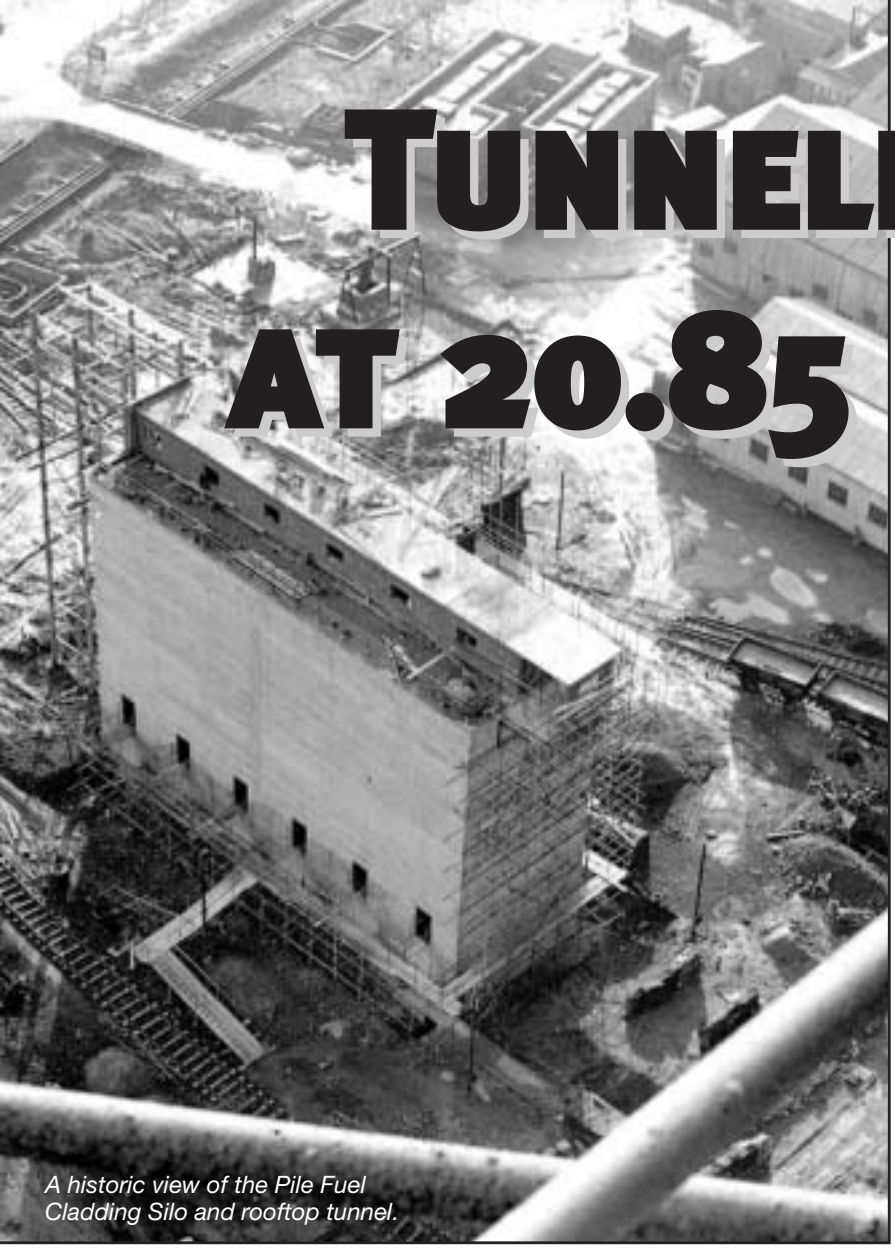


A historic view of the Pile Fuel Cladding Silo and rooftop tunnel.

Tunneling Out at 20.85 Meters

Cleanup Progress at Sellafield's Pile Fuel Cladding Silo

By David Skilbeck

The Pile Fuel Cladding Silo, located on the Sellafield Nuclear Site in West Cumbria, England, was originally constructed to be the dry storage silo for intermediate-level waste (ILW) arising from the Windscale Pile Reactors. Subsequently, however, the silo was used as the main storage facility for all ILW arising from the Sellafield Site. It continued to operate until it was full, at which time the Magnox Swarf Storage Silos were constructed.

