Canadian Nuclear Society
Waste Management, Decommissioning and Environmental Restoration
for Canada's Nuclear Activities: Current Practices and Future Needs
Ottawa, Ontario Canada May 8 -11, 2005

DESIGN AND OPERATION OF DSC TRANSPORTERS AT ONTARIO POWER GENERATION

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ABSTRACT

Special purpose vehicles are used for the transportation of Dry Storage Containers at Ontario Power Generation. At present three transporters are currently utilized for moving the DSCs between a nuclear station and storage facilities. The purpose of this paper is to cover functional and performance design requirements, safety analysis and commissioning for the DSC transporters. The future plans are discussed in light of present operational experience.

1. INTRODUCTION

Ontario Power Generation Inc. is using Dry Storage Containers (DSCs) for moving used nuclear fuel from the wet storage in irradiated fuel bays at its nuclear stations at Bruce Power and Pickering Nuclear Station to dry storage facilities. The fuel is always loaded into a DSC under water, the DSC is closed with a heavily shielded lid and locked in place with a clamp. Then the DSC is transferred from the irradiated fuel bays to the processing facility where all welding and quality assurance processes take place. Subsequently the DSCs are moved into its storage area where they are stored at a predetermined spacing which is approximately 9-10 in. within a row of DSCs and 25-30 in. between the rows depending on the facility. In order to move the DSC from the fuel bay to the dry storage facility, special purpose vehicles were designed to carry the DSC safely and efficiently between the two locations.

A third site at the Darlington Nuclear Station, with Processing and Dry Storage Facilities, will be added in 2007. Two more vehicles are proposed to be designed and phased into the operations over the next few years.

2. TYPES OF VEHICLES FOR TRANSPORTATION OF DSC

Currently, two vehicles are available at Pickering Waste Management Facility (PWMF) for Pickering Nuclear Station and one at Western Waste Management Facilities (WWMF) for Bruce Power Station.
A vehicle designed and manufactured by Hammant Car was commissioned at Pickering in 1995 (see Figure 1). It has been used successfully for years for the transportation of DSCs between the station and the processing facility and also for placing the same containers into storage. Another vehicle was designed by Liftking Industries in 2002 and was phased in at Pickering early in 2003 (see Figures 2). It is commonly known as the Liftking vehicle. Another Liftking vehicle, identical to the one in operation at Pickering, was manufactured in 2003 for the WWMF. As a result, three transporters are currently utilized for moving the DSCs. They are known as PWMF Hammant Vehicle, PWMF Liftking Vehicle and WWMF Liftking Vehicle.

Two more vehicles for the transportation of DSCs are in the planning stages. One will be a repeat of the Liftking vehicles and another will be a self powered Transfer Vehicle capable of carrying the DSC without built-in self-loading and unloading options. See Section 6 for more details.

Figure 1
Hammant Vehicle

Figure 2
Liftking Vehicle

3. DESIGN REQUIREMENTS FOR DSC TRANSPORTERS

The vehicles used for the transportation of a DSC carry either an empty or loaded container with used nuclear fuel. The DSC is equipped during transportation with a transfer clamp and an additional protective cover to shield it against atmospheric conditions.

The fundamental requirements for transporting a DSC include the ability to pick up the DSC at the nuclear station, carry it to the Processing Building for processing, and place it in the Storage Building.

The vehicles for the transportation of the DSCs are designed to operate within the nuclear site boundaries. They meet the Ontario Highway Regulations in areas such as the lights, brakes, safety equipment, exhaust emissions, etc. In addition to standard requirements for heavy trucks, the vehicles for transportation of the DSCs are equipped with a number of special systems such as: pre-heaters, fire suppression system in the engine compartment, foam-filled tires, and emergency stop controls located on the inside and outside of the vehicle.

In some cases upgrading of existing on-site roads to meet the vehicle operating requirements has been necessary. Extensive precautions are being taken to ensure accident free operation. For example, in some selected cases along the route from the nuclear station to the storage facility, concrete barriers are used in order to limit potential accidents.

Figure 3
Liftking Vehicle carrying a DSC during commissioning

3.1 Functional Requirements

The following are the typical functional requirements for the vehicle transporting a DSC. Such a vehicle will:

- be capable of placing and retrieving a DSC in its designated storage position in the Storage Building
- be self powered and self loading thus eliminating the need for cranes or tow vehicles
- be supporting the DSC by its lift plates
- be equipped with a handheld remote control
- be operated by a single driver
- operate during all seasons weather and road conditions based on normal winter road clearing.

