed 5 years.

Therefore, it is required to have a permanent storage facility by 1995 and it is convenient to analyze alternatives used in other countries, and to evaluate their applicability for México.

Based on these conditions, it is necessary to define first, the location and then the type of facility for the Laguna Verde Station.

In regard to the location, it is extremely convenient the construction of a facility at the Station site, considering, among other factors, the infrastructure available, waste transportation and existing access control and protection at the Laguna Verde Station.

This is also advantageous from the public opinion point of view. The population around the plant has become familiar with the safety and control concepts that are essential in a Nuclear Station. In general, this is not the case in the rest of the country. If another location is selected, independently of the compliance with regulations for the facility design and the waste transportation, an interface with public opinion has to be anticipated around the new location and along the transportation route.

A facility at the site, could accomplish an integral solution to waste generated by Units 1 and 2, and potentially, to new units in the same site.

In regard to the type of facility, in Spain, France and the United States, there is a good experience with permanent storage facilities using above-ground or near surface structures.

One of these technologies, is the french concept of above-ground vaults with an earthen cover, known also as tumulus, in the storage centers of La Manche and L'Aube. This design is interesting for the Laguna Verde case considering its simplicity and the modular construction concept.

The conceptual design lies in the use of multiple barriers starting with the bitumen or cement matrix and the drum or container. It continues with the disposal structure for physical protection and control of water infiltration, and the final barrier is the geological site in which the structure is constructed. Figure 2 presents the concept of the tumulus, outlining the protection of the disposal modules during the filling operations, the stabilization process once the containers are in place, the construction and waterproofing of the cover and finally, once a group of modules are full, the protective earthen cover to be laid down. Rainwater is controlled through surface drainage and the module has a collection and monitoring system for infiltrated water through the disposal.

It is clear, that the operation of a permanent low level storage facility at the Laguna Verde site, requires as a first milestone the confirmation of the site suitability.

Several studies have been conducted in the areas of Geology, Geophysics and Hydrology, and a great deal of information is available. Results of resistivity explorations provide a good indication of site feasibility. However, additional studies are to be performed, to assure the structural stability and the proper understanding of the groundwater behavior in soil materials at the site.

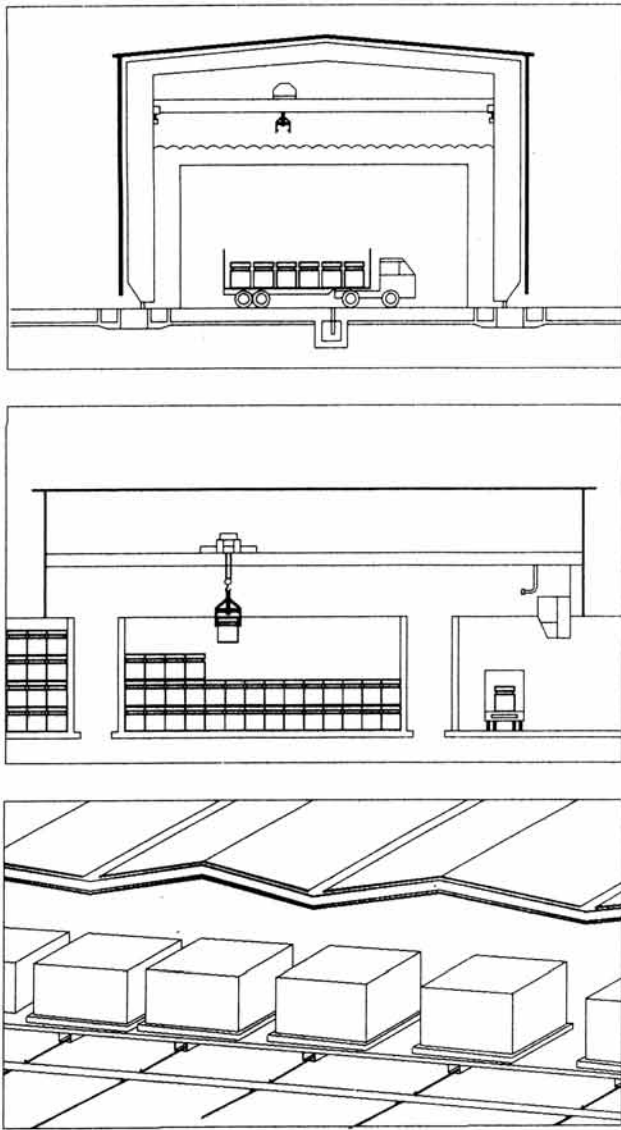


Fig. 2. Earthen cover vault concept.

