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| **Title: Purchase Specification of the Waste Segregation and Repacking Facility in Pelstore** | |

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**Revisions**

This document has been revised according to the following schedule:

| Revision | Date Approved | Nature of Revision | Prepared by |
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| 1.0 | See title page | First Issue | JH Lubbinge |

**Contents:**

## 1.0 PURPOSE

The purpose of this purchase specification is to provide details of the requirements for design, manufacture, supply and installation of fully functional sorting boxes (glove box type) and a fume cupboard along with all accessories. These sorting boxes and fume cupboard form the Waste Segregation and Repacking Facility (WSRF). This facility is required for containing low level radioactive waste in order to inspect the waste and remove liquid from it. This specification details the scope of supply expected to be met by suppliers.

## 2.0 INTRODUCTION

Drums up to 210L containing uranium contaminated waste (compressible and non-compressible) are received from storage and emptied onto a sorting table inside a sorting box to remove liquid and other unwanted items. This process requires extra safety precautions since there is a high possibility of radionuclide contamination. The sorting box will be operated at a negative pressure of at least 30 Pa below atmospheric. This negative pressure will be maintained by the ventilation system, which will provide adequate extraction through a set of HEPA filters (Note: mentioned ventilation system is supplied by Necsa). The drum containing the contaminated waste will be secured in position by a sorting box iris port that seals the sorting box off against the outside of the drum before removing the lid from the inside of the sorting box.

A facility hazard level determination was done and found to be HL(N) = 0.

## 3.0 SCOPE OF SUPPLY

1. The scope includes the design, manufacturing, supply and installation of:
   - 1.1. Two sorting boxes with associated drum lifting and tilting mechanisms, conveyors, and in-drum compactor,
   - 1.2. A fume cupboard for liquid sampling,
   - 1.3. Computer system with monitors and barcode readers for each sorting box,
   - 1.4. A height adjustable workstation for each sorting box.
2. Both sorting boxes shall enable the segregation of dry waste from liquids.
3. Both sorting boxes shall enable the repacking of waste into another drum.
4. The supplier shall develop a quality control plan for the fabrication and assembly of the components.
5. The supplier shall source materials of construction, fabricate and assemble the equipment in accordance with supplier's design specifications and the purchase specification supplied by Necsa.
6. The supplier shall perform non-destructive tests where applicable. Do a factory acceptance test on the components before shipment to Necsa and do a site acceptance test after installation at Necsa.
7. In addition a fabrication and manufacturing data pack with approved mechanical drawings and related design documents e.g. electrical and instrumentation design documents and drawings,

control and automation system design documents etc., to be supplied to Necsa together with equipment on delivery of all the components by the supplier to Necsa.

8. An operational manual detailing the safe operation of the facility.
9. A maintenance manual indicating routine maintenance and the spare parts list for all components must be supplied by the supplier to Necsa together with equipment on delivery of the equipment.
10. Supply of the required spare parts for all components at commissioning stage to Necsa together with equipment on delivery of the equipment.
11. SAT and functional test, commission and operator training to be part of this package.

## 4.0 REFERENCES

No references applicable.

## 5.0 DEFINITIONS AND ABBREVIATIONS

### *5.1 DEFINITIONS:*

| | |
|---|---|
| Liquids: | A wide variety of liquids of unknown consistency (e.g. water, oil, chemicals). |

### *5.2 ABBREVIATIONS:*

| | |
|---|---|
| NLM | Nuclear Liabilities Management department of Necsa |
| WSRF | Waste Segregation and Repacking Facility |
| WTS | Waste Tracking System |
| AGS | American Glovebox Society |

## 6.0 GENERAL REQUIREMENTS

The sorting boxes will be connected to an existing ventilation system which will be operated at a slightly negative pressure (-40 to -30 Pa) relative to the atmosphere, to contain radioactive and toxic components present in the waste feed and thereby protecting the operating personnel when they perform their tasks. The glove-box will be used as primary containment system.

The sorting boxes should enable 1) the safe segregation and 2) repacking of low-level radioactive waste. The fume cupboard should enable the sampling of liquid from the 5L containers described below.

