Contained Waste Processing System for UK Nuclear Facility – 14025

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ABSTRACT

The paper describes a bespoke system for the recovery and re-processing of Uranium Dioxide, stored for over 20 years in 25 gallon steel drums. The UO_2 was originally recovered as part of a decommissioning project and is heavily contaminated with construction and building debris.

The steel drums contain varying levels of contaminants, but the exact contents of the drums are un-known and cannot not be established until each drum is de-lidded and visually inspected. The condition of the drums is generally deteriorating and a solution was required to establish the contents of the drums, empty the drums, and process the recovered nuclear material. The recovered material is size reduced and the powder produced is fed into an acid dissolver for further processing.

INTRODUCTION

An engineered solution was required to recover and re-process Uranium Dioxide, stored for over 20 years in 25 gallon steel drums. The UO_2 was originally recovered as part of a decommissioning project and is heavily contaminated with construction and building debris.

Fig. 1. Typical Drum Store.

The steel drums contain varying levels of contaminants, but the exact contents of the drums are un-known and cannot be established until each drum is de-lidded and visually inspected. The condition of the drums is generally deteriorating over time and a solution was required to establish the contents of the drums, empty the drums, and process the recovered nuclear material.

The process involves the following key stages:

- Drum handling
- Waste sorting
- Initial size reduction (pre-breaking) & Second stage size reduction (milling)
- Powder collection
- Powder feeding

WASTE RECOVERY AND PROCESSING SYSTEM DESCRIPTION

Stage 1, drum handling

The drum is loaded into the glovebox transfer chamber where the operator removes the drum lid using the gloveports and carries out an initial visual inspection of the contents.

The inner powered transfer door is opened and the drum moves into the tipper cradle inside the glovebox main chamber.

The drum is then tipped by the operator using the external tipper controls and the contents begin to fall out of the drum into the base of the glovebox.

Fig. 2. Drum Loading & Sorting Glovebox

Stage 2, waste sorting
Through the gloves, the operator manually sorts the waste material and separates pieces of UO_2 from the other general waste which could include bricks, nuts & bolts, concrete etc.

The rejected waste material is passed into the waste chute and and the UO_2 pieces are fed into the re-processing chute using the vibratory feeding system which is integrated into the glovebox base.

Stage 3, size reduction
The UO_2 is fed via the re-processing chute into the first size reduction stage.

The pre-breaker is a Hosokawa hammer mill incorporating swing hammers and has been re-engineered to ensure that the mill requires the minimum level of maintenance during the operating lifetime of the plant.

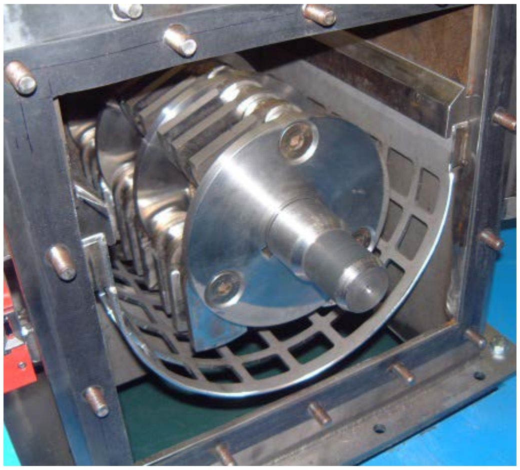

Fig. 4. Hosokawa Hammer Mill

The second stage of size reduction also uses a Hosokawa hammer mill but with a finer screen to ensure that the discharge powder is within the required particle size distribution parameters.