The placement of waste into the silo ceased in 1965, and the contents have not been disturbed since that time. Just when waste placement was coming to an end, some difficulty was encountered when waste became trapped on the deflector plates above each waste storage compartment. This prevented full discharge of the

As can be seen in this photo taken from a video image, radioactive waste dating from the 1960s jammed the tunnel charge holes leading to the storage silos, requiring a significant cleanup effort by BNG.

Prior to retrieving stored wastes, the cleanup contractor at Sellafield's Pile Fuel Cladding Silo had to improve the overall safety performance of the facility, which involved installing new fire prevention systems, improving structural integrity, clearing waste from the transfer tunnel, and improving seismic performance.

waste into the storage compartments and resulted in the buildup of waste in the transfer tunnel at the top of the silo (20.85 meters above ground). In 1986, the Nuclear Installations Inspectorate (NII) carried out a safety audit of the facility and requested options for the future. They also required that the silo eventually be emptied and decommissioned.

The cleanup contractor, British Nuclear Group Ltd. (BNG), has adopted a systematic and as-low-as-reasonably-practicable (ALARP) risk reduction approach to address issues in order of risk probability. Prior to being able to retrieve stored wastes, BNG had to improve the overall safety performance of the silo. This involved installing new fire prevention systems, improving structural integrity, clearing waste from the transfer tunnel, and improving overall seismic performance.

Risk Reduction Strategy

Due to the deteriorating condition of the facility, BNG implemented a cleanup strategy for risk reduction that focused on progressive improvements to fire resistance, structural integrity, and seismic performance as a precursor to removal of the stored waste. This strategy was based on ALARP principles and is represented in Fig. 1.

A fully developed safety case that relied on the waste contents remaining undisturbed had originally covered the facility. The NII accepted that waste disturbance could take place safely if the contents of the silo were maintained under a blanket of inert gas to prevent the risk of a fire within the silo.

A phased approach to the improvement operations was adopted with Phase 1 aimed at reducing the risk of fire.

