A COLD DEMONSTRATION OF FUEL CONSOLIDATION
PART 1 COMPACTING THE FRAMES

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ABSTRACT

Spent fuel consolidation is an option for increasing Spent Fuel Storage capacities being considered by many utilities. The process of consolidating fuel involves separating the fuel rods from the structural frame which holds them in a square array. The rods are then repackaged into a tightly packed bundle which occupies about half the cross-sectional area of a fuel assembly. Thus approximately twice as much fuel can be stored in the underwater racks at a spent fuel storage pool.

There have been several demonstrations of fuel consolidation to date. These have had varying degrees of success but it is reasonable to conclude that the technology exists for repackaging fuel rods. Not so, however, for dealing with the remaining frames. The industry accepted goal of 10:1 compaction of this hardware has yet to be successfully demonstrated. Without a practical compaction scheme for the frames utilities will rightfully judge consolidation to be an immature technology.

Recognizing the need for a complete and integrated system, the B&W Fuel Company teamed with SGN, the French firm which designed the fuel shears at the LaHague reprocessing facility, to reduce to practice the concept shown in Figure 1. This system consists of two independent machines each with individual control systems. The consolidation machine uses direct-loading and single rod transfer. Several papers have been written concerning the development of this unique mechanism (see Refs. 1-4). The focus of this paper is the development and subsequent demonstration program of what has been to date the missing link the shear/compactor.

DEVELOPMENT OF THE SHEAR/COMPACTOR

The end fittings employed on fuel assemblies are too massive to allow compaction with a reasonable sized machine. Noting that these fittings are basically box like structures, the design approach employed takes advantage of this shape. The idea is simply to fill up the boxes with pieces of the sheared frame i.e. guide tubes, grids, etc. This requires that attention be paid to the packing sequence, placing fittings in the can at the proper intervals.

Figure 2 shows the shear structure being prepared for testing at Verboom/Durochard in Dreux, France. The three main elements of this machine are the feed stack, the shear housing and the canister trolley. The frames are fed into the feed stack, sheared, and the pieces end up in the catch canister below. The following table provides some key information regarding the shear/compactor:

<u>Task 1 BWFC Shear/Compactor Features</u>

Installed Size:	4'W x 7'L x 35'H
Capacity:	45 Tons Shear Force
Weight:	Approximately 2 1/2 Tons
Rate:	1 Frame Every 1 1/2 Hours
Shear Piece Length:	35mm
Compaction Ratio:	10:1

The general schematic layout of the shear/compactor is shown in Fig. 3. The spent fuel frame is introduced by side loading through the feed stack door which is hydraulically actuated. A motor driven plate applies positive downward pressure on the frame at all times.

The first shearing operation involves removal of the lower end fitting (the upper end fitting was already removed during fuel consolidation). A special chamber is provided for this purpose. The action of the hydraulic ram causes the shear canister blade to bear on the frame just above the end fitting, cuts it cleanly, and moves it fully to the right where it can be picked up by the motor driven handling pole. This pole places the fitting into the can controlling the clearances through the entire 13 feet of travel so that jamming is avoided.

The shear then proceeds to cut the frame 3 cm at a time until the entire length has been processed. After each pass of the blade the cut pieces are allowed to fall through an actuated trap door into the canister. The entire shearing/compaction operation is independently controlled (i.e. not coupled to the consolidation operation). When the canister is full of pieces and end fittings (after 10 or more fuel assemblies), the canister is capped and removed. To facilitate canister loading operation a hydraulically actuated trolley is provided. Capping the canister with a recycled upper end fitting completes the process.

RESULTS OF THE COLD DEMONSTRATION

The cold demonstration of the machine was held in Dreux France in February 1989. Ten frames from B&W 15 x 15 fuel assemblies were sheared. This design presents a challenging test since the lower end fitting has a welded skirt connected to the lower grid. All of the grids are fabricated from Inconel 718 including the grid skirt.

The most force was encountered during the shearing of the lower end fitting from its skirt. Over 20 tons of force had to be applied to complete this operation. (This represents less than half the capacity of the machine.) The cut was cleanly made by first actuating the ram backwards and then forwards against opposing counterblades. Fig. 4 shows the cut end fitting.

