FUEL TRANSFER CASK CONCEPTUAL DESIGN FOR REACTOR TRIGA PUSPATI (RTP)

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ABSTRACT

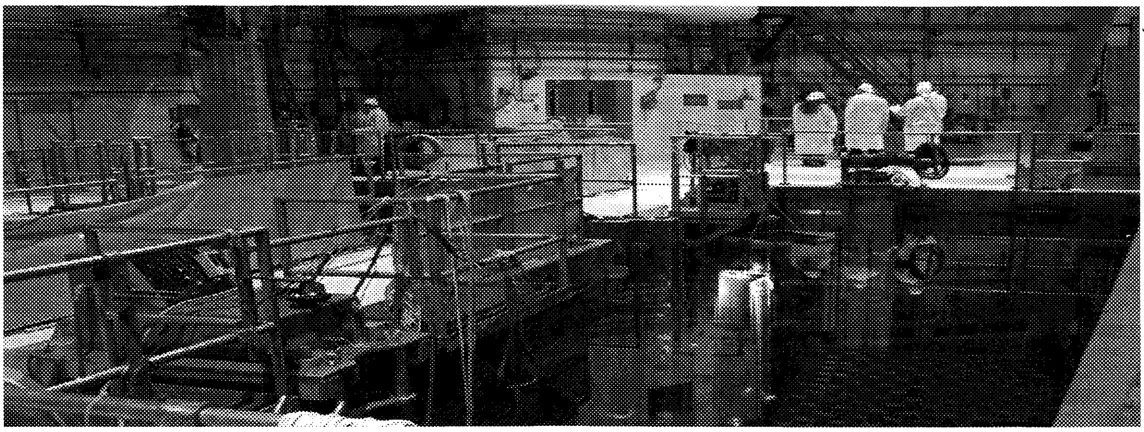
Reactor TRIGA PUSPATI (RTP) has been operated since 1982 till now. For such a long period, the organization feels the need to upgrade the power from 1 Megawatt to 3 Megawatt which involved changing new fuels. Spent fuels will be stored in a Spent Fuel Pool. The process of transferring spent fuels into Spent Fuel Pool required a fuel transfer cask. This paper discusses the design concept for the fuel transfer cask which is essential equipment for reactor upgrading mission.

Keyword: Fuel Transfer Cask

1. INTRODUCTION

The only one research reactor in Malaysia, PUSPATI TRIGA Mark II was first operated in July 1982 with the capacity of 1 Megawatt. It has been operated more than 20 years until now and has provided irradiation facilities safely. Nowadays, the increasing demand for irradiated samples for higher flux and power require RTP to be upgraded from 1 Megawatt to 3 Megawatt to provide better irradiation facilities for customers.

One of the main steps in the RTP upgrading involve with replacing spent fuels with fresh fuels to meet the 3 Megawatt capacities. The current core filled with spent fuels must be emptied before fresh fuels take in place. The spent fuels will be transferred from current reactor core into spent fuel pool using fuel transfer cask to provide a safe transfer operation. This paper will discuss the design concept of fuel transfer cask.