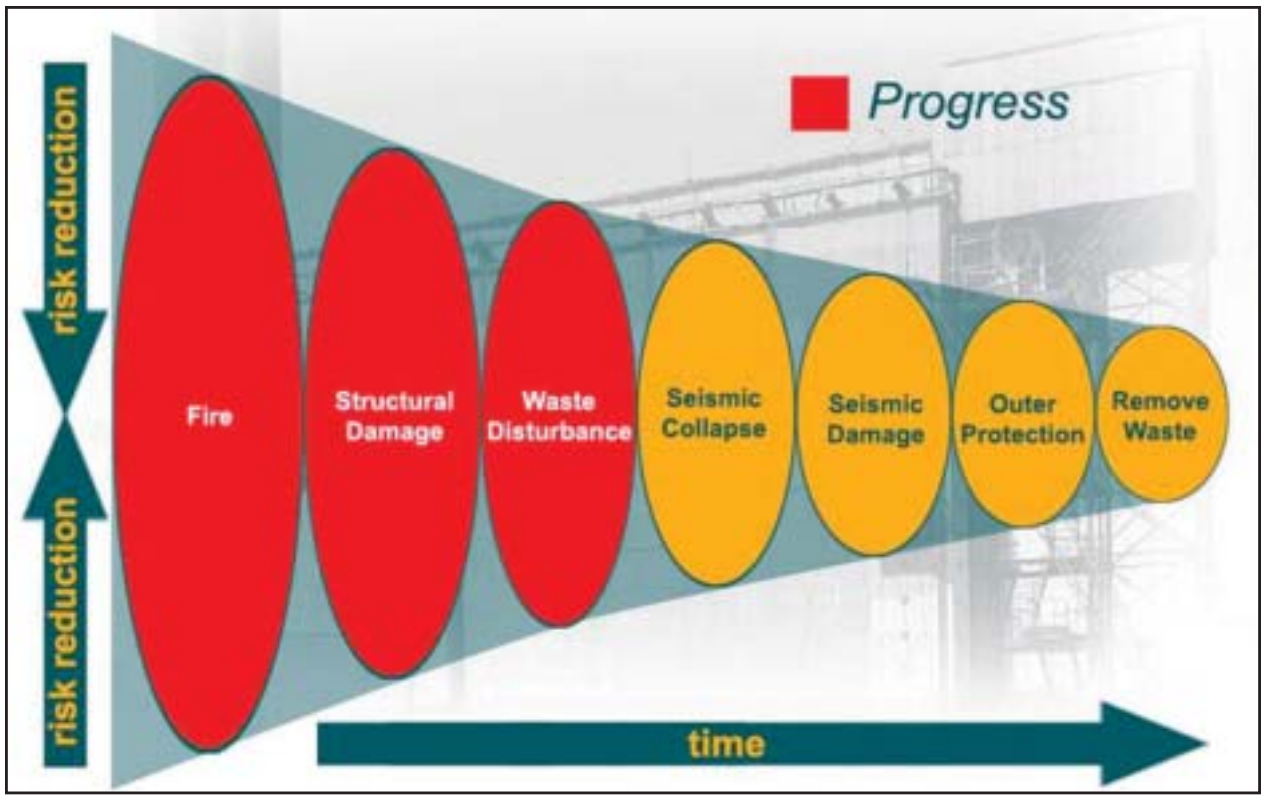


Fig. 1. ALARP risk reduction strategy for the Pile Fuel Cladding Silo, including a risk-based approach for cleanup work.

The successful commissioning and operation of an argon inerting plant achieved this in early 2001. This plant effectively inerted the silo waste compartments and the transfer tunnel with argon gas to a level of less than 2 percent oxygen, opening the possibility for waste disturbance for the first time.

Plugging the Six Compartment Charge Holes

Preparation

A major step toward reducing the overall risk profile of this facility was sealing the six charge holes in the transfer tunnel, which had been used for placing the waste into the silo compartments during operation. Work on these charge holes, located on the top of the transfer tunnel, could be completed only following fire hazard reduction (Phase 1). The second phase of work involved the structural damage and the preparation for sealing the six compartment charge holes.

A number of enabling tasks were required to plug the charge holes and subsequently demolish the tunnel:

- The East Tower needed to be refurbished and structurally improved to enable access to the transfer tunnel roof.
- The East Tower Penthouse was stripped of redundant equipment, and the cladding on the tower was replaced, new lifting beams and hoists installed, and load bearing covers and transfer bogeys installed to safely transfer equipment.
- New ventilation connections had to be drilled into the roof of each waste compartment and then connected to new pressure protection lutes and into the existing ventilation extract ducting to enable argon to be drawn directly from each compartment.

View of structural damage of east tower steelwork prior to the refurbishment necessary to gain access to the tunnel roof.

Working on top of the 20.85-m facility, workers dressed in protective gear use a Pokey Stick, designed by the group, to push waste located in the tunnel down into the charge holes that lead to the waste silo.

- The antechamber of the transfer tunnel had to be refurbished and modified. Redundant bogeys and contaminated equipment were removed. New oxygen monitoring equipment and a new interlocked pressure-retaining door were installed. The bulkhead into the transfer tunnel was then removed.

The waste that had remained in the tunnel since the 1960s had to be cleared. At first workers conceived a method known as "the Pokey Stick" to poke the waste back into the storage compartments. They later developed a pole equipped with hydraulic cutters to chop up scaffolding and steel covers. With this method they successfully cleared all of the bulk waste and scaffolding into the silo compartments.

Performance

The installation of the charge hole sealing equipment required human access into the transfer tunnel and would expose people to high radiation doses, the potential for falling into the storage compartments, and asphyxiation from the argon. While the waste was under a blanket of argon, workers needed to carry out cleanup

Workers dressed in supplied-air suits install decking material over the waste charge holes. (Photo taken from a video.)

activities duties dressed in supplied-air suits. Managers developed strategies to manage and overcome these problems and held trials off-site in a low-hazard simulation. They developed and refined plans and actions that led to all personnel who would take part in the plugging task becoming fully trained and well practiced in all planned operations, including firmly established emergency and evacuation procedures.