The cutting of the inconel grids and Zircaloy guide tubes presented no problems. Typically the sheared pieces are also flattened, further aiding compaction. Measuring the volume for one full assembly and considering the additional displacement of end fittings in the canister, it is

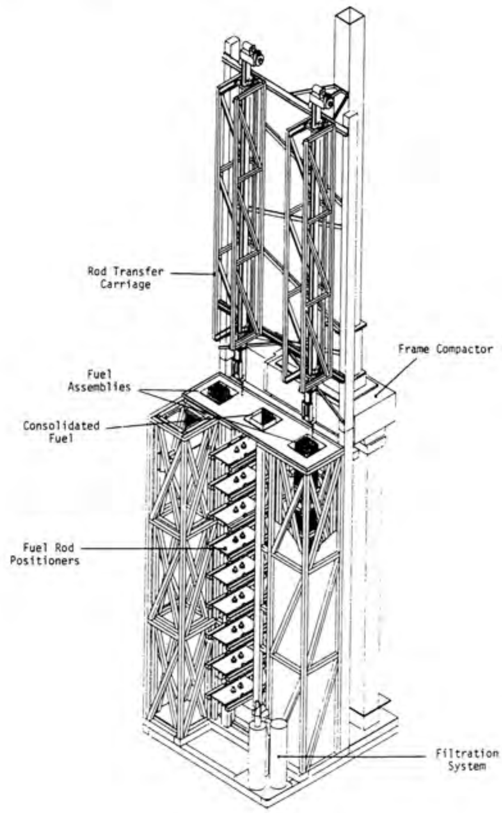

Fig. 1. The Fuel Master Machine.

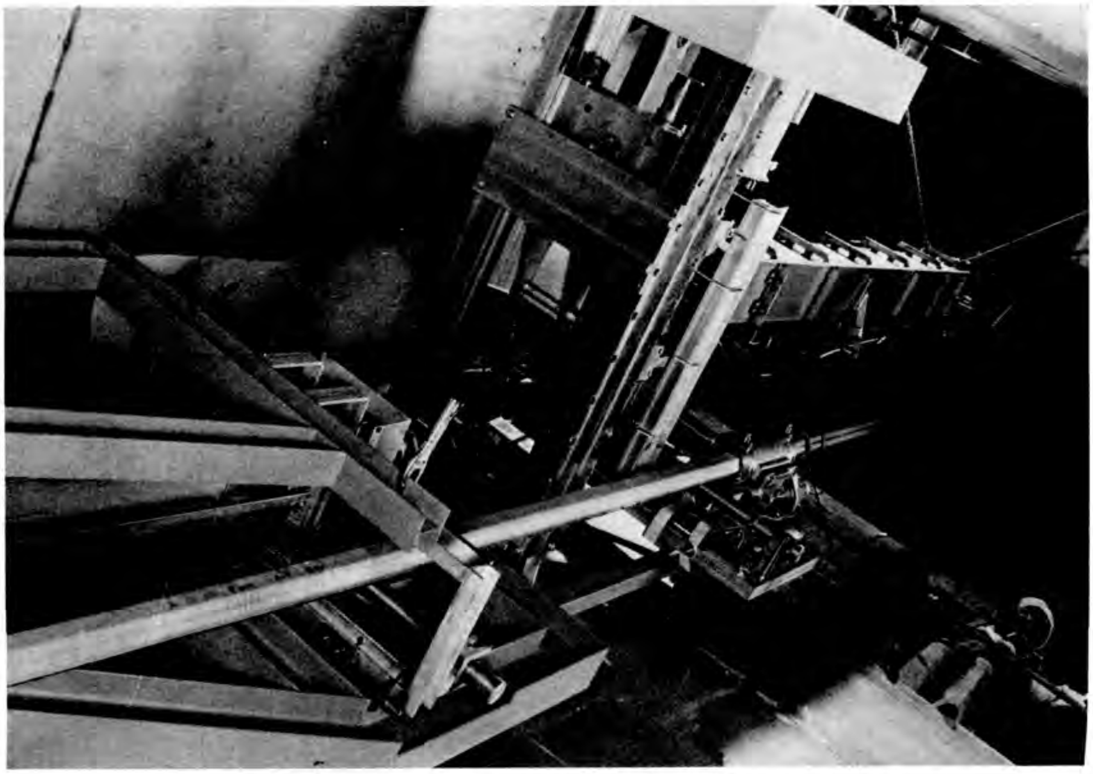

Fig. 2. Assembly of the Shear/Compactor at Dreux, France.

