EXPANDING THE STORAGE CAPABILITY AT ET-RR-1 RESEARCH REACTOR AT INSHASS

A. Mariy M Sultan & M. Khattab
Reactors Department Nuclear Research Center
Cairo, Egypt

ABSTRACT

Storing of spent fuel from Test Reactor in developing countries has become a big dilemma for the following reasons:

- The transportation of spent fuel is very expensive.
- There are no reprocessing plants in most developing countries.
- The expanding of existing storage facilities in reactor building require experience that most of developing countries lack.
- Some political motivations from Nuclear Developed countries intervene which makes the transportation procedures and logistics to those countries difficult.

This paper gives the conceptual design of a new spent fuel storage now under construction at Inshass research reactor (ET-RR-1). The location of the new storage facility is chosen to be within the premises of the reactor facility so that both reactor and the new storage are one Material Balance Area.

The paper also proposes some ideas that can enhance the transportation and storage of spent fuel of test reactors, such as:

- Intensifying the role of IAEA in helping countries to get rid of the spent fuel.
- The initiation of regional spent fuel storage facilities in some developing countries.

INTRODUCTION

Developing countries face the problem of getting rid of the spent fuel from their research reactors. When this spent fuel is under international safeguards it was thought that this problem could be solved easily with the help of international organizations, but the problem in fact remains difficult as such. Ways of solving the problem of accumulation of spent fuel from research reactors in developing countries can be:

- Transportation of fuel outsides the country,
- Reprocessing of spent fuel, or,
- Expanding the capacity of existing storage facilities in reactor building.

Developing countries find it difficult, perhaps not feasible to build or procure reprocessing facilities. Besides the fact these facilities are expensive, the reprocessing of fuel imply other problems such as getting rid of fission products and generally radiation hazardous materials.

The transportation of spent fuel from developing countries to other countries having reprocessing plants or big storage facilities is very expensive and the cost of transportation may exceed the value of the transported fuel.

Political motivations sometimes intervene which makes the procedures and logistics for the transportation or reprocessing of spent fuel in developing countries really difficult.

Expanding the storage capacity of spent fuel at the reactor site is by far the most feasible and quick solution of the problem. However, increasing the storage capacity for spent fuel require experience that most of developing countries lack.

This paper gives an insight of how the reactor department at Inshass Nuclear Research Center solved the problem of accumulation of spent fuel from ET-RR- 1 research reactor.

In 1997 a contract was signed between KFKI in Budapest, Hungary to design and construct, in collaboration with the Egyptian Reactors Department, a new spent fuel storage facility to be built within the premises of the research reactor. The fulfillment of such a project is a manifestation of cooperation between Egypt and Hungary in constructing such a storage facility.

The paper proposes also some ideas that can enhance the transportation and storage of spent fuel of test reactors in developing countries.

THE NEW SPENT FUEL STORAGE FACILITY AT ET-RR-L RESEARCH REACTOR

This section describes briefly the conceptual design of the new storage facility at the ET-RR-l reactor, and reviews the engineering safety features of the storage facility.

Design Concept:

Since the start of operation of ETRR-1 test reactor in 1961 the spent fuel was stored in the old storage affiliated with the reactor facility. Nearly after forty years the problem of accumulated spent fuel became serious and a new storage had to be built. It was decided to construct a new fuel storage facility (NSF) to be within the premises of the reactor facility and as close as possible to the old storage. Figures 1 & 2 show the location and the layout arrangement of NFS. The design concept justifies simple and safe handling of the transporting cask during loading from old storage, during unloading in the NFS and also during shipment of spent fuel outside the ETRR- 1 reactor facility.

The design concept takes into consideration the accommodation of all inventory of fuel of the type (EK- 10) owned by the operator. Provisions are made in the design to accommodate also in future spent fuel of enrichment up to 20%. The total capacity of the fuel storage is for 176 fuel bundles. The storage grid lattice is a square array with pitch of 180 mm. This maintains enough subcriticality in the storage system (Keff > 0.95).

The new fuel storage tank is illustrated in Fig. 3. It consists of a double layer stainless steel tank with a 15 mm. air gap between the layers. The stainless steel is of type 316L, thickness 8 mm. for the outer layer and 4 mm. for the inner layer. The inner layer acts as liner of a less permeable ordinary concrete structure of thickness 950mm. The height of the tank is 4,3 meters. The demineralised Water volume is 30 m3. The storage tank is covered with concrete slabs, cask harbor and handling.

Engineering Safety Features

All materials in contact with the pool water are compatible with the pool water or effectively protected against undue degradation or corrosion.