Stage 4, powder collection
The powder is collected in SGCs (Safe Geometry Containers) which have outer rings around the container to ensure there is no possibility of critically if the containers are stacked in close proximity to each other. The SGC is loaded into the lower glovebox transfer chamber and de-lidded by the operator via the gloves. The SGC is then transferred into the lower glovebox main chamber and the filling cone is lowered into position onto the top of the SGC. A downward inflating seal is used to seal the filling pipe to the filling cone inlet and there is a local extraction ring which will remove any dust released during the un-docking of the filling head.
After filling, the SGC is transported back into the transfer chamber, re-lidded and removed from the containment. The flow of powder into the SGS is controlled using a double valve arrangement

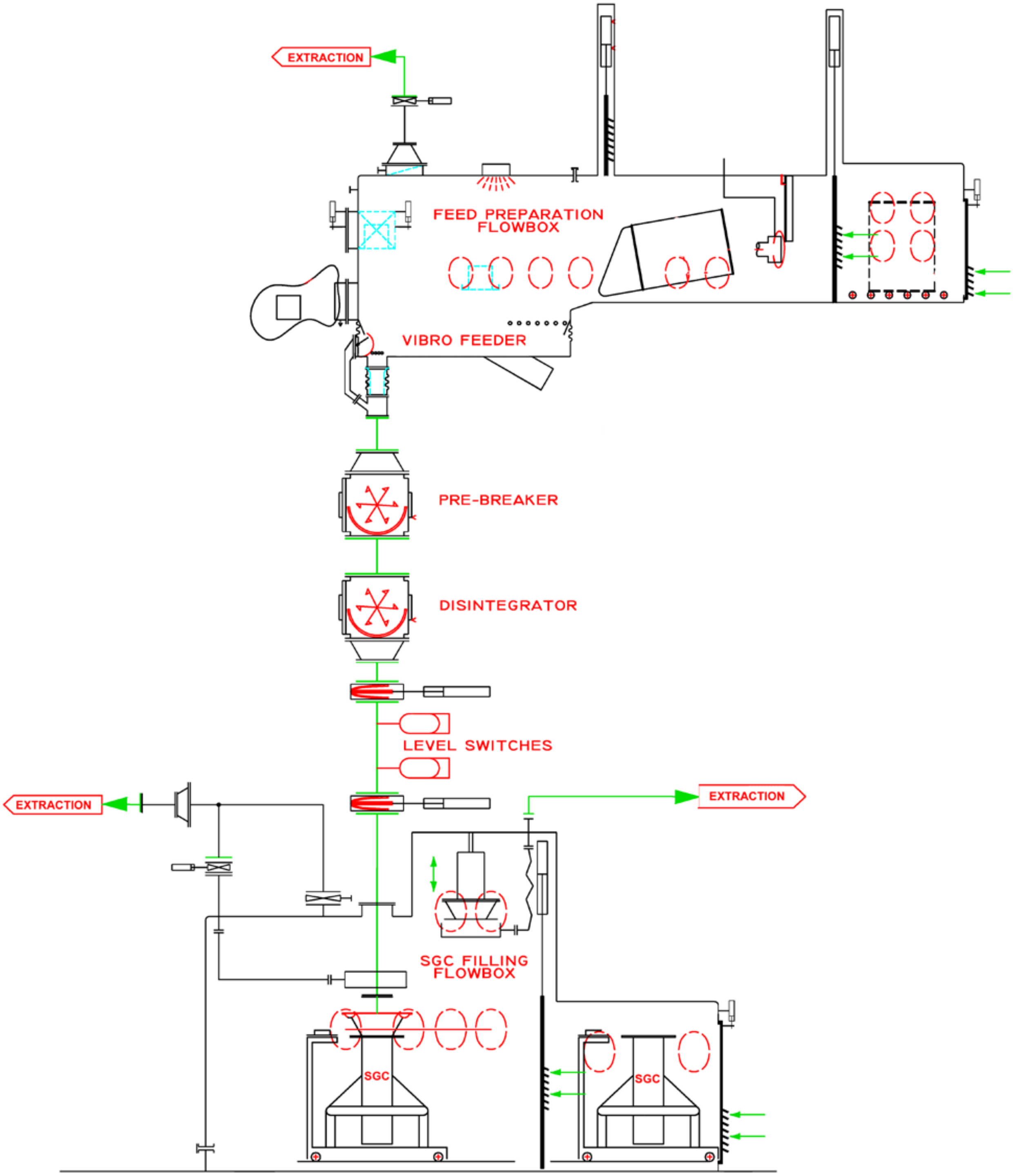

Fig. 5. Process Flow Diagram, Stages 1-4

Stage 5, powder feeding
The SGC is loaded into the transfer chamber of the powder feeder glovebox and de-lidded by the operator via the gloveports.