Example of Spent Fuel Pool at Carso Nuclear Power Plant

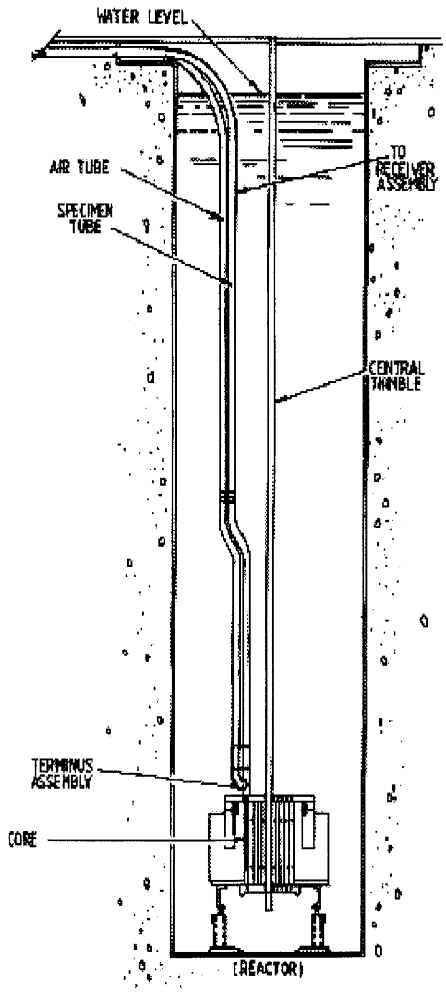
2. METHOD AND DESIGN CONSIDERATION

Since this is a design concept transfer cask, this paper illustrates more on what possible features or profiles are needed in the design using Autodesk Inventor Professional 2010. Three main criteria are being used as guidance in the process of making the design concept.

First, the design should not have continuous straight path opening or hollow from the spent fuel to outside of the cask. It is understand that radiation travels in a straight path. Every opening or hollow from the source must have step profile or barrier so that radiation from the spent fuel can be shielded.

It is also crucial to determine the methods on how the spent fuels will be transferred into the cask easily and safely. As the longer time the process of transferring the spent fuels into the cask takes time, more radiation will be exposed to the operator. Therefore, the proposed casks are designed so that the process of transferring spent fuel can be fast and secure.

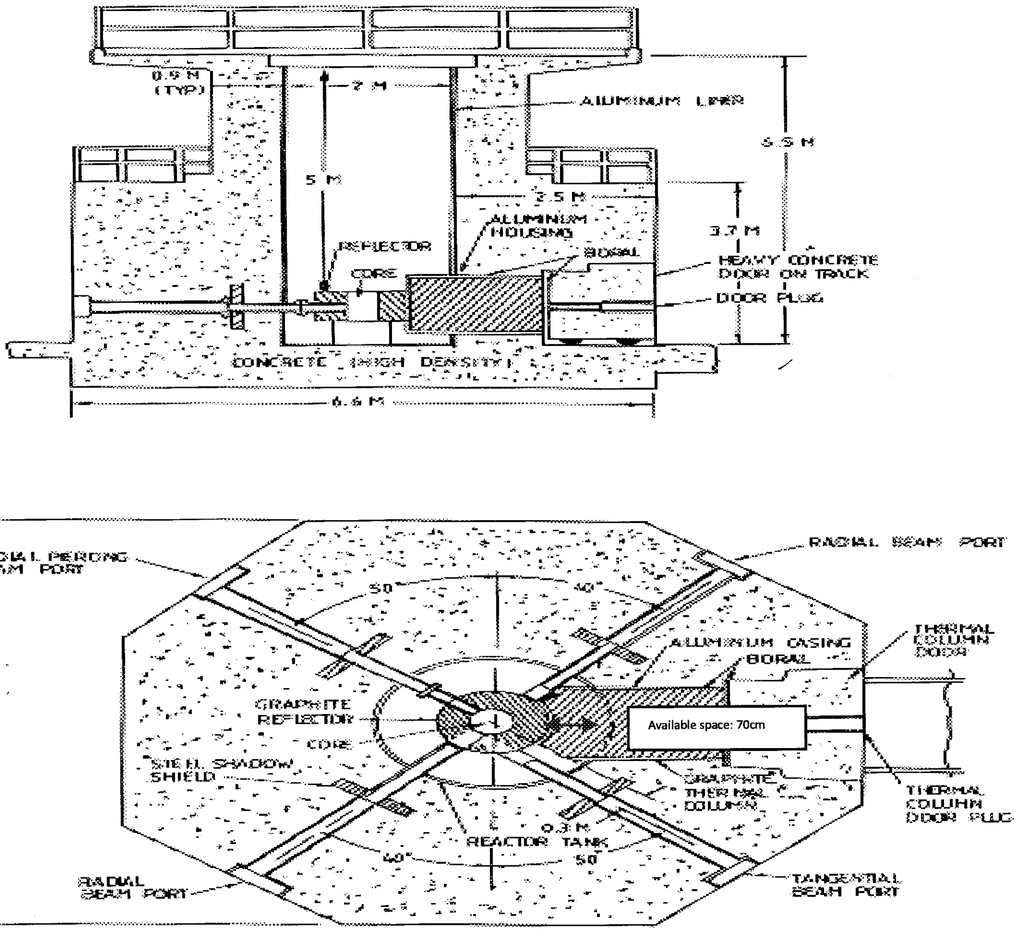
Besides, the reactor tank structures and components limitation also must be considered. It is important to



