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A Clear-Eyed View of the MPC vs The Metal Cask

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The dialog in the public square on the MPC and cast steel or ductile iron casks has been replete with passion but bereft of technical facts. This white paper is my humble attempt to set the scientific facts straight in the hope that factual evidence and rational reasoning would help change the course and tenor of our dialog.

By way of factual evidence, it should be noted that not one MPC out of thousands stored across the US and overseas *has ever leaked in service*. The same cannot be said for metal casks; the gasketed joint between the lid and the cask body is the Achilles heel of metal casks where the risk of a leak is ever present. All that separates the radiological matter inside the cask from the outside air is the elasticity of a slender circular gasket. Most times the seal works well, except when it does not. Recall the Challenger spacecraft disaster in 1985; it owes its place among the great tragedies in space exploration to a polymeric seal! No matter how thick the wall of the cask, it is the integrity of the gasket that divines its seal-worthiness - the weakest link in the chain defines the strength of the chain.

The MPC is a direct result of America's decision to forego reprocessing. The US decided that the energy remaining in the fuel after its 3 to five years of irradiation in the reactor would not be leveraged for generating additional power. Because the used fuel would not be re-used, it became "nuclear waste." The most sensible thing to deal with hazardous waste is, of course, to package it in supremely safe containers. This led to the notion of the MPC which was proposed by the US Department of Energy (DOE) in 1991 and was embraced by the overwhelming majority of the nuclear engineering community in the US. The DOE published successive revisions of the MPC Specification reflecting the input from the technical community over the following 5-6 years. Thus, through an extensive process of public input and consultation, the MPC was born. Its near universal acceptance is not the product of a government fiat. Rather the MPC has triumphed over metal casks because it meets every aspiration of the engineers and scientists who have toiled to isolate used fuel from the environment since President Carter's permanent ban on reprocessing in 1979. Some simple facts:

a. The MPC is made from austenitic stainless steel, one of the most fracture resistant materials made by humankind. Fracture resistance is a measure of how much shock a material can withstand. A flaw in a high fracture resistance material (austenitic stainless) is arrested and fails to propagate under impulsive or impactive loads. It is just the opposite for the case of cast steel. A cast steel metal cask, despite its thickness and bulk, is quite vulnerable to the propagation of any flaw during a severe mechanical loading event. It is this vulnerability of cast metal casks, among others, that led the NRC to reject the license application for the metal transport cask submitted by Germany's noted cask supplier GNS in the late 1990s. (It should be recalled the

German cast steel and ductile cast iron industry was promoted by Prussia's Frederick the Great to drive the early days of the nation's industrialization, centuries before incomparably better material such as austenitic stainless steel were developed).

b. The MPC's material (stainless steel) is also extremely ductile: stretch a 10-inch bar of stainless steel to 14 inches (40% strain), it will not rip! Under high energy events it is even more failure-resistance: pull on the 10-inch bar with a sudden jerk: it will not fail even when stretched to 18-inch (80% strain)! Typical strains that an MPC would experience is less than 0.2%.

c. The DOE wrote the Specification for the MPC to be a permanent *waste package* which it is. It will withstand over a million cycles of daily heating and cooling in storage; it would not crack if dropped from a considerable height (25 feet) on to a concrete surface. My paper, "MPC: The bulwark of safety in the post 9/11 age" (attached to this white paper) explains this matter.

d. In recognition of its safety mission, the MPC is manufactured with the same inspection and testing regimen that is used to manufacture nuclear reactors. Every square millimeter of the MPC's wall is ultrasonically examined, every weld is 100% radiographed - not a spec of flaw or defect is permitted. The manufacturing of the MPC utilizes fabrication techniques that leave a compressive stress field on its outer surface inoculating it from stress corrosion (which can occur only in a marine environment *and* in the presence of tensile stresses).

Well, the above begs the question: why are not Canisters made from a thicker wall? The answer is the MPC is also a heat dissipation device. Its selected thickness provides the desirable rate of heat rejection so that *the fuel can be transferred from pool to the pad in as little as three years after its discharge from the reactor.* The waiting period before the fuel is moved from wet to dry storage would be substantially lengthened if metal casks were used instead.

The MPC has two basic functions: to maintain confinement of radiological matter under all conceivable conditions and to reject heat efficiently to protect the stored used fuel against thermal degradation. Thanks to the MPC, Holtec expects to place all of the used fuel in less than 3years at the plants Holtec has undertaken to decommission. It would permit them to be deconstructed and returned for unrestricted use in about 8 years (instead of 20 to 30 years typical of the industry), save for a small plot of land where the used fuel Canisters will reside.

Furthermore, we expect to move the Canisters to our HI-STORE consolidated interim storage facility in New Mexico for the willing owners and with DOE's concurrence. Our informed confidence in the MPC is so absolute that we have agreed to take full custodianship for the MPC after they arrive at HI-STORE. That is putting one's money where one's mouth is!

In the MPC facilities, the radiation shielding is provided by the storage module, like the below-the-ground modules at SONGS, A metal cask is required to do the duty vested in both the MPC and the storage module. It does not render either function particularly well. Leakage of its contents, propagation of crack and mediocre shielding ability are its major drawbacks. The MPC is the settled solution for long term, safe and low dose solution for used fuel. Metal casks in America will be used to transport fuel to the interim storage facility like HI-STORE or to a repository.

Finally, how about fixing a crack in the MPC wall? I have stated that although it may be theoretically possible to repair a leak (or crack) in a canister, in my opinion it is not practical when one considers efficiency and radiation dose to the workers.

Those who fret about leakage from the Canister should take comfort in the resilience of the austenitic stainless-steel materials: even in the most adverse environment it would not develop a thru-wall crack for several decades after initial pits have formed on the surface. The material has self-healing properties: when a pit forms, its bottom develops a prophylactic barrier against the advance of corrosion. While, the risk is remote, the NRC requires all licensees to conduct an Aging Management Program to monitor, inspect and act on any anomalous MPC surface indication.
The ability to verify the condition of the Canister's surface is getting better all the time. Holtec has successfully employed eddy current testing of the Canister under limited operating conditions. I am sure, with further development, the eddy current testing process will become an accurate tool for establishing the Canister's wall integrity. Surface examination by remote radiography is already a mature inspection technology.

In the remote event that an MPC's surface shows signs of distress, I see two practical solution paths available:

1. Install the MPC inside a sequestration canister which would prevent further weather induced damage and provide a second confinement barrier. The Canister continues to stay in the storage cavity; or
2. Transfer the afflicted canister to the HI-STAR transport cask which provides a fully competent containment and confinement boundary.

Either solution will work equally well. There will be no risk to public health and safety.

Postscript: From a commercial standpoint, Holtec has no incentive to back the MPC technology; we have numerous licensed metal casks that we principally sell to countries that are amenable to reprocessing. Adoption of metal casks in America would have more than doubled our revenue and given our country' nuclear plants an expensive and non-optimal solution to store used fuel. I strongly feel that the activists, patriotic citizens of our great land, will come to realize it ...eventually.