Acknowledging the importance and the complexity of these studies, CFE requested support of the International Atomic Energy Agency and a mission was conducted in October 1992 to review work performed to characterize sites for low level waste repositories.

The mission indicated also the need of additional investigations to qualify or disqualify the Laguna Verde site as a repository. The principal activities recommended were to perform additional hydrological testing, to extend the piezometer network, to characterize the geochemical environment and to integrate the information into a hydrogeological performance model at the site. Present site workscope has been directed to address these recommendations.

In addition, an integral Low Level Waste Laguna Verde Feasibility Study has been initiated by CFE in December 1992, with the assistance of a french company. The study is intended to cover not only the site evaluation area but also the characterization and inventory of the radioactive waste, the safety rules and regulations, the engineering of the multiple barrier system, the facility layout, the operating plans and procedures and the final site closure procedures.

For the Laguna Verde Station, the accomplishment in the short term of an integral solution to low-level waste at the site, will depend on the results of the site studies and the feasibility study.

In regard to future plants, the National Energy Program outlines scenarios from 1600 to 5500 MW Nuclear by the year 2010. As indicated before, additional units at the Laguna Verde site could use the same permanent storage facility. Potentially, this facility could also be selected to store the low level waste of new nuclear plants in other locations, following the approach taken by France and Spain. These options remain to be considered in the future, pending confirmation of the site suitability of a low level repository at the Laguna Verde Station.

HIGH LEVEL WASTE MANAGEMENT

The original spent fuel pool of each of the Laguna Verde Units, considered initially a storage capacity of 580 fuel assemblies per unit that was increased to 1242, using high density racks that provided storage capacity for 8 to 10 years of operation. Figure 3 shows this configuration.

Comisión Federal de Electricidad (CFE) sought alternatives to increase the storage capacity in a safe and economical manner and a feasibility study was performed. This study included the analysis of the available technologies and their applicability in México, considering the safety and licensing aspects as well as the economics. Three alternatives were selected for further analysis, dry storage, high density poison racks and rod consolidation.

The installation of stainless steel racks using BORAL (Boron Carbide in an Aluminum Matrix) as neutron absorber, was selected. To support this decision, the feasibility study included a detailed structural capability analysis of the Reactor Building and additional studies covering the areas of plants operations, fuel pool cooling, nuclear criticality and nuclear shielding.

The storage capacity was increased to 3177 cells, providing the Laguna Verde Stations with 28 years storage capacity plus full core reserve for a standard burnup fuel cycle and a maximum of 37 years capacity plus full core reserve for the extended burnup fuel cycle. The present spent fuel pool arrangement is shown in Fig. 4. This arrangement considers provisions for storing control rods and in-core detectors.

Old racks were removed and the new racks were installed in the Unit 1 pool by June, 1991, before the first refueling outage, under dry and uncontaminated conditions. The Unit 2 racks were installed as part of the construction phase during November 1992.

This storage capacity, provides the Laguna Verde Station with time to prepare for an adequate high level waste final disposition.

This decision could consider the extent of México's Nuclear Program to be defined in the near future. As indicated before, the National Energy Program outlines scenarios between 1600 and 5500 MW with nuclear stations by the year 2010.

The decision in the mexican case, could benefit from the experience of proven technologies and/or technologies being implemented. The decision could also consider the technologies to be developed as a result of the research being conducted in this field.

Among the proven alternatives, with experience in countries such as France and England, reprocessing has to be