Service water supply system

The function of the system is to provide water for the initial filling and make-up water of the storage tank. The service water makeup is carried out from the feed water tanks located in the Reactor Hall. Emergency feed is done from the demineralised water line, located in the demineraliser room. If the water level reaches the low-level limit, the replenishing of the Tank is started automatically. The filling of the tank continues until the level regulator switches replenishing off. Minimum and maximum water levels in the storage tank are 3700 mm and 3930 mm respectively. The storage tank, the storage tank pit and the pump pit are drained into the special drainage that guides the active water to the septic tank, located in the yard, as shown Fig. 1.

The design includes the capability to purify the pool water. A mobile ion exchange unit located next to the pump pit can be linked to the water circulating system. The Flow Chart of the technological water Supply System is illustrated in Fig.4.

Water quality control

The objective of water quality control is to maintain the conditions that minimize the corrosion of spent fuel and the pool components, control concentration of radioisotopes in the storage water and guarantee the clarity of storage water.

The parameters considered for monitoring to minimize the risks of cladding degradation are: pH, conductivity, chemical composition, and activity of water. Maintaining these parameters within prescribed limits, there is no foreseeable degradation process that will cause unacceptable cladding failure.

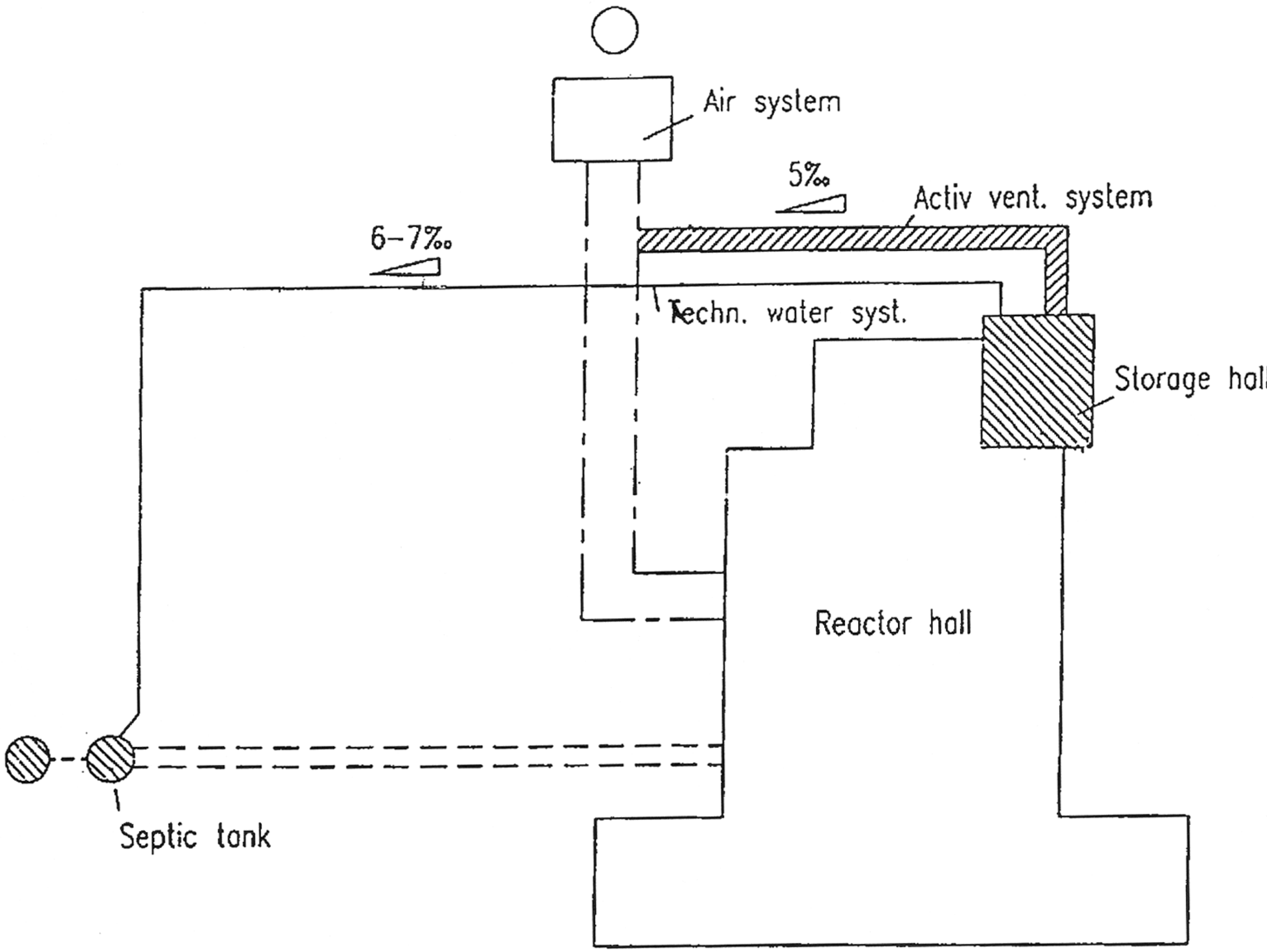

Figure 1: General Plan

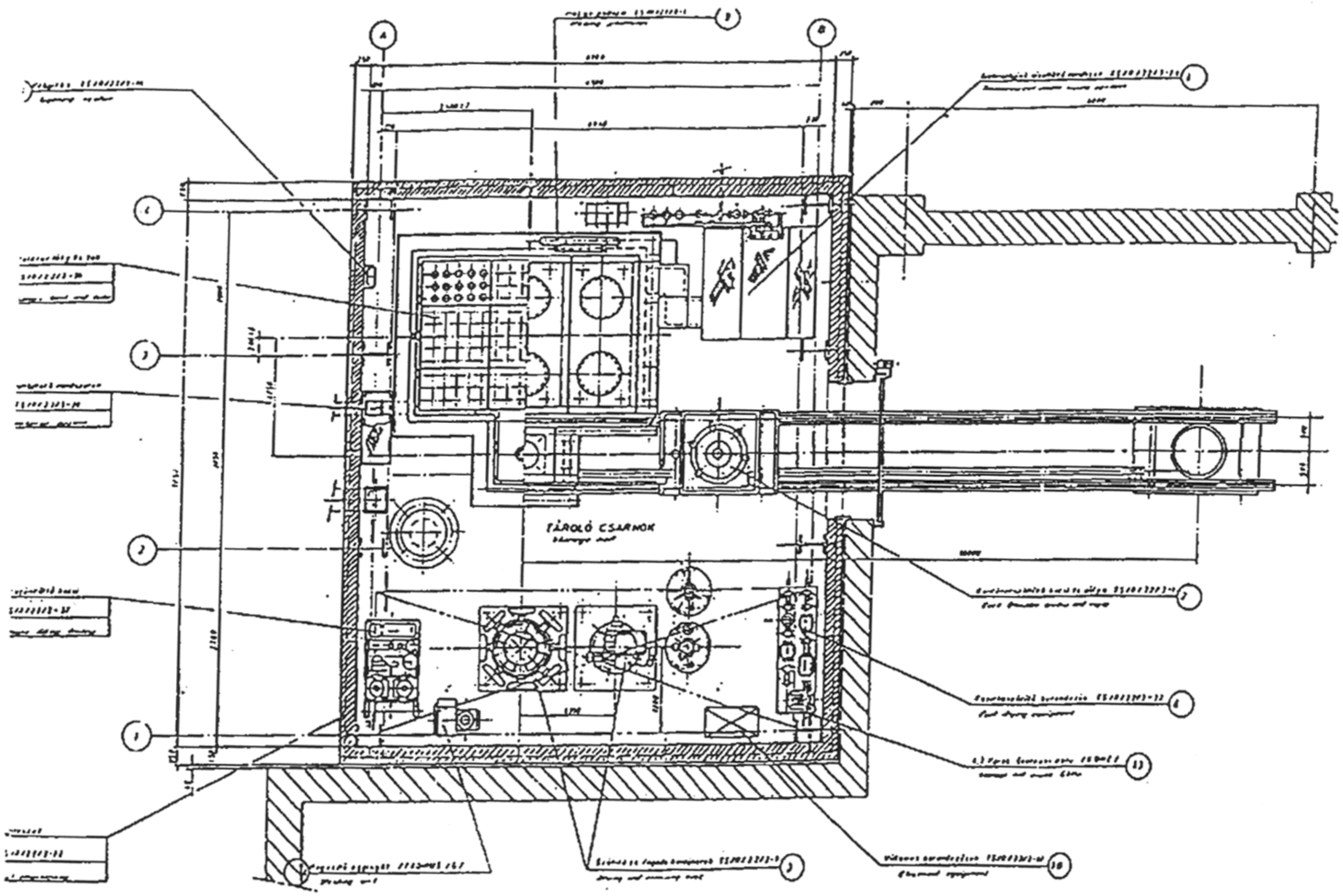

Figure 2 General arrangement of the NSF

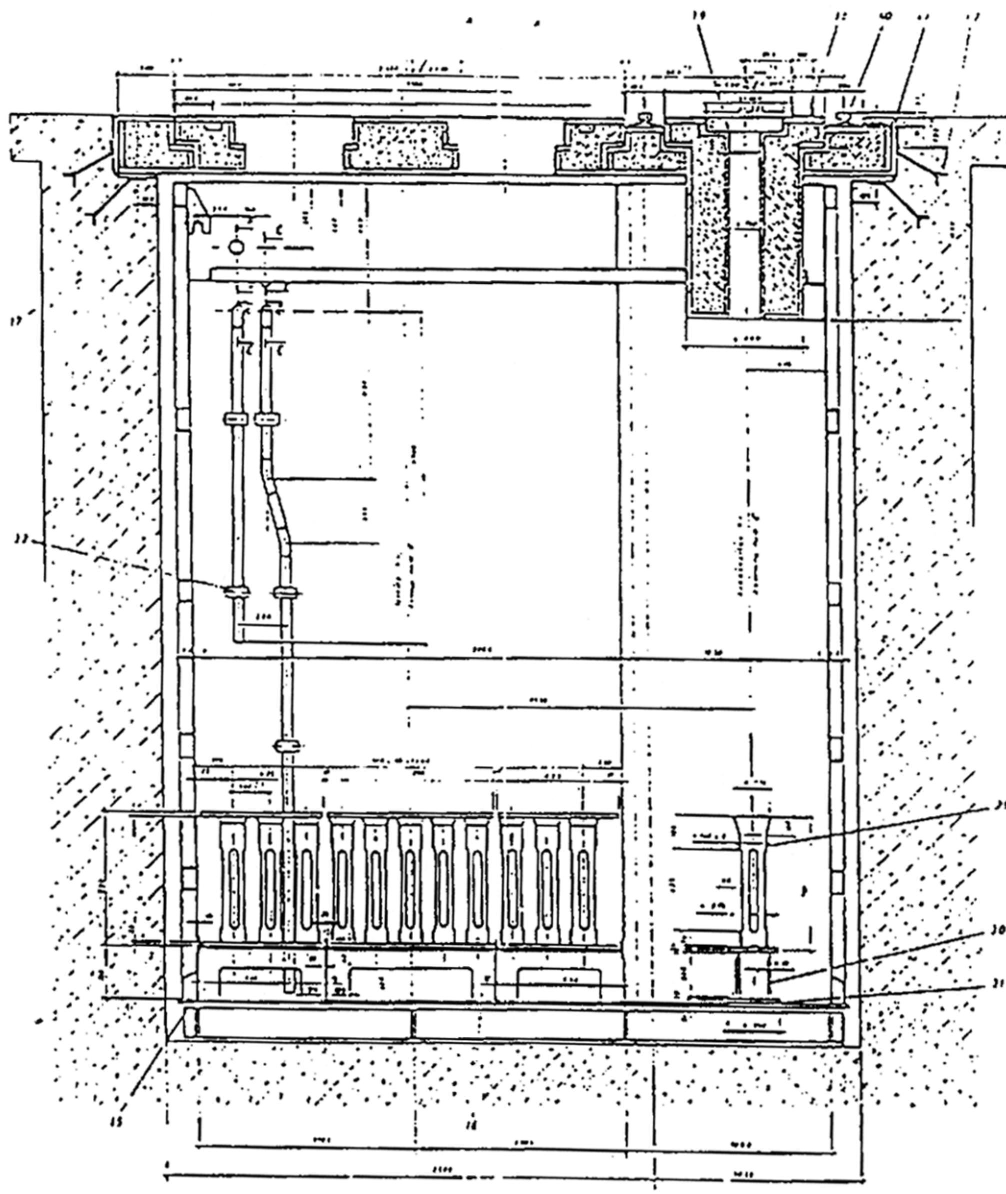

Figure 3 Storage Tank

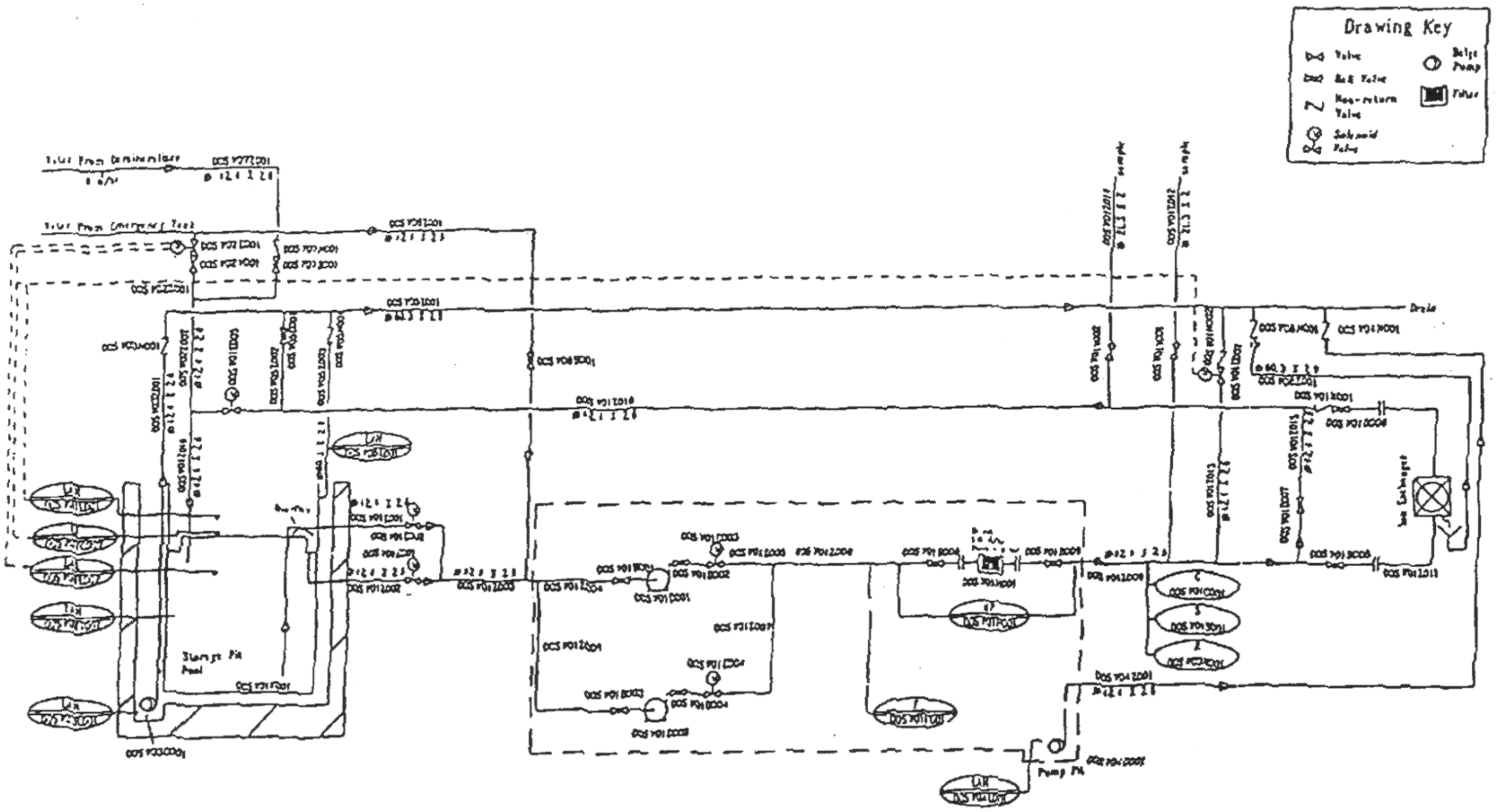

Figure 4 Technological water Supply System

Ventilation system

The main goals of the ventilation system:

- To provide fresh air to the Storage Hall, with temperature and humidity equal to the air in the Reactor Hall.
- To remove the air which can be contaminated from the Storage Hall and the space of the Storage Tank.
- To prevent spreading of possibly contaminated air from the technological systems of the Storage Hall.
- Cooling of pool surface

The exhaust system of the Storage Hall primarily ensures the exhaust from the Storage Hall. The storage Hall air supply system ensures air replacement of the Storage Tank air volume.

The exhaust system of the Storage Tank ensures air exhaust from the storage pool. An air sampling stub fitted with ball valve is available on the line . All the three systems are running in continuous operation.

The Flow Chart of the Storage Hall and Storage Tank ventilation system is shown on Fig. 5.

Fig. 6 illustrates the storage hall cross section. The double ceiling of the hall provides natural circulation of air in the roof in order to maintain comfortable ambient temperature inside the hail. An overhead crane of 6.3 tons capacity is mounted in the hall for transportation services.

Storage Hall exhaust system:
Air volume exhausted: 1650 m3/h
Air volume replaced: 3.6 air change/h
Depression 50 pa
Air replacement system:
Air volume injected: 2407 m3/h
Storage tank exhaust
Volume exhausted 1048 m3/h
Exchange of the air volume in the Tank: 68 air change/h
Depression of the closed Storage Tank: 70 mm Pa
Fuel handling systems

For safe transfer of fuel, the NSF facility is provided with Fuel Handling Systems and Tools including:

- Cask Transfer Trolley
- Drying system (including the transfer I Drying Cask)
- Reception Cask
- Mobile platform
- Overhead crane, 6.3 Mp

The iron mass of the cask has very great heat stability, therefore we can consider that the cask has a constant temperature, within the ambient temperature. The fuel and canning procedure is presented in Fig. 7.