The passive half of a split butterfly valve is docked onto the top of the SGC.

The SGC is then transported into the feeding chamber of the glovebox, inverted and docked into the active half of the split butterfly valve.

The split butterfly valve is opened and the powder is fed into a buffer hopper via a rotary valve and then metered into the acid dissolver using a loss in weight vibratory feeder.

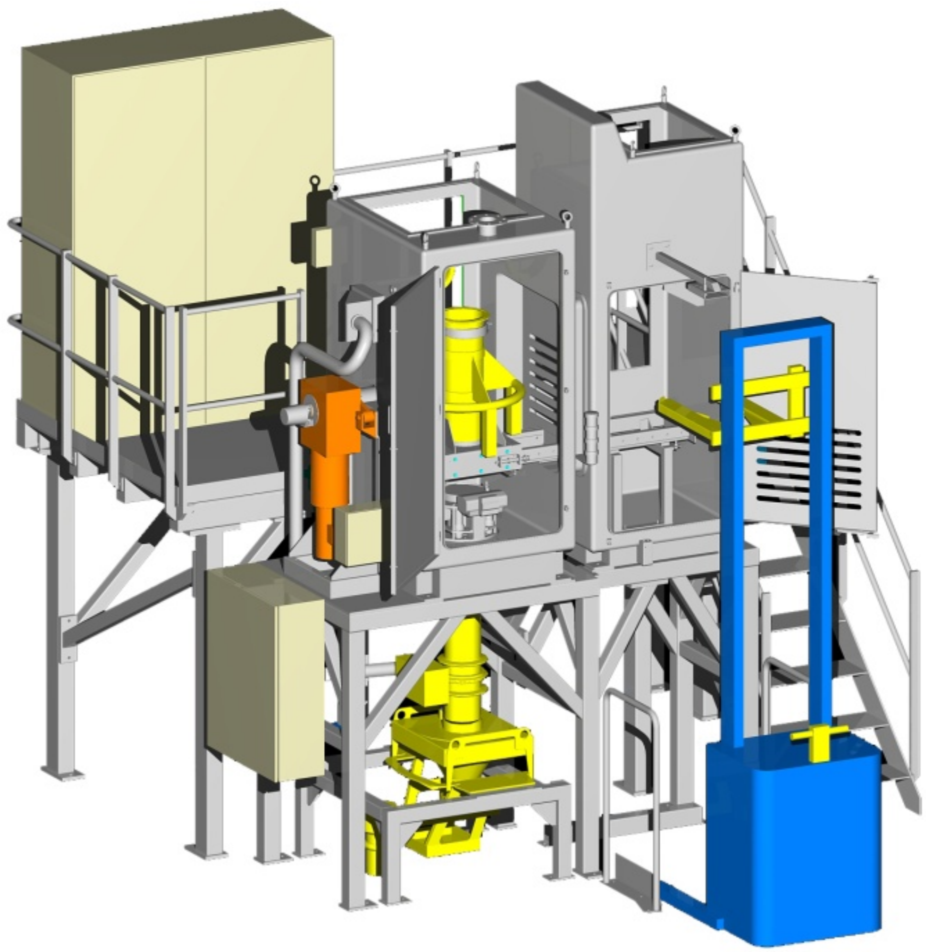

Fig. 7. Powder Feeding System

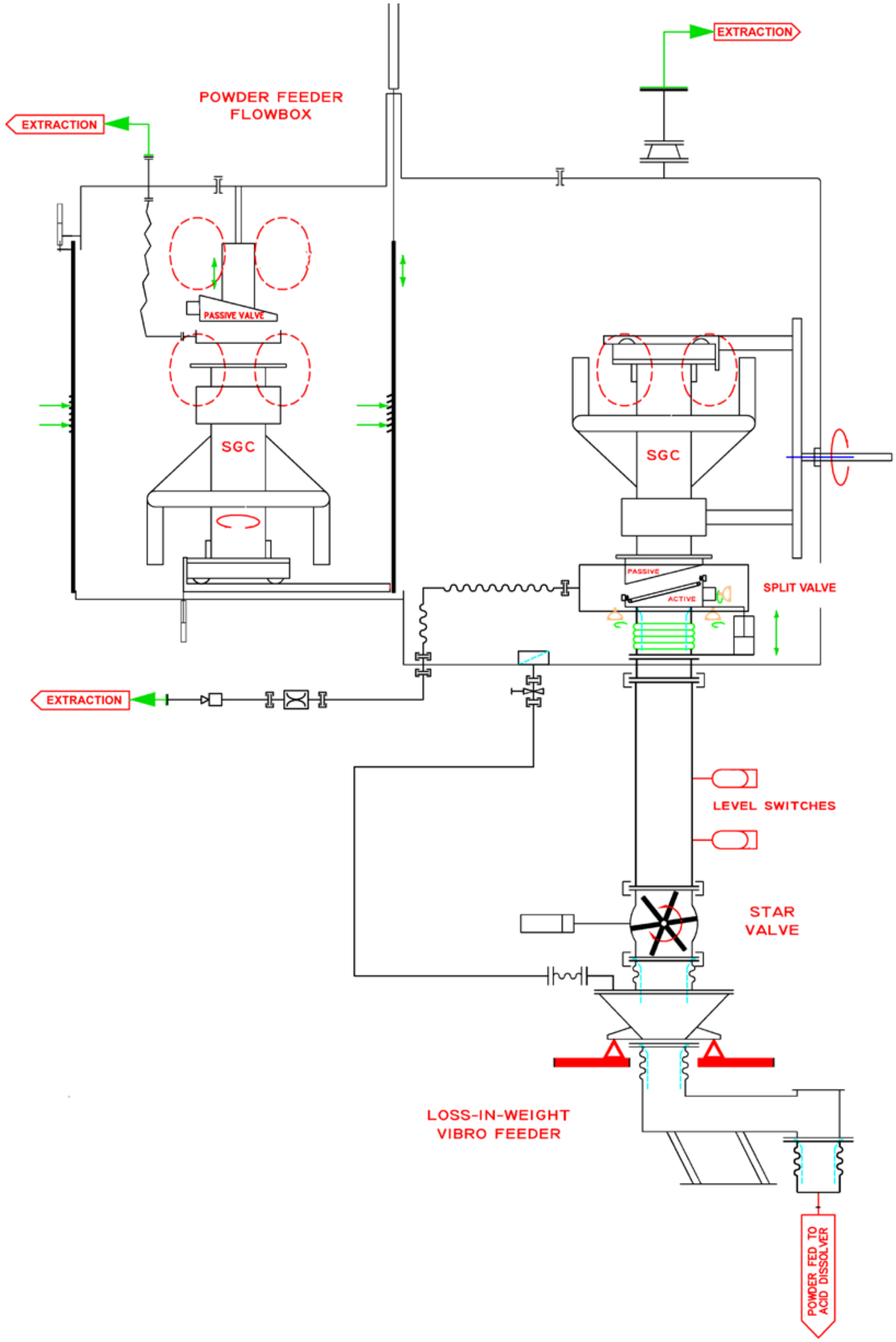

Fig. 6. Process Flow Diagram, Stage 5

DISCUSSION

The system described above was installed at a nuclear fuel manufacturing facility and although the exact content of each drum is not known, the plant records were used to demonstrate that the level of containment provided was suitable for the potential risk of operator exposure to the contents.

In many cases the type of materials or level and type of radioactivity may not be known and in some cases the recovery and processing may have to take place in highly shielded containments and the use of remote handling systems may be necessary.