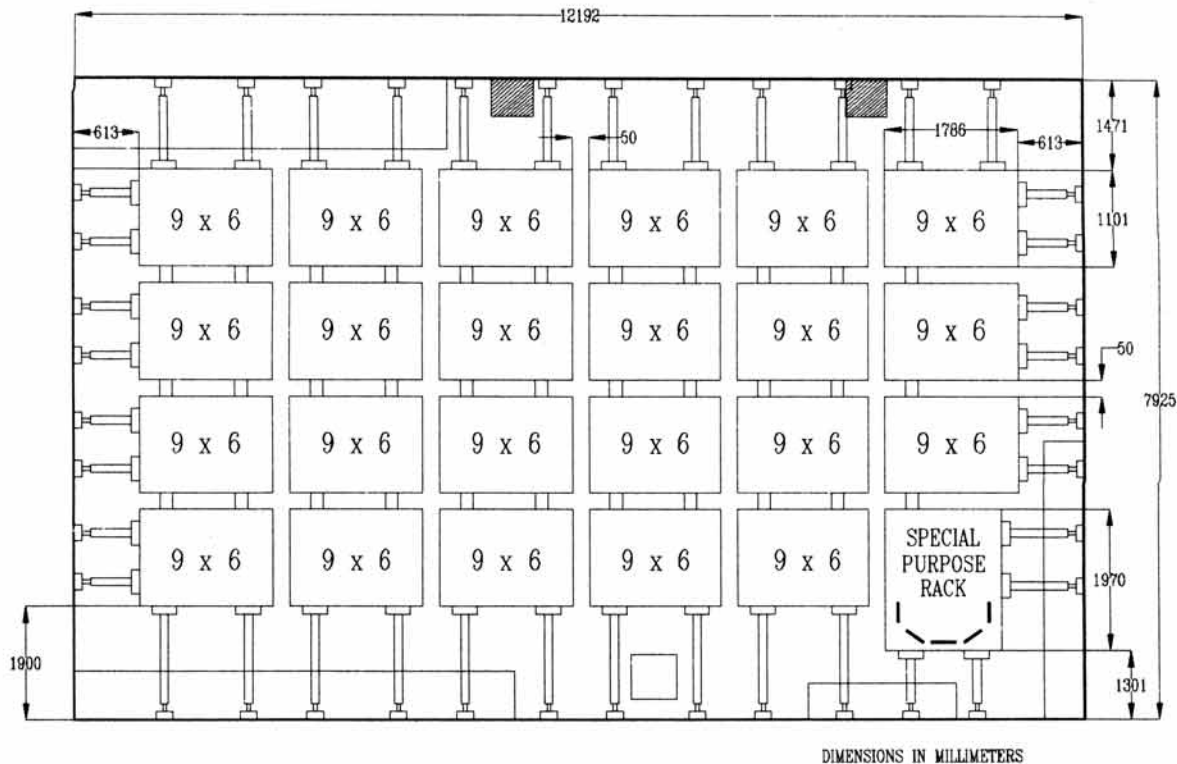


Fig. 3. Original fuel pool arrangement.