The sorting boxes shall be designed to accommodate drums with diameters ranging between 0.455m and 0.630m (Drum size over top end with lid installed). These would be for example 100L / 160L / 210L metal drums, or plastic barrels. The waste to be handled will typically consist of compressible or non-compressible waste mixed with liquid containing containers. Liquids may also be absorbed into the waste or free standing inside the drum.

When segregating waste, the sorting boxes shall enable the manual removal of waste from the intended waste containing drum. The operator should then be able to segregate dry waste and collect it in a drum designated for dry waste and segregate the liquid (which is inside containers) into a container designated for liquid. If free liquid is in the drum it shall be diverted to the receiving drum for dry waste (in this case the drum will be marked as 'wet').

When repacking the waste, the facilities should enable the removal of waste from the waste containing drum and placement of the waste into another drum.

The sorting box shall have an in-drum compactor to compact the waste into the receiving drum if required.

Lead shielding, including a shielded glass window, shall be installed to reduce the radiological dose to operator.

## 7.0 DESIGN

### *7.1 GENERAL*

The Sorting boxes and related items must be designed to sound engineering and scientific practices and appropriate technical standards to ensure intended performance. Utilize the AGS guideline, the design checklist and applicable AGS Standard of practice, such as:

1. Application of Linings to Gloveboxes #AGS-G003-1998 or latest revision,
2. Gloves for Gloveboxes #AGS-G005-2003 or latest revision
3. Design and Fabrication of Nuclear - Application Gloveboxes #AGS-G006-2005 or latest revision, to ensure all issues are considered.

Assembly drawings; shell drawing showing windows, glove-port locations, and other openings with welded appurtenances; miscellaneous details; dimensioning; tolerance; parts list; and manufacturing drawings.

Safety, human factors, appurtenances, cleanliness, maintenance, and other interfaces must be considered when designing the sorting box shell.

Formed from sheet, Coved corners, 16 mm Radius is standard and sloped front.

Adhere to Occupational Health and Safety Act 85 of 1983.

Utilize the applicable nuclear industry related ISO standards, as necessary.

- ISO 10648-1: Containment enclosures Part 1
- ISO 10648-2: Containment enclosures Part 2
- ISO 11933-1: Components for containment enclosures Part 1
- ISO 11933-2: Components for containment enclosures Part 2

1. The design must aim to minimise dead spaces in order to prevent accumulation of fine particulates.
2. The design must aim to minimise maintenance since the equipment will be contaminated with uranium.
3. Sufficient glove portals shall be provided to enable operator reach inside the sorting boxes to enable operational and cleaning activities. Cut resistant gloves shall protect the operator from sharp objects and hazardous chemicals.
4. A press/ compactor for in-drum compaction shall be provided for in each sorting box to compact waste into the receiving dry waste drum when required. Said press shall have a compaction force of at least 600kg.
5. The sorting box design shall enable the taking of photographs of the receiving drum while open in the compartment. The photos shall be taken from the top and a frame shall be provided on the outside of the sorting box for the holding of the camera. A window shall be provided to enable photos to be taken. The position of the window and frame should prevent any glare/ reflection on the photos or distortion of the image taken. Photos shall be uploaded to the database. See section 7.12 for more details on the camera.
6. Drums shall be moved to the clamp and lifting equipment (described below) on an automated conveyor system which is linked to the neighbouring X-ray system (See Section 7.20 for details).
7. Automated mechanical equipment shall be provided to clamp and lift and tilt the input drum. The lifting and clamping equipment shall be operated from an operator console at least 1.5m from the drum. A horizontal drum loading port shall be provided. This port shall be between 40mm and 100mm above the sorting table to allow emptying of waste from the drum. The port shall have an opening and closing mechanism that is automated or operated from the operator console. The opening and closing mechanism shall be such that the spreading of contamination is prevented at all times.
8. Drums to be segregated / repacked shall be securely connected to the sorting box by means of a durable seal while closed. This seal shall prevent spillage of liquid from the sorting box and contamination from spreading to the surrounding area. Opening of the input drum lid shall be done from the inside of the sorting boxes. A vertical cabinet shall be provided to place the drum lid and closing ring in. This vertical cabinet shall be ventilated in such a way that airflow out of the cabinet is ensured as to minimize contamination entering into the vertical cabinet. The supplier to consider means of easing the opening of the drum from inside. This could be a challenge as the depth of the box is 650mm which is outside the reach of the operator from the front of the sorting box. One option is to enable the drum to be pushed into the sorting box to bring it into reach. After opening the drum can be pulled back for the sorting activity.
9. A 200mm diameter coupling shall be provided to connect the ventilation system to the sorting box and 200mm diameter for the fume cupboard.
10. A sorting table (floor of sorting box) manufactured from stainless steel shall be installed in both sorting boxes and should be sloped down to the receiving drum.
11. On the left hand side of the sorting table shall be an opening for the receiving drums described in Table 1 to receive dry waste. The same size opening will be used for all receiving drum sizes. A lip shall be installed on the inside of the opening that extends down for about 20mm into the top of the drum (to act as a kind of funnel). The slope should be such that waste can be easily scraped into the drum.
12. To the right of the sorting table there shall be a horizontal coupling point, slightly sloped downwards, in the wall of the sorting box. This is to couple a wide mouth 5L container that