The new generation Transfer Vehicle, currently in design, will not be equipped in the self loading mechanism. Instead, the DSC will be loaded and unloaded with a help of an overhead crane and the DSC will rest on a platform rather than being suspended by its trunnions during transportation.

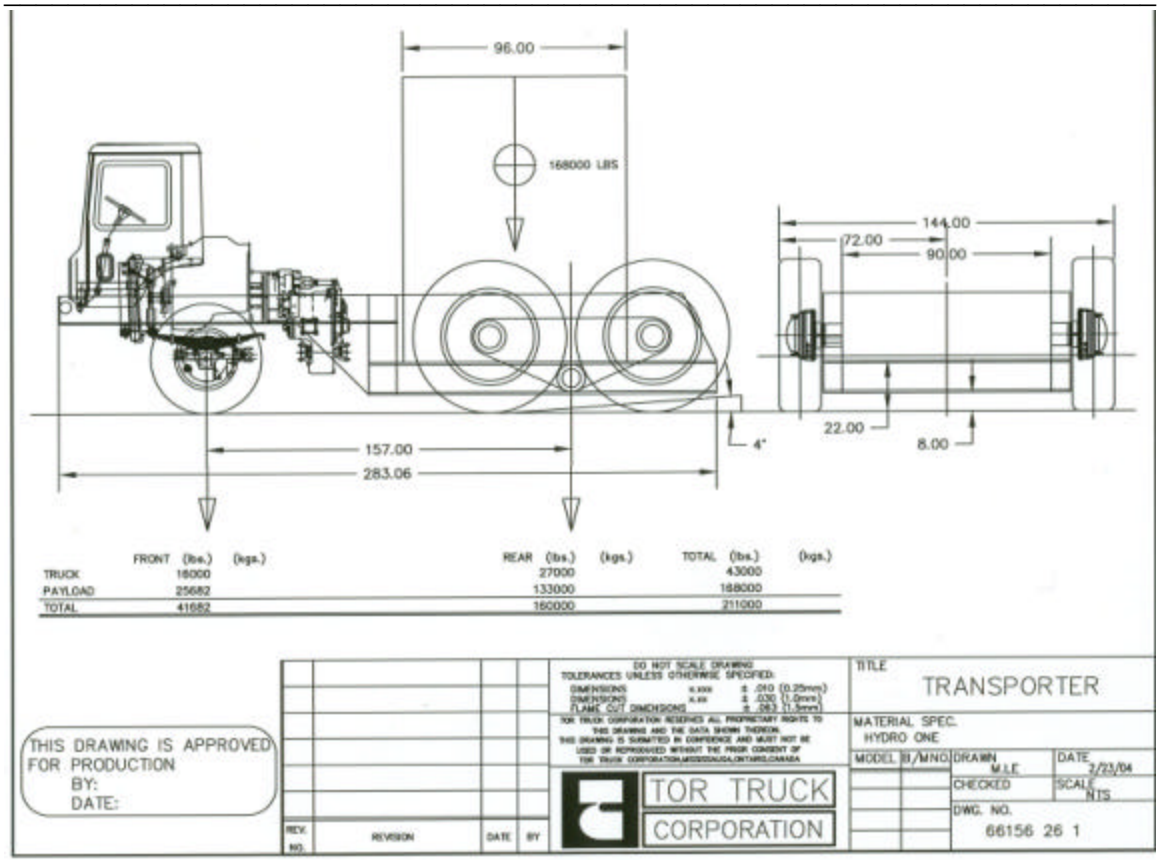

Figure 4
Proposed concept of a Transfer Vehicle

3.2 Performance Requirements

The following are the basic performance requirements for the vehicle transporting a DSC. Such a vehicle will:

- travel at a maximum speed of 4 km/h (vehicles currently in use)
- travel at a maximum speed of 20 km/h (vehicles currently in design)
- have a DSC ground clearance of 6-8 in.
- have a rated capacity of 80 ton
- have a specific turning radius
- be capable of ascending and descending a slope of up to 7 percent
- be capable of stopping in emergency conditions within 3 m when traveling at the speed of 4 km/hr and within 9m when traveling at the speed of 20 km/hr .

In addition, the permissible height of the future Transfer Vehicle platform will be no higher than 22 in. in order to meet the maximum allowable lift height of 24 in.