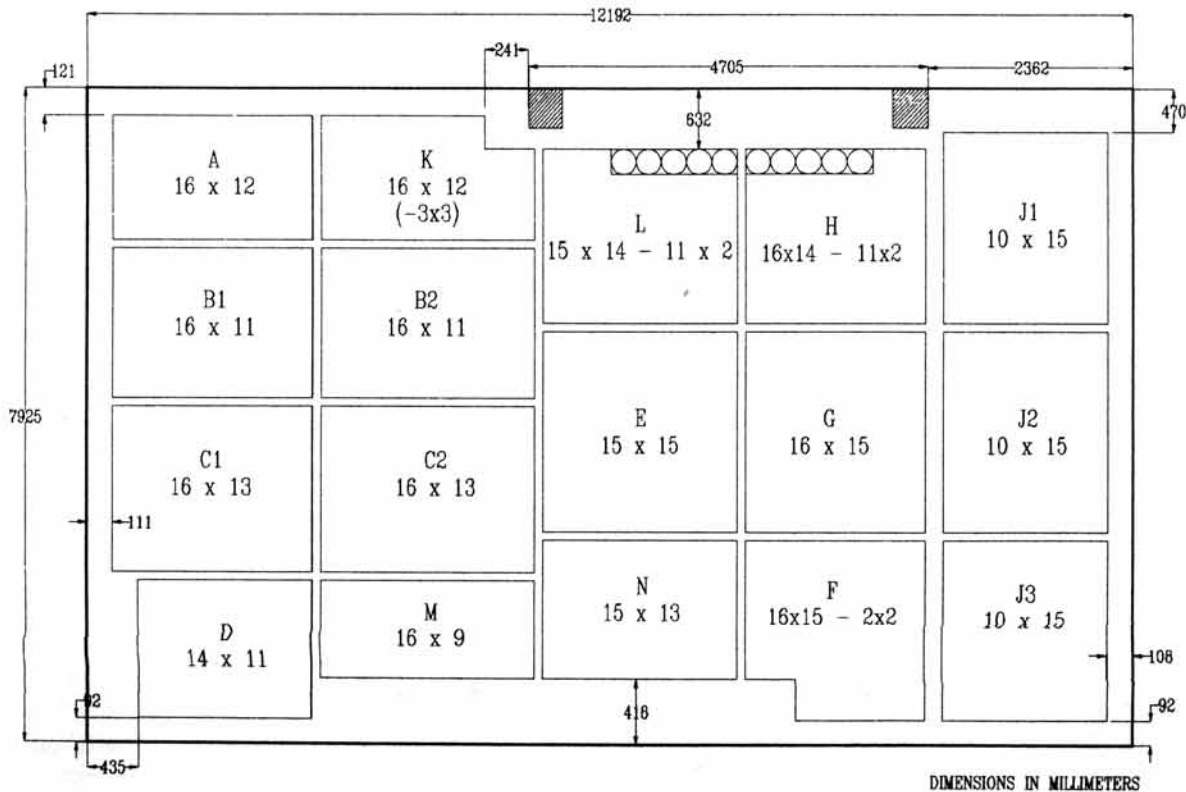


Fig. 4. Pool layout for Laguna Verde Unit 1.

considered. This alternative allows the recovery of valuable energy resources to be used in new fuel fabrication and reduces the amount of waste for final disposition.

For the Laguna Verde Station this technology is readily available throughout a contract with a reprocessing facility. In case of a European facility, transportation by ship with proper containers is available. Facilities in México, for final disposition of recovered high level waste are to be considered under this option.

Another alternative for spent fuel, is the storage in geologically stable formations. Several countries are seriously following this approach even though no site has been confirmed yet. The closest dates for the operation of this type of facility are 2008 in the case of Germany and 2010 for France and the United States.

It is clear that the design of this facility, as a combination of natural and engineered barriers, is highly complex and imposes on the Engineering the challenge to guarantee for future generations, a safe performance for hundreds of years. This challenge justifies the extensive field and laboratory research in the site characterization process.

In the Laguna Verde case, mid term storage of spent fuel is under control, however the process of site characterization, structural design and licensing of an underground repository should be observed in those countries following this option.

In addition, considering the extent of a site characterization process, it is convenient to begin the search inside the country for potential locations of a repository. In principle, desertic areas with geological stability and depth of water table are preliminary identified in the northern part of México.

Another alternative for the Laguna Verde case, is spent fuel storage in pools as approached by Sweden. However, these pools can be considered as interim storage and are built when the plant pool has been saturated.

Other interim storage options to be considered are the dry storage and rod consolidation. For the Laguna Verde Station, these alternatives should be considered complementary with the present spent fuel storage, in the event that additional capacity is required, for example, as a result of life extension.

In the economics, a good reference on cost exists for the different alternatives described herein, with the exception of the repository which will be known as the design and studies are completed. It is clear that when the time comes, an economical evaluation of the different alternatives will be influenced by specific parameters such as the quantity of spent fuel

to be stored, the location of the facility and the design of the selected storage system.

As indicated before, in the long term, the Laguna Verde Station high level waste management is closely related to the scenarios of future Nuclear Plants in México. Reprocessing is an available option. A decision on a repository can not be taken at this point. Nevertheless, it is convenient to initiate site selection and characterization studies in the near future.

SUMMARY AND CONCLUSIONS

Nuclear Waste Management is currently playing a major role in the nuclear industry.

In this regard, CFE acknowledges that the design and maintenance of a successful nuclear program has to consider, in addition to the safe operation of the plants, an adequate strategy for the radwaste handling and disposition.

The technology in this field is available and allows to complete, in a responsible manner, the fuel cycle.

The Laguna Verde Station design provides facilities for the storage of low and high level waste, however a mid and long term strategy needs to be developed.

In the case of low level waste, it is recognized the importance of the initial characterization and the convenience of having a permanent storage facility at the site. Earthen cover vaults are a proven alternative to be considered in the Laguna Verde Station.

Provided the site suitability can be confirmed in the near future, an integral low level waste management can be obtained with the installation of a permanent storage facility at the site.

In regard to the high level waste, it is an advantage to have in both Laguna Verde units, a spent fuel storage capacity for the plant design life. Reprocessing is identified as a proven technique and the underground final repositories as an alternative being implemented, where the site characterization studies play an important role and should be initiated. Another important factor to be considered is the definition of a Nuclear Program for México.

It is concluded that the available mid term spent fuel storage, provides the Laguna Verde Station with time to develop an integral long term strategy.

In the Nuclear Waste Management cycle, Laguna Verde Station works following the approach outlined in this paper. Comisión Federal de Electricidad acknowledges the responsibility of operating the first Nuclear Station in México and maintains as a goal, the safety and protection to the public and the environment throughout the complete cycle of nuclear energy use.