Heat Removal

Passive cooling cools the fuel assemblies stored within the storage tank. The heat removal is ensured by water that also provides biological protection for the operators. The pool heat capacity is such that the temperatures of all fuel cladding, cooling media and constructional materials in the NSF do not exceed the maximum temperatures for the type and condition of the fuel to be stored.

The design of the storage structure and the preliminary cooling period of the fuel assemblies, unloaded from the reactor into the old storage, facility (OSF), make it possible to rely only on self cooling of the system, without using any forced circulation system.

Also, it is possible to put some spent fuel assemblies in the NSF, having shorter cooling time. In determining the heat removal capability of the system, the post-irradiation cooling interval and the burnup of the fuel to be stored are considered.

CONCLUSION

The objective of the present paper was stated to be the increasing of the storage capacity at ET-RR- 1 research reactor in Egypt. The paper illustrated how this problem was solved in this reactor of BBP-s type which was build in many countries other than Egypt. The idea of building such facility is considered cost effective here from the point of view of extended lifetime of the reactor. This is not in fact the end of the scenario. After some years another stage for getting rid of spent fuel at ET-RR-1 reactor should begin, namely, the encapsulation and transportation of spent fuel elements to somewhere else, perhaps to a dry storage which should be built outside the reactor area. Some problems may arise in other developing countries, which makes the cost of storage of spent fuel exhaustive. For this reason international cooperation is essential and in that respect the following can be proposed:

- The IAEA should play an active role in solving the problem of transportation and storage of spent fuel in developing countries, through the implementation of the safety guides issued by the IAEA and the technical and financial assistance. The experience and financial support of IAEA is indispensable in some developing countries.
- The initiation of Regional Spent Fuel Storage Facility is a fair idea, which can be adopted by IAEA. In fact this is essential in case of accumulation of large amounts of spent fuel from developing countries.

The above mentioned proposals would in fact secure the required safety aspects as well as the safeguards of spent fuel from developing countries.

