1. INTRODUCTION

Four VVER-440/213 type reactors operate in the Paks Nuclear Power Plant. The original nominal power of these Russian VVER reactors was 440 MW. This value has been increased for today due to some modifications. Presently the rated power of Paks units is 470 MW and a total nominal electrical power of 1860 MW. This amounts to about 40% of Hungary’s electrical energy production.

The original arrangements for dealing with the spent fuel from these reactors, which depended upon an understanding with the Soviet Union concerning the use of its facilities, were called into question by the political developments taking place in that country. As a result, Hungary wished to pursue a disposal policy for its spent nuclear fuel which provides options which are independent of the facilities of any other single country.

The management of the Paks NPP had decided to establish a dry storage system which could store spent fuel for a minimum 50 years and which would enable the selection the fuel cycle back end option to be postponed (reprocessing vs direct disposal) on the basis of the investigation made during 1991 and 1992, and of the evaluation of different commercial proposals, the final decision of the Paks’s management was to choose the GEC ALSTHOM’s Modular Vault Dry Store (MVDS) system.

The MVDS system is used for interim storage of VVER – 440 reactor fuel assemblies and followers on the owner controlled property at the Paks NPP site.
The technology

The fuel assemblies are transported to the MVDS from the on-site reactor pool using a transfer cask. The transfer cask is received in the Transfer Cask Reception Building (TCRB) where it is removed from its transporter and prepared for fuel assembly unloading. The fuel is raised into a drying tube directly above the cask where the fuel assembly is dried prior to being lifted into the fuel handling machine. The fuel assemblies are transferred, via the fuel handling machine, to the vertical fuel storage tubes in the vaults.

The fuel assemblies are stored vertically in individual fuel storage tubes (FST), the matrix of storage tubes being housed within a concrete vault module that provides shielding. The fuel assemblies are maintained in inert atmosphere inside the storage tubes. Decay heat is removed by a once – through buoyancy driven ambient air cooling system, the air flowing across the exterior of the fuel storage tubes which contain the irradiated fuel assemblies. There is no direct contact between the fuel assemblies and the cooling air flow.

2. GENERAL DESCRIPTION

The complete storage facility consists of three main area:

- **The Transfer Cask Reception Building (TCRB)**, where spent fuel received and despatched
- **The charge hall**, where spent fuel is transported from TCRB to the vaults by the Fuel Handling Machine
- **The storage modules (vaults)**, where spent fuel is stored
Transfer Cask Reception Building

The TCRB is an independent but interlinked part of the structure. The building adjoins the first vault module and provides the fuel transfer cask handling and service facilities. Routine movement of the transfer cask is by conventional means of operation using the existing rail system extended between the station and the storage facility. The TCRB is designed to accept the C30 spent fuel transfer cask in standard form containing up to a maximum of 30 fuel assemblies or followers.

The railway bogie is positioned beneath the TC crane structure, where the cask is removed using a lifting beam, and lowered onto the transfer trolley. The transfer cask preparation area houses the transfer cask degassing and lid unbolting station. The platforms at this station also allow operators access to the transfer cask lifting trunnion while the transfer cask is seated on the transfer cask trolley. The fuel drying and unloading cave houses two operation stations which are required to facilitate the routine movement of fuel assemblies:

1 – Railway bogie  
2 – Transfer Cask crane  
3 – Transfer Cask preparation area  
4 – Cask transfer trolley  
5 – Transfer Cask  
6 – Fuel drying and unloading cave  
7 – Steel roller shutter door  
8 – Transfer Cask lid removal station  
9 – Cask Load/Unload Port  
10 – Drying tube  
11 – FHM maintenance cave  
12 – Charge hall  
13 – FHM rail  
14 – Vault module  
15 – Storage Tubes  
16 – Air inlet labyrinths  
17 – Outlet stacks  
18 – Fuel Handling Machine
- Transfer cask lid removal
- Cask load /unload port

The fuel drying and unloading cave is closed off from the transfer cask preparation area by a steel roller shutter door. During fuel handling operations in the unloading cave personnel are prevented from access to the preparation area by a locked door. The operations are monitored using the CCTV equipment provided.

The fuel drying and unloading cave is maintained at a small negative pressure, relative to the outside atmosphere, by a filtered ventilation extraction system.

**The charge hall**

A clad, lean-to, steel roof structure is provided to afford weather protection to the FHM and charge face structure. It is supported on one side by the outlet stacks and on the other by steel columns founded on the vault walls. This enclosed area is known as the charge hall. The outlet stacks are surmounted by a steel framed canopy and spoilers to improve airflow and to prevent the ingress of snow, rain, debris, birds, etc.
Vault module

The structure, generally constructed from reinforced concrete, provides the rigid box type vaults for the interim storage of the fuel assemblies. The vaults are completed with integral outlet stacks and air-inlet labyrinths to allow the controlled flow of cooling air through the vaults. The structure is designed to be constructed in three phases. Phase 1 being the TCRB and 3 vaults, Phases 2 & 3 being 4 vault extensions. These structures are designed to be independent of each other to alleviate the effects of settlement and seismic movement.

The roof of each vault is provided by the charge face structure, a concrete filled carbon steel box, which provides access and lateral support for the storage tubes.

Fuel storage tubes

Each FST is sized to hold one irradiated fuel assembly or follower assembly. The FST with its shield plug and connecting nitrogen services provides the confinement boundary for the fuel assembly. The normal operating environment inside the FST is dry nitrogen gas.

The FST is fabricated from three basic components, top ring, body and base. All components are carbon steel. The top ring has a feature for the gas monitoring connection. Exterior surfaces the FST are protected from atmospheric corrosion by an aluminium spray coating. Internal surfaces are protected with self-etching primer.
Arrangement of the Fuel Storage Tube and Shield Plug

- Charge face
- Shield plug
- Fuel storage
- Support plate
- Spent
- Metal filter
- Sealable gas
- Lifting pin
- Service valve
- Support plate with guide pin

Dimensions:
- 140
- 1000
- 3217
- 296

Technical section

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3. CONCLUSION

The MVDS provides 4950 store positions carried out in three phases. These 11 vault modules can accommodate 10 years’ spent nuclear fuel of Paks NPP. The storage facility has been filled up with 3497 spent fuel assemblies up to the present.

Provision was made in the design to extend the MVDS to a total of 33 vaults (14850 storage positions) covering thirty years of station operation.

**Modifications for the further enlargement**

The array of storage tubes in the charge face structure will be modified. Instead of the triangular pitch pattern the tubes will be arranged in a square pitch. This will enable each vault to contain 527 storage tubes instead of 450 within the same area.

The storage tube seal integrity monitoring system, which was previously continuously supplied with nitrogen, will be simplified by coupling together the storage tube seal interspaces.

The rubber O-ring sealing of the storage tube plug will be replaced by double metallic seal rings.

Conditions for the storage of the hermetic fuel assemblies and fuel assemblies from the research and training reactors will be assessed.