Available Space in the Reactor

ensure the available space in the tank to locate transfer cask in the tank so that a proper dimension can be proposed.

a) The design specs for reactor pool is as below:



Reactor Tank Side Dimensions and Cross Sectional View

The tank size is 2m in diameter and 6.5m depth. However, there are central thimble, specimen tube, air tube and control rod at the center of the core. So only half part of the tank could be utilize to locate the cask that is about 70cm from the tank liner to the centre of the core.

b) Crane System

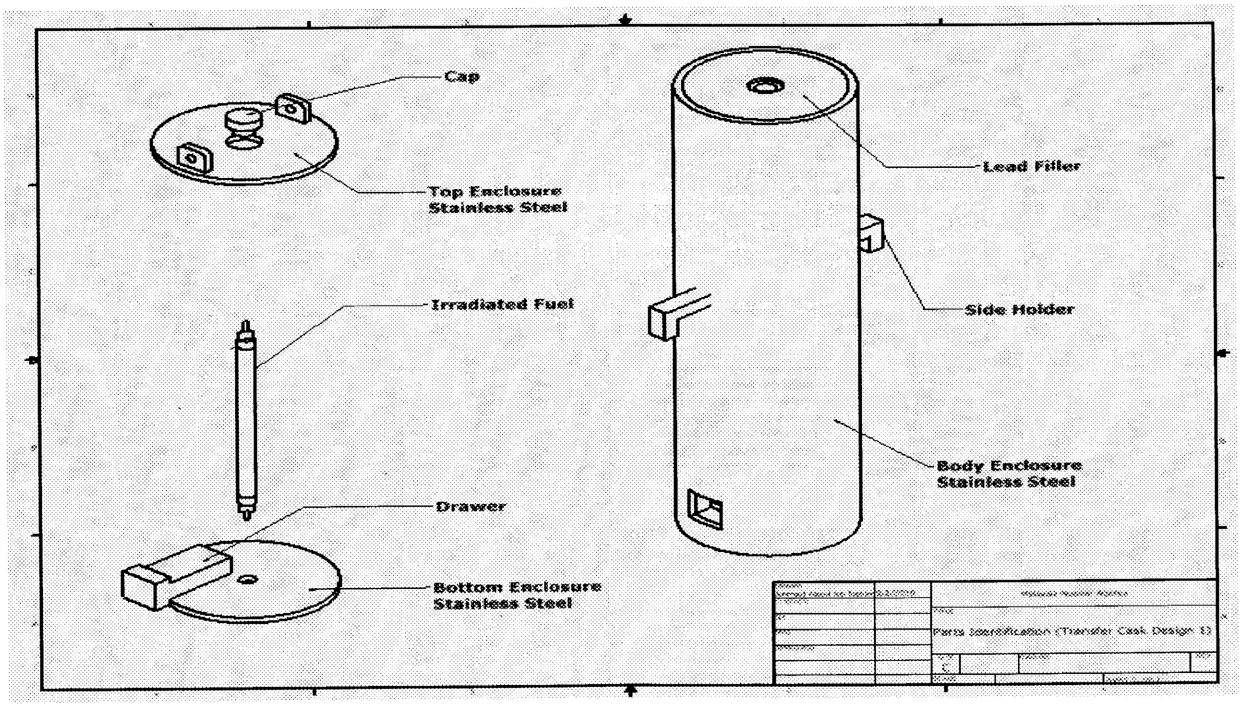
The crane in the reactor hall is a 10-tonne overhead crane. Therefore, it is essential to consider the weight of the cask is less than that the crane capabilities. The crane will be used as a mean to transfer the cask from the reactor tank into spent fuel pool. Among other specs of the crane are as follows:

i. Hoisting - 4 m/min
ii. Creep - 0.4 m/min
iii. Cross Travel - 4 and 16 m/min
iv. Long Travel - 5 and 20 m/min

The crane is provided with a service platform with hand-railing. Access to this platform is via a door from the third-floor plant room.