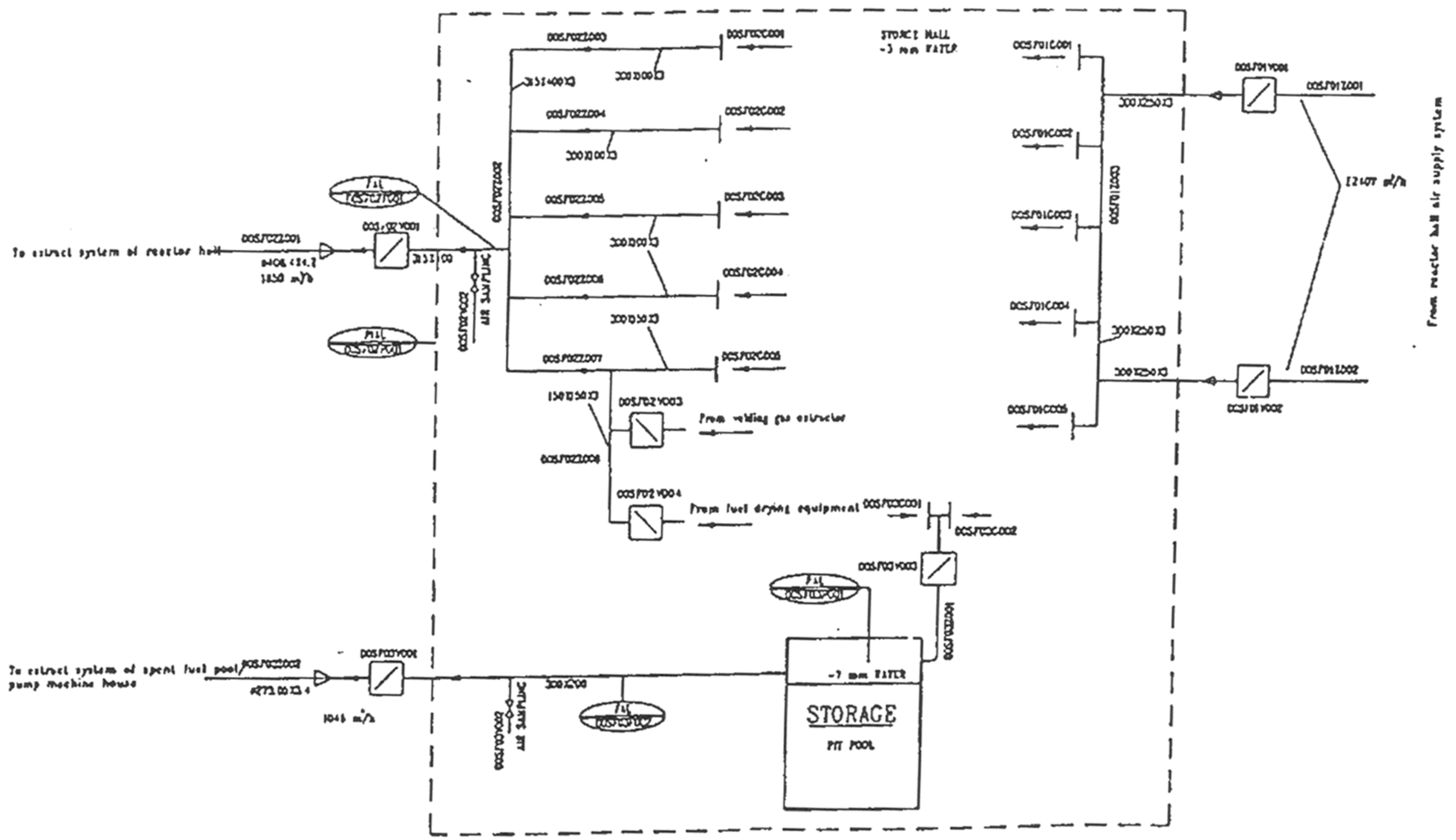

Figure 5 Storage Hall and Storage Tank Ventilation System

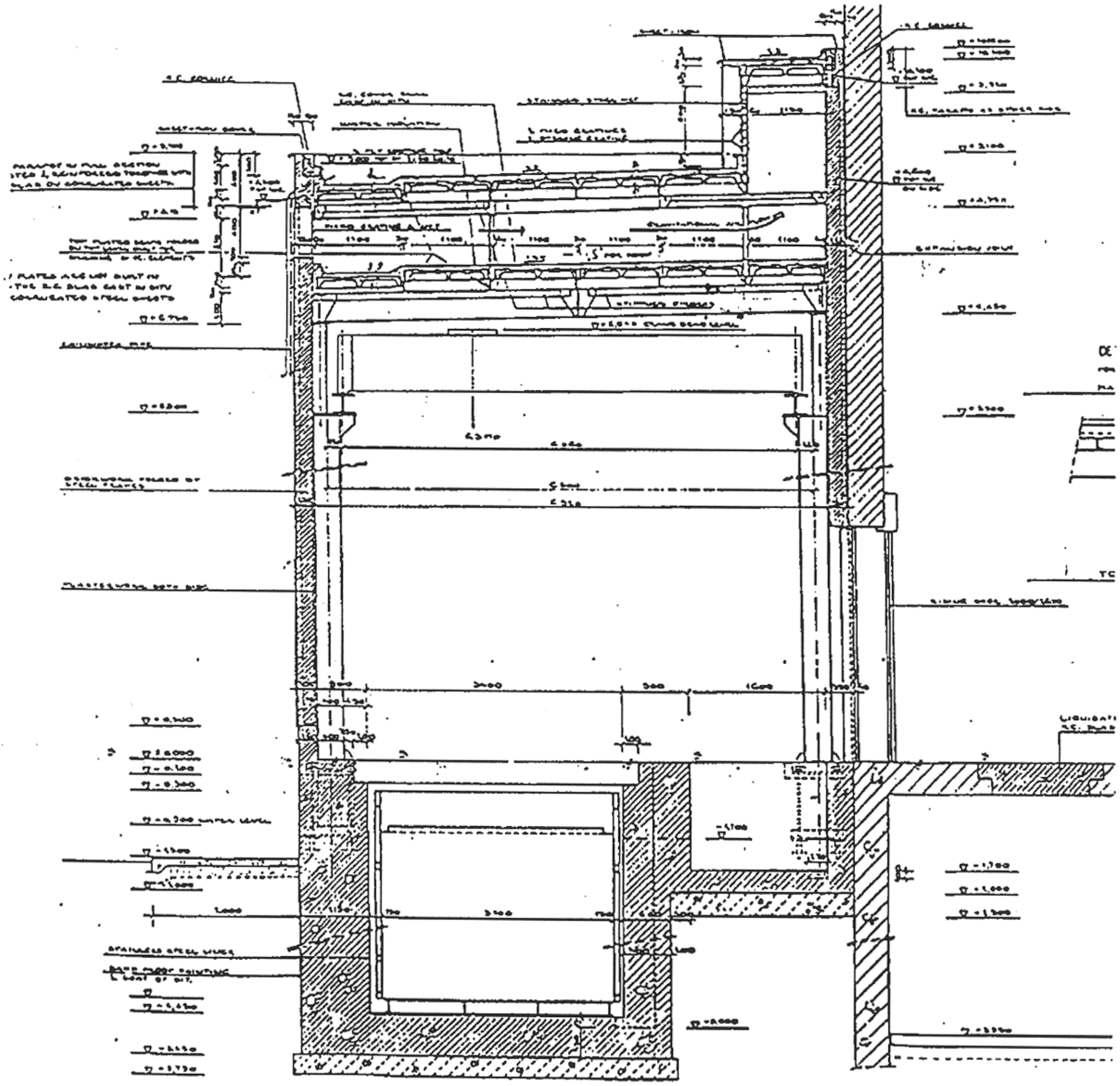