will receive containers with liquid removed from the waste. This container shall screw onto the structure (or a mechanism to hold the container in place while the opening is pressed against, a seal shall be provided). A drip tray shall be installed underneath the 5L container. A cover shall be provided to close the coupling point if no liquid receiving container is attached. The 5L container shall screw into position with the screw thread for screwing a lid onto it (or held in position as described above). All of these ports shall consist of a replaceable connection part in order to ease the change to another size opening or to another type of screw thread. Optionally an iris port may also be used.

13. The output (receiving) drum shall connect to the sorting facility while in the upright position. The sorting table shall be high enough to enable the connection of the receiving drum while it is on a jack trolley. The jack trolley shall be used to lift the drum to make contact with the sorting table.
14. The sorting table shall be stainless steel with smooth surfaces for easy cleaning, strong enough to hold the entire content of a drum. The corners of the sorting table shall have a radius for easy cleaning.
15. Covers must be provided to close all openings when a drum or 5L container is not connected. These covers shall cover the openings from the outside and shall be easy to clean. This is to prevent possible contamination from dropping to the floor and to keep the ventilation pressures within limits. The movement of covers shall be such that the spreading of contamination is prevented.
16. A double door airlock shall be provided to enable the loading / unloading of equipment / tools / other items, to / from the sorting boxes (0.5m x 0.5m x 0.5m). It must be ensured that there is a constant inward flow of air through the airlock.
17. A computer with barcode scanner and display screen shall be provided for each sorting box. The X-ray Facility information shall be displayed on the screen after scanning the applicable input drum's barcode. This will assist the operator to determine segregation activities applicable.
18. The outer panels of the sorting boxes shall be shatterproof and transparent to ease viewing inside. Panels shall also be removable to enable maintenance work. The front window shall be of shielding glass as specified below.
19. The sorting boxes and fume cupboard shall be bolted/ secured to the facility floor to ensure stability.
20. The sorting boxes and fume cupboard shall be connected to the ventilation system. The fume cupboard shall be large enough to enable the sampling of liquids from the 5L containers.
21. Workers may be seated if required.
22. Proper lighting shall be provided (install outside of containment area to ease maintenance).
23. Lifting equipment shall be provided for lifting of heavy objects (e.g. input drums).
24. Enough space shall be provided for maintenance activities.
25. Ergonomics must be considered during the design of the facility and equipment. The height of workstations etc. must be designed to limit operator fatigue.
26. Equipment to remove waste from a drum shall be provided.
27. All applicable safety and radiological signs and markings shall be installed.
28. Materials used shall prevent the spread of fire.