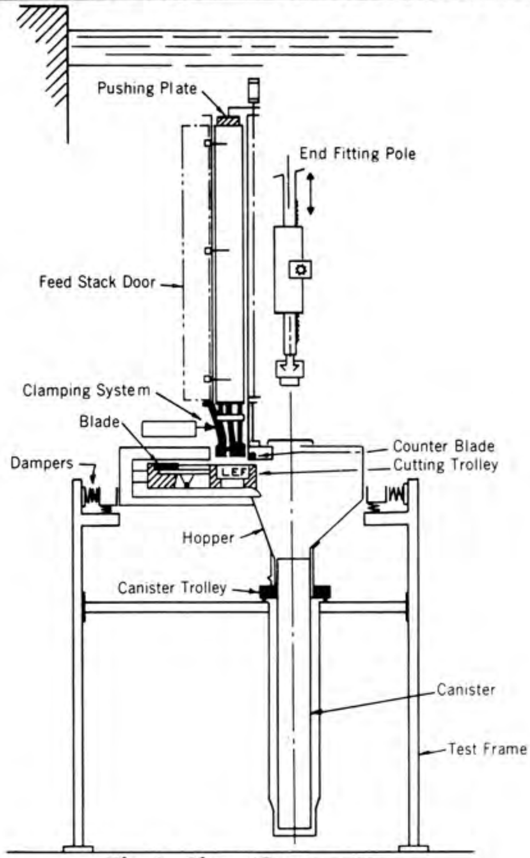

Fig. 3. Shear/Compactor.

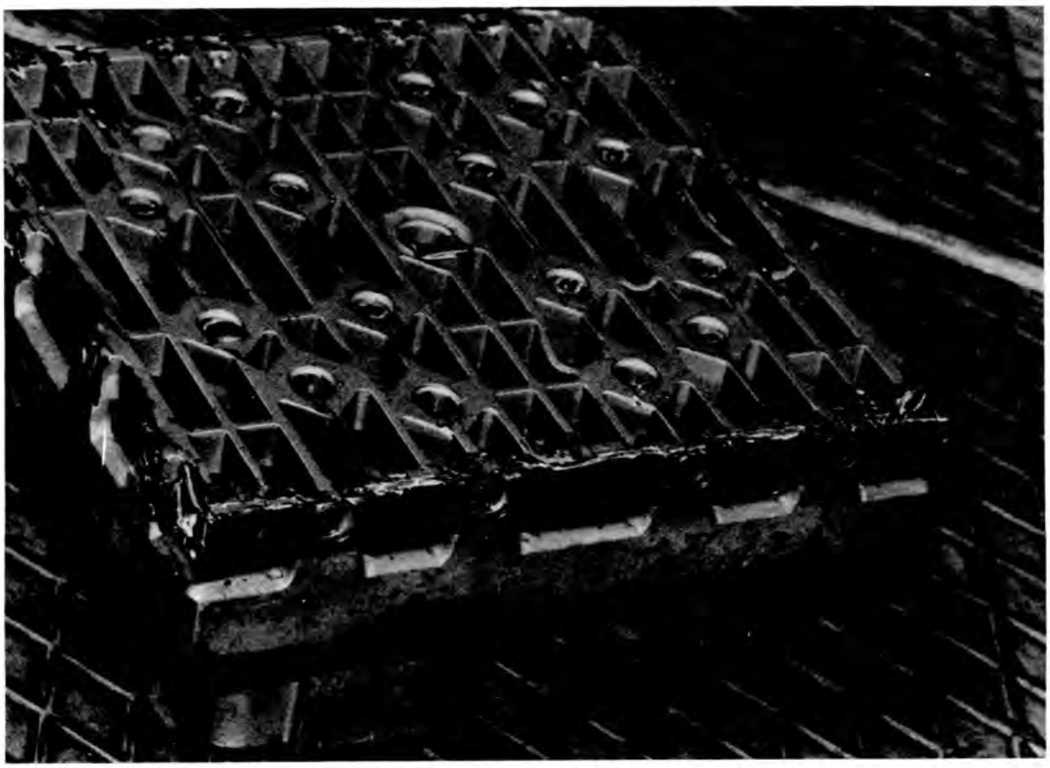

Fig. 4. The Sheared End Fitting.

estimated that a minimum of 10 fuel assemblies can be placed in a single canister.

SUMMARY

A March 1987 article in Nuclear Fuel stated "A practical system for compaction of non-fuel bearing hardware is essential . . . but none of the many vendors . . . have yet achieved the accepted goal of 10:1 volume reduction in hot hardware." In February 1989 the B&W Fuel company and SGN conducted a cold demonstration of a volume compaction machine in France and achieved the desired compaction ratio. The next step is a hot demonstration. There is no reason to expect any less success under those conditions. In fact the brittle nature of irradiated materials should make the job easier.

The missing link in the evolution of a complete fuel consolidation has been the availability of an effective frame compactor. This demonstration has proven that such a machine can be designed and built thus making fuel consolidation an economical and practical choice for many utilities.

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