The vehicles need to meet tight turning requirements in order to conform to the station conditions and be able to place the DSC in storage where a spacing of 10 in. within a row of DSCs and 30in. between the rows needs to be adhered to in order to use the space efficiently and be able to retrieve the DSC in the future.

4. SAFETY ANALYSIS AND COMMISSIONING

The analytical safety analyses performed for the DSC vehicles include acceleration and braking, rollover, toppling, impact due to an explosion, tornado generated missiles and all the standard accident scenarios. Following the design and manufacturing all vehicles undergo very rigorous factory acceptance tests and on-site commissioning trials.

An actual DSC with added weight to simulate the intended weight is utilized when the newly manufactured transporter is subjected to functional and performance tests. In addition, as part of commissioning, a number of trips with an empty production DSC are made before the transporter is declared fit for service. So far, all the transporters have operated without any safety related incidents.

5. OPERATIONAL EXPERIENCE

The operating experience of the Hammant Vehicle over the last 10 years and the Liftking Vehicles over the last 3 years allowed for the preparation of improved design requirements and technical specification for the next generation of vehicles. Among the improvements are: an operating speed of up to 20 km/h, ability to handle a slope of up to 7%, cleaner emissions, and elimination of a need for a tie-down system on the Transfer Vehicle.

Over the years a significant operating experience was accumulated in using the present DSC transporters. The maximum speed of operation, allowed at present in the Safety Report, is 4 km/h although the operating speeds are currently being assessed. The early transporters were not equipped with external cameras whereas the latest unit (WWMF Liftking Vehicle) has cameras installed in a way that enables the driver to maneuver the vehicle with minimum assistance from the ground crew during picking up or placing a DSC in storage. In an emergency situation if the Liftking vehicle engine fails during a transfer, the vehicle has a back up motor which allows the DSC to be put safely on the ground. A tow bar assembly can facilitate towing the vehicle with a DSC in both forward and reverse directions.

The Liftking vehicles meet CARB 2001 diesel fuel emission standard. It is anticipated that the new transporter will meet 2005 EPA diesel fuel emission standards. In addition, bio-diesel and ultra low sulphur fuel may be used in future in their operation in order to limit the emission particulates in indoor and outdoor operation of the vehicles.

It is anticipated that the Liftking vehicles will remain the primary mover vehicle inside dry storage at WWMF while the new Transfer Vehicle will become a primary vehicle transporting the DSCs between the Bruce stations and WWMF. Only the Liftking Vehicle will be used for placing the DSCs into the storage area because there are no cranes in that facility. The DSC movement at Pickering Dry Storage facilities will continue to rely on the existing Liftking and Hammant Vehicles. A comprehensive maintenance and refurbishment program is currently being implemented to ensure the continued serviceability of the Hammant vehicle since it has been in operation for about ten years.

6. FUTURE DIRECTION

Two more vehicles for transportation of the DSCs will be designed and manufactured over the next 2 years. These vehicles will be used at the dry storage facilities presently in operation and at a new facility to be designed and built in the vicinity of the Darlington Nuclear Station. One of the two vehicles will be similar to the present Liftking transporter while the other, known as the DSC Transfer Vehicle will function as a self-propelled moving platform. Typically, the DSC transporters are equipped with self contained lifting apparatus while the DSC Transfer Vehicle will need a crane for loading and unloading the DSCs.

The concept of the DSC Transfer Vehicle was borne out of concerns for retaining the complex and expensive transporter for critical DSC placement for which it is uniquely qualified. A simpler and less expensive vehicle can perform the easier function of moving the DSC between the station and WWMF facility. It is anticipated that the DSC Transfer Vehicle will be half of the cost of the DSC transporter. The availability of crane facilities at both ends of the transportation route allows for such savings. This way there are fewer systems on board the vehicle. Hence there is a potential for higher reliability and lower maintenance and depreciation costs.

7. CONCLUSION

The design and operation of the DSC transporters used at Ontario Power Generation was presented along with a description of two new vehicles currently in planning stages. Existing vehicles have been successfully used over the last ten years in transporting used nuclear fuel from the stations to dry storage facilities and placement in storage of DSCs having it's processing completed.

Acknowledgement

The staff of OPG's PWMF and WMF who operate the present vehicles provided input to this paper and assisted in formulating and assessing the requirements for the future vehicles. Special thanks are due to Brian Parker and Greg Halpenny of PWMF.