### *7.2 Shell and Shell Joints*

1. Shells shall be fabricated from formed 300 series austenitic stainless steel sheet; 304L or 316L shall be utilized for corrosion resistance concerns.
2. Design should minimize contamination traps created by sharp corners, cracks and crevices.
3. Shell must be continuously welded, and all internal shell welds are ground flush.
4. Shell welds are dye penetrant tested to find all pits and cracks.
5. Flanged joint is commonly used, and Avoid "3-way" joints, keep all sealed connections on a single plane.
6. Avoid fastener connections that penetrate the containment boundary with through holes, use weld studs to prevent a leak path, make gaskets from one piece to avoid corner joints or seams.

### *7.3 Weld studs and Fasteners*

1. Capacitor Discharge (CD) weld studs should be used whenever possible to eliminate holes through the containment boundary.
2. Use dome head bolts on the inside and nuts on the outside where needed.

### *7.4 Gaskets materials*

Flat gaskets can be made from many materials, most common are neoprene, EPDM, butyl rubber, and silicone. The gasket hardness should be 35 to 45 durometer. Thickness used shall range from 3.175mm to 6.35mm.

### *7.5 Glove Ports and Gloves*

1. Glove-ports may be oval or round, mounted in the window or in the shell. Gloves can be right or left handed or ambidextrous. Glove materials shall be acid and cut resistant.
2. Use gloves with a "grasp" design to reduce fatigue by allowing the hands to reach in their normal relaxed position, and Improve contact friction with textured finger surfaces.
3. Clamping devices shall be installed to house gloves when not in use.
4. Provide adequate spacing for glove-hand and finger clearance.
5. Glove height should be adequate for extended usage by an operator.

### *7.6 Transfer Devices*

Airlocks and doors shall be used as transfer devices to provide a means to transfer materials into or out of the glove-box without breaching containment.

### *7.7 Windows*

1. Windows provide the primary means of viewing inside the glovebox. Common types of window materials include laminated safety glass, tempered glass and polycarbonate.
2. Work station windows shall be tilted away from operator at 10° to 15° for improving visibility in the glovebox and minimizing back strain on the operator.

3. Select material based on transparency, and resistance to abrasion, corrosion, and breakage, as necessary.
4. Maximize size to optimize visibility, with the goal of eliminating blind spots.
5. See Section 7.17 for information regarding shielded window.

### *7.8 SHELL PENETRATIONS*

Penetrations like lighting, access and service panels' technical specification, and feedthroughs shall be used to allow access to the glove-box for specific purposes while maintaining containment.

### *7.9 LIGHTING*

1. Lighting mounted outside to minimize maintenance inside the glovebox. Fluorescent or LED lighting shall be used. High Intensity Discharge (HID) lighting can be used when space is an issue, and locate lights on top when feasible.
2. Provide luminaries with baffles to diffuse light, and ensure light tube is not directly visible to a user's eye.
3. Provide flat, matte finishes on interior surface of the glove-box to reduce glare and avoid glossy finishes, which induce glare.

### *7.10 FEEDTHROUGHS*

Services, controls, and instrumentation leads must be passed through glove-box confinement barriers without breaking containment.

### *7.11 SUPPORTS AND STANDARDS*

Glove-box supports and stands to be fabricated from standard structural shapes, square or rectangular tubing. Supports will be made from stainless steel or painted carbon steel and constructed by welding or bolts, anchored to the floor.

### *7.12 INSTRUMENTATION AND COMPUTER*

1. Provide camera linked to computer for the taking of photographs (minimum 8 mega pixels). Taking of photo to be controlled from the computer. Drum barcode number to be shown on image. Restoring of saved images for review and manipulation purposes.
2. Provide simplistic labels for quick identification and interpretation of any controls and displays.
3. Computer linked to WTS or own database. Screens to view X-ray images. Barcode readers. Linked to control console for operator to lift and tilt drum. Minimum specification for computer: Processor: INTEL i7-9700 @3.00GHz, RAM: 8GB, Hard disk: 1TB SSD.
4. Handheld barcode reader for input of barcode into database (Barcode type: Code 128).
5. Computer with Windows 10 Operating System
6. Two 24 inch monitors to be provided for each sorting box. One monitor for operational activities and the other (in portrait/ vertical orientation) for X-ray image viewing.
7. Uninterruptable power supply for 20 minutes of operation of computer and monitors.