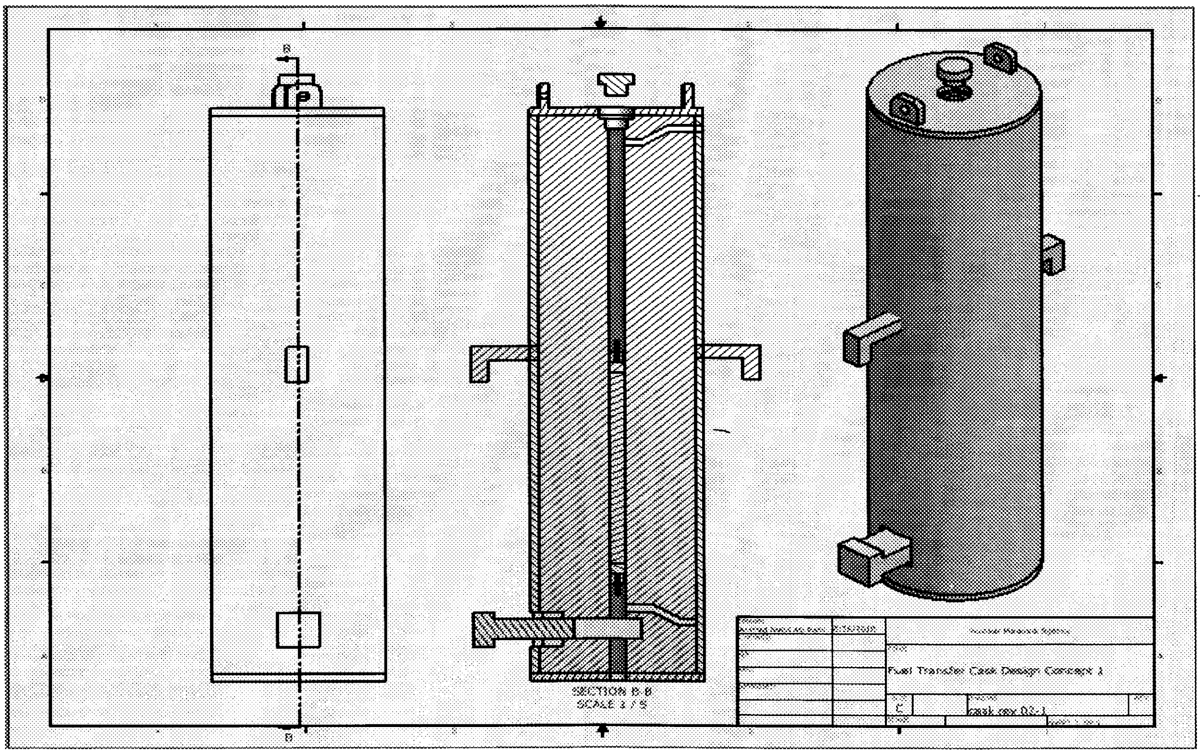
3. RESULTS

Fuel Transfer Cask Design 1



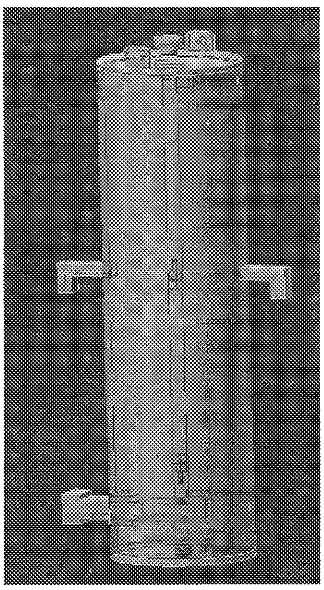
Design Concept 1 Parts and Components

The fuel transfer cask design 1 is based on Morocco design. Morocco Research Reactor is a 2 Megawatts capacity but the fuel specs are the same as RTP. Overall cask has 41 cm diameter and 163 cm height. The cask is filled with lead and the outer layer is enclosed with stainless steel. Drainage system is available at the top and the bottom of the cask to allow coolant to be drained out. On the top of the cask is the cap that shields radiation on the top side. At the bottom is the sliding drawer to prevent the fuel from drop.