Initial entry into the transfer tunnel revealed that the floor of the tunnel was in a much poorer state than had been envisaged. Heavily corroded liners, loose or missing grouting, and widespread contamination necessitated a major clean-up and repair exercise prior to the installation of the main plugging frames. The first-stage trays had to be installed before this cleaning to remove the fall potential and improve the radiation shielding and argon retention. Upon completion of cleaning and repairing, workers painted a two-stage membrane onto the floor of the transfer tunnel to provide a base to seal against.

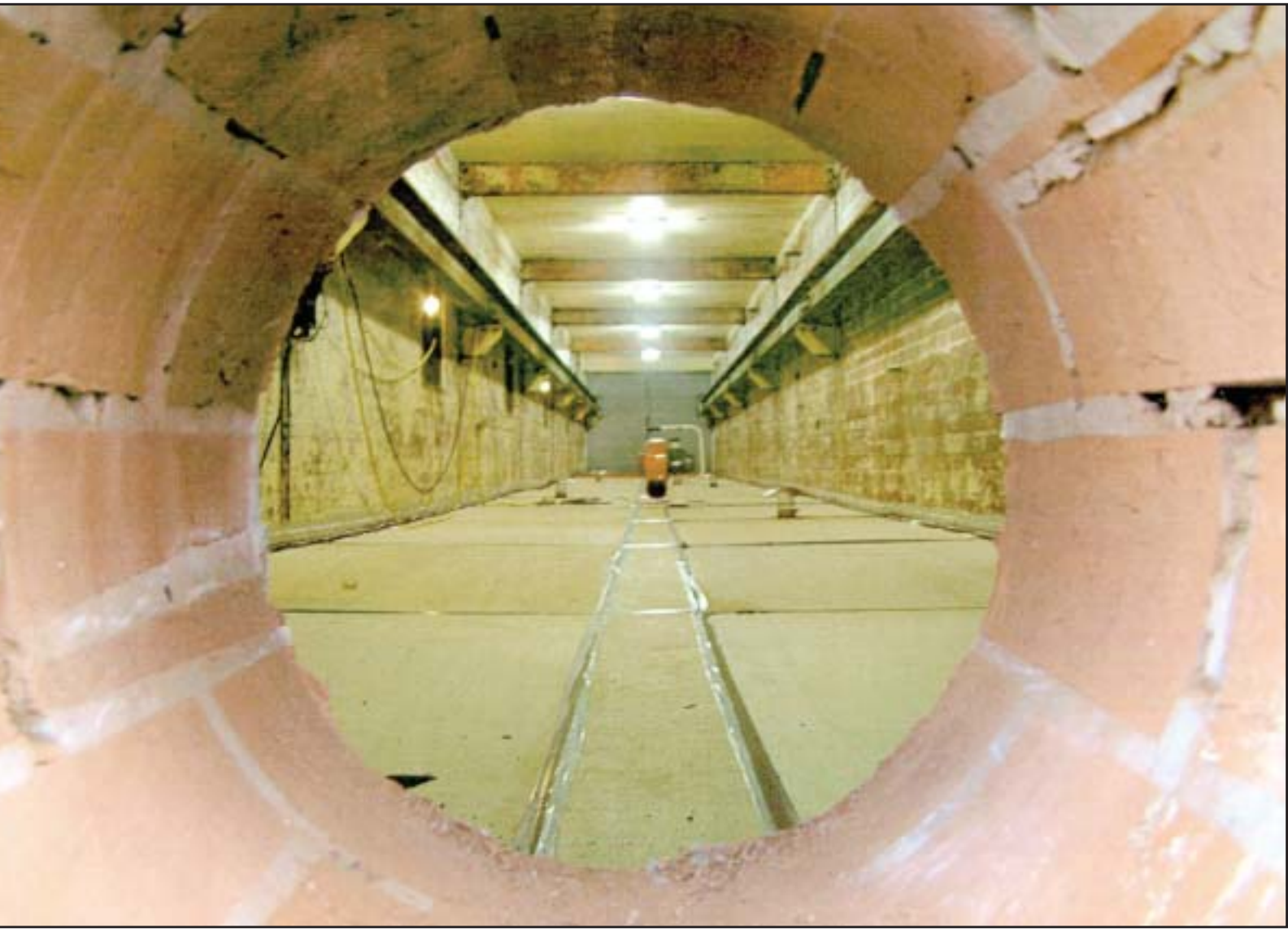
Workers hoist an h-frame mount used to cover the charge holes in the tunnel of the Pile Fuel Cladding Silo. These frames provided workers with a stable base to install decking and the waste charge hole covers.