The hammer mills are not contained inside gloveboxes and maintenance is carried out with the engineer using appropriate PPE. If a higher level of containment is required it is also possible to integrate size reduction machinery into containment gloveboxes using through-wall drive systems.

This means that maintenance on the drive systems can be carried out easily without risk of external contamination. The machine components which are installed inside the containment are ergonomically designed so that they can be disassembled and re-assembled easily using gloves.

Fig. 8. Hosokawa Lead Shielded Glovebox During Assembly

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Fig. 9. Contained Hosokawa Impact Mill

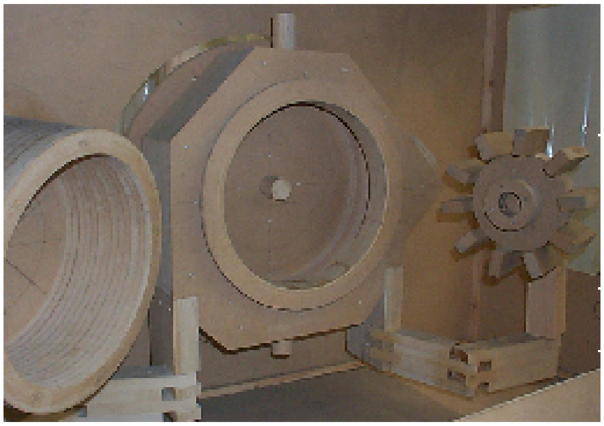

Fig. 9. Impact Mill Wooden Mock-up for Ergonomic assessment

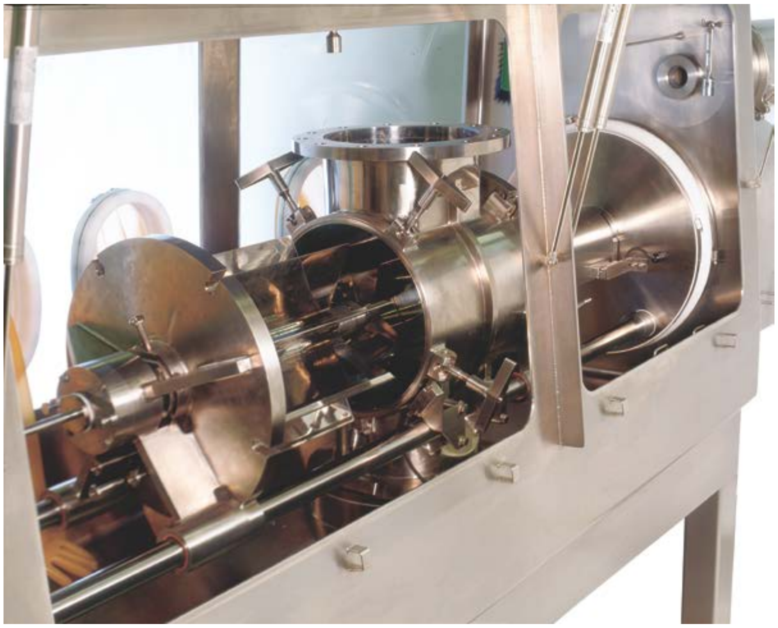

Fig. 10. Rotary Valve, Re-engineered for Glovebox Integration

CONCLUSION

There are many legacy waste stores on nuclear sites which need to be dealt with for both inventory and safety reasons.

It is a common problem to have un-marked and deteriorating drums which have to be dealt with and the level of containment required for operator and environmental protection obviously depends on the potential risk posed by the contents of the drums.

The technology used here combines containment for operator and environment protection as well as size reduction technology which has been optimised and integrated to provide a solution suitable for the processing of nuclear waste material.

The size reduction of waste material can be carried out either as part of a recovery & re-processing system, or to reduce the overall volume of waste for more efficient & lower cost storage.

Due to the bespoke nature of the system, it could be adapted to provide containment and processing of other nuclear materials and could incorporate a higher level shielding or remote handling systems to handle higher hazard waste materials.