Figure 6   Storage Hall Cross-Section

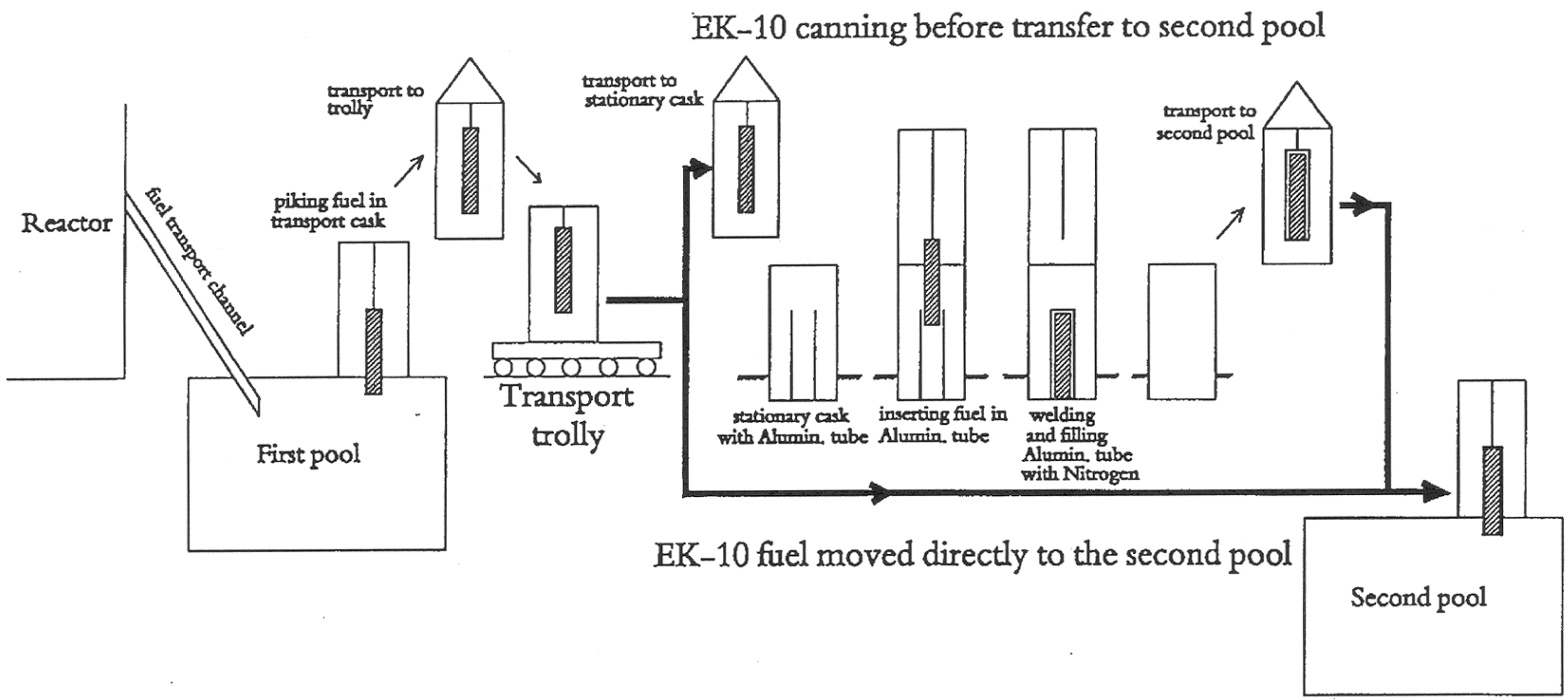

Fig. 7 Fuel Canning System