Then over a one-month period, workers installed main seal arrangements. During this time, personnel carried out commissioning tests and progressively improved the sealing arrangements of the compartments. This minimized air leakage into the silo, thus maintaining oxygen concentrations within acceptable limits.

Completion of this work improved the overall fire risk by separating the compartments. It also allowed the subsequent demolition of the transfer tunnel, which was one of the remaining and significant seismic weaknesses of the facility. It had the potential to collapse during a seismic event and damage the main silo structure.

The journey toward plugging the charge holes was complex and difficult. The team completed the job by working together to overcome difficulties and rationalize the complexi-

Preparing the tunnel for demolition, workers dressed in supplied-air suits apply the final coat of paint, sealing the waste charge holes off from the tunnel. (Photo taken from a video.)



Looking into the waste-cleared tunnel through a vent connection hole.

After workers completed cleanup of the tunnel annex, they began the next phase of work: demolition of the tunnel structure located on top of the 20.85-m facility. Demolition was completed using conventional tools of the trade.

ties. All personnel played a part on the team—operators, maintainers, contractors, designers, safety case producers, constructors, commissioners, and many others.

Demolition of the Transfer Tunnel

Following successful completion of the plugging task, the preparatory tasks for demolition were implemented. This comprised the isolation and strip-out of redundant tunnel monitoring and alarm systems, ventilation, and mechanical equipment. Natural ventilation of the tunnel was established by drilling circular openings in the tunnel walls. The tunnel doors and antechamber roller shutter door were removed. A temporary works scheme for installation of lower and intermediate demolition platforms was implemented.

On completion of the preparatory work, the removal of the tunnel roof and antechamber commenced. The method employed was to use a diamond drill to create openings in the roof. This then allowed access for hy-

Wall demolition in progress.

draulic crunchers to break up and remove large concrete lumps of the tunnel roof. All demolition waste had to be bagged and winched down to ground level for discharge into containers for transfer to the low-level waste repository at Drigg.

Recently, following complete removal of the tunnel roof, the tunnel walls were demolished. Finally, the crew will construct low walls and install weatherproof covers, supported on the walls.

Systematically Reducing the Risk

The Pile Fuel Cladding Silo is the oldest purpose-built waste storage facility at Sellafield. It represents one of the most hazardous and challenging environments associated with the British nuclear legacy. The silos cleanup will continue to rank high on the BNG agenda, as well as the agendas of its customers and regulators. The success of this project has proven that BNG can effectively manage its own teams, along with those supplied by subcontractors, to deliver in harmony with common project goals executed flawlessly. "Our cleanup team did an exceptional job in a difficult work environment; their innovative efforts are instrumental to the success of this cleanup," said Tony Price, director of Cleanup, BNG Management Services.

Since the start of work in 1996, the risk posed by the silo has been systematically reduced by several orders of magnitude. The main work packages, like charge hole plugging and tunnel demolition, have been accelerated by three years compared to the reference program. The BNG cleanup team's next step in decommissioning the silo is to find the best waste retrieval method. ■

David Skilbeck is a project manager for the Cleanup Department at BNG, a business established by British Nuclear Fuels Ltd. to focus on nuclear cleanup and operations.