### *7.13 ELECTRICAL CONSIDERATIONS*

1. The glove-box should be earthed in the facility. Glove-box lines may require earth jumpers due to the use of seals that act as insulators.
2. The glovebox should have at least one double adapter single phase, 230 V power outlet on the outside of the sorting box.

### *7.14 TESTING*

A Factory acceptance test shall be performed by the supplier as prescribed by Necsa. This test will be to test compliance with this purchase specification.

### *7.15 PACKAGING, LOADING AND SHIPPING*

Design should include lifting lugs on the sorting box, and equipment to facilitate handling.

### *7.16 PROCESS PARAMETERS*

**Table 1: Sorting boxes input.**

| **Sorting boxes input** | | | |
|---|---|---|---|
| **Drum description** | **Drum height (m)** | **Drum opening diameter (m)** | **Maximum drum weight** |
| Metal drums/ Barrels to be processed | Maximum: 0.885 | Range between 0.455 and 0.61 | 500kg |
| Empty 100L or 160L | Maximum 0.885 | 0.495 / 0.53 | Drum net weight |
| Empty 210L drums | Maximum 0.885 | 0.58 | |
| Empty liquid container | Maximum volume of 5L | | |

The above mentioned drums are segregated into dry output and liquid output.

The dry receiving (output) is:

**Table 2: Dry output of sorting box.**

| **Sorting boxes output (dry)** | | | |
|---|---|---|---|
| **Drum description** | **Drum height (m)** | **Drum diameter including lid and closing ring(m)** | **Maximum drum weight** |
| Filled 100L or 160L metal drum (for compressible waste) | Maximum 0.885 | 0.495 / 0.53 | 500kg |
| Filled 210L drum (for non-compressible waste) | | 0.63 | |
| Empty metal drums/ Barrels after processing | Maximum: 0.885 | Range between 0.455 and 0.63 | Drum net weight |

The liquid output is:

**Table 3: Liquid output of sorting boxes.**

| **Sorting boxes output (liquid)** | |
|---|---|
| **Container description** | **Container description** |
| Container | Maximum volume of 5L. |

### *7.17 RADIOLOGICAL REQUIREMENTS*

The facility shall ensure that radioactive contamination is contained. Environmental impact should be minimized. The sorting boxes shall be operated at a negative pressure of at least 30 Pa below atmospheric.

Radiological exposure to operators should be limited by isolation from contamination. The sorting boxes shall be fitted with additional shielding to protect the workers against external radiation exposure when working in front of the sorting box. Lead and lead glass with the composition shown in Table 4 shall be fitted to protect the operator. The lead and lead glass shall be 10mm thick. Lead shielding shall be installed on:

1. Two sides (closest to the operator) of the receiving drum.
2. Underneath the sorting table
3. Surface facing the operator while segregating the content

The lead glass shall be installed on the window section facing the operator position while segregating the content.

**Table 4: Material composition of Lead and Lead glass shields.**

| Lead Glass ($\rho$ = 6.22 g cm$^{-3}$) | | Lead ($\rho$ = 11.35 g cm$^{-3}$) | |
|---|---|---|---|
| **Nuclides** | **Atomic Fraction** | **Nuclides** | **Atomic Fraction** |
| O-16 | 5.915111E-01 | Pb-204 | 1.400000E-02 |
| O-17 | 2.253218E-04 | Pb-206 | 2.410000E-01 |
| O-18 | 1.215552E-03 | Pb-207 | 2.210000E-01 |
| Si-28 | 1.610284E-01 | Pb-208 | 5.240000E-01 |
| Si-29 | 8.176633E-03 | | |
| Si-30 | 5.390097E-03 | | |
| Ti-46 | 8.457075E-04 | | |
| Ti-47 | 7.626744E-04 | | |
| Ti-48 | 7.557037E-03 | | |
| Ti-49 | 5.545791E-04 | | |
| Ti-50 | 5.310018E-04 | | |
| As-75 | 2.146000E-03 | | |
| Pb-204 | 3.080784E-03 | | |
| Pb-206 | 5.303350E-02 | | |
| Pb-207 | 4.863238E-02 | | |
| Pb-208 | 1.153093E-01 | | |