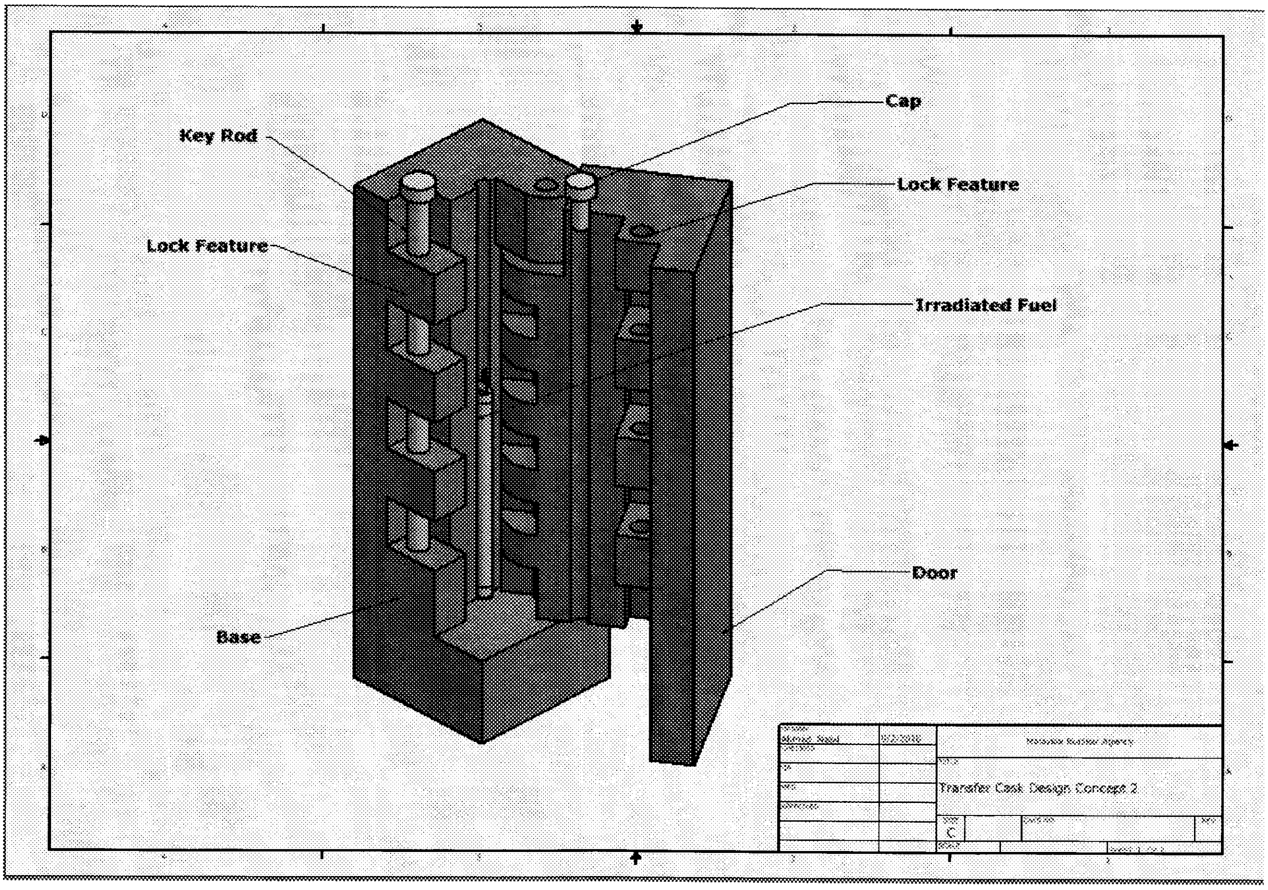
Fuel Transfer Cask Design Concept 1 Views

How the spent fuel will be inserted into the transfer cask design concept 1?