### *7.18 PROCESS CONTROL*

The following drum information must be tracked and stored when sorting or repacking drums content:

1. Original drum barcode.
2. New child drum barcodes (drum(s) with dry waste and container(s) with liquid)
3. Whether waste is placed back into original drum or new drum.
4. Drum barcode scan: system to indicate whether drum is accepted or not. System shall not load drum if not accepted.
5. Interlock on the drum tilting mechanism to prevent accidental activation while drum is being sorted.
6. Interlocking of any other equipment and processes to ensure safe operation.

### *7.19 TECHNICAL SPECIFICATION*

| Parameter | Specification |
|---|---|
| Dimension of sorting box | Length =1800 mm<br>Height = 800 mm<br>Depth = 650 mm<br>Volume – 0.94 m3 *Note.: Refer to* ***Attachment 1*** *for details* |
| Loading and unloading of drums to be processed. | Loading will be achieved by emptying drums into the glove-box. Drums shall be lifted via a lifting mechanism driven by an appropriate device, to lift drums from a vertical position up to a 100° angle, to allow easy emptying of drums into the glove-box. This should be done through an appropriate airlock to minimise contamination. Liquids and other unwanted items will be removed. Liquid in containers will be placed in the 5L container at the side of the sorting box. |
| Surrounding environment | 10 to 40 °C, and up to 80 % Relative humidity to protect the operation and control panel. |
| Equipment operating electrical power | Single phase 220 VAC ± 10 % “OR” three phase line to line 380 VAC +10/-5 % 50 Hz or 60Hz ± 2 Hz. |
| Essential Spares | Provide a list of essential spare parts. Supply essential spare parts that are not readily available off the shelf. |

Note: The purchaser reserves the right to ask for minor modification in specification without affecting the cost of the glove-box.

### *7.20 CONVEYOR SYSTEM*

The conveyor system has to link to the neighbouring X-ray facility. The X-ray facility conveyor is a gravity feed conveyor at approximately 700mm high and slope of 2 degrees. The connection to be supplied shall change the conveyor direction 90 degrees to the right and thereafter continue straight for about 12 m. The conveyor shall then split in two so that drums can be send to the required sorting box. This action shall be operated by the operator from an operator console. The movement of drums on the conveyor shall be motorised and automated as much as possible. Each conveyor line shall move the drum up to the drum lifting and tilting mechanism at the back of the sorting box. See 11.0ATTACHMENT 2 for a layout drawing.

Guides shall be installed to prevent drums from falling of the conveyor.

### *7.21 FUME CUPBOARD*

A fume cupboard shall be installed with the following dimensions: 1m wide x 0.6m deep x 0.6m high, installed on a frame that is at comfortable working height. The fume cupboard shall be fastened to the floor.

## 8.0 FABRICATION AND ASSEMBLY REQUIREMENTS

The following information needs to be taken into account during fabrication and assemble of the glove-box.

### *8.1 NORMAL WORKING AND DESIGN PRESSURE*

The glove-box will be used to handle radioactive and toxic material, and it will operate under a negative pressure of 30 Pa relative to atmosphere.