The cap and the drawer of the cask will be removed since fuel handling tools will be going through the channel. The cask will be hanging in the reactor tank about 2.5m from the water surface. The other end of fuel handling tool will pick a spent fuel from the storage rack. Once the spent fuel is grabbed, it will be pulled upward. Once the spent fuel is inside the channel, the drawer will be inserted so that the fuel would not drop. Then, drop the fuel inside the channel and remove the fuel handling tool. Close the top of the cask with the cap. Now the spent fuel is ready to be transferred into spent fuel pool.

Design Concept 2

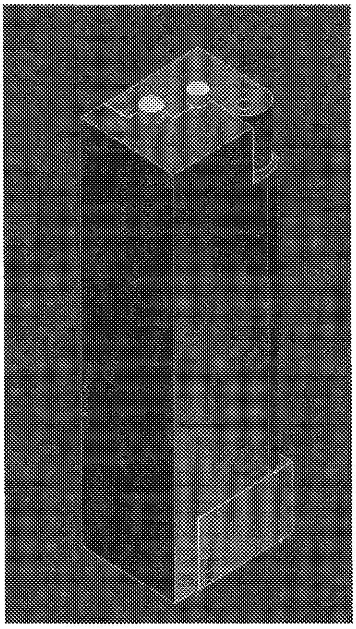


Fuel Transfer Cask Design Concept 2 Parts and Component s

This cask design concept 2 is 150cm height and 40cm by 50cm thick. It is made of lead and enclosed with stainless steel. This design allows the cask to be open and closed so that the channel can be reached through its side. This will reduce radiation exposure to the top of the tank since the spent fuel would not need to be raised more than one meter from the core. A rod lock is design to secure the cask from being open. The other side is a joint that allow the cask to be open and close. On the top will be a cap to shield the upward radiation from spent fuel. While at the bottom side there will be no hole through the cask. Drainage system is available at the bottom side so that unnecessary coolant can be drain out. Even though the cask design could be open and close, the radiation is shielded properly. Since the radiation move in straight line, all the opening is designed so that another profile will block it from going through.

How the spent fuel will be inserted into the transfer cask design concept2?

This is the illustration of the cask when it is fully closed and the fuel is secured in the cask. On the top side is the key rod to lock the cask and the other one is the shielding protector for top side.



The cask will be at rest very near to the core. Firstly, the key rod and the cap will be removed so that the cask can be fully open. Then, spent fuel from the core will be picked up the using fuel handling tool and inserted into the channel through side opening. Once the spent fuel is stable in the channel, the cask door will be closed and the key rod will be inserted to lock the cask. Lastly, the channel will be closed using the cap to shield upward radiation. Now, the cask concept design 2 is ready to transfer into spent fuel pool.

4. CONCLUSION

Both of the design concepts allow readers to visualize how RTP transfer cask would be and imagine how process of transferring spent fuel from the core into the cask would be. Design 1 might take lesser steps to locate the fuel in the cask but the process will expose higher radiation to the top since the cask has to be located at nearer to the water surface compared to design concept 2 where it is placed very near to the core. A further study is needed to design a proper fuel handling tool since current handling tool would not meet this project requirement. An extra tool is needed to help maneuver fuel handling tool from the bottom of transfer cask. On the other hand, design concept 2 is easier because the space to insert the fuels is much guided and the cask will be at rest near the bottom of the tank. Both designs have their pros and cons but further studies is needed to check radiation exposure level after the spent fuel is in the cask so that a best dimension can be proposed.

5. ACKNOWLEDGEMENT

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REFERENCES

[1] *Safety Analysis Report for PUSPATI TRIGA Reactor (2008),* Nuklear Malaysia

[2] *Safety Analysis Report for National Center for Energy, Sciences and Nuclear Technologies (1992),* General Atomic

[3] A.T. Silva, M. Mattar Neto, R.P Mourao, L.L. Silva, C.C Lopes, M.C.C. Silva, *Option for the interim storage of IEA-R1 research reactor spent fuels,* Power Progress in Nuclear Energy 50 (2008), ScienceDirect