### *8.2 CORROSIVE AND DEGRADING ATMOSPHERES*

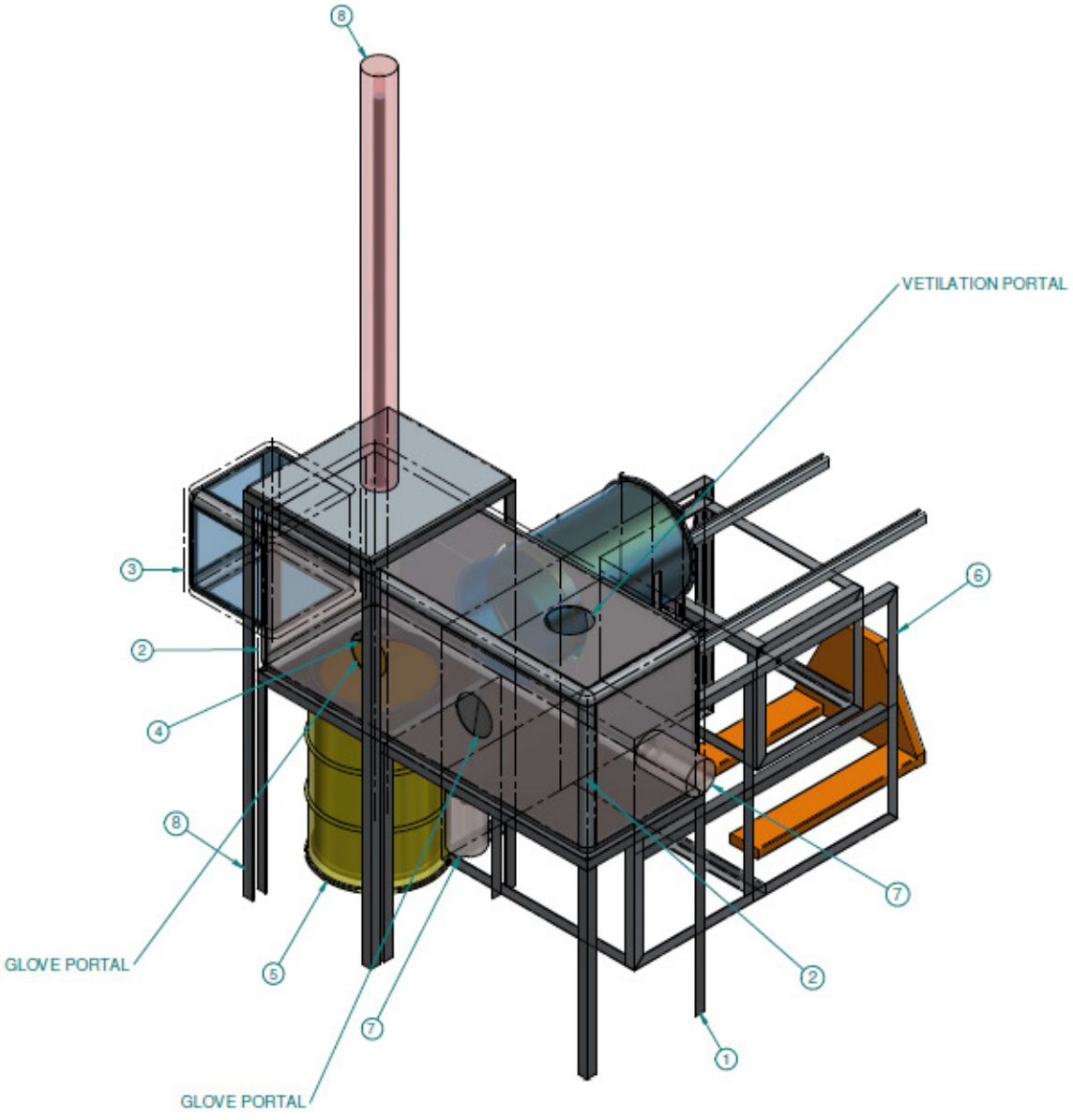
Care should be taken when selecting plastic fittings and assemble material for use in a radioactive and corrosive environment. In such circumstances the component materials need to be able to withstand chemical, radiological and corrosion product attack. Proper material selection shall ensure that material resistant to radioactivity, toxicity and corrosion attack are selected and used.

## 9.0 RECORDS

No records applicable.

## 10.0ATTACHMENT 1

Below is a concept drawing. Note: the below drawing is merely an indication of the facility. The sorting box shall be as small as possible. The position and number of glove portals shown below are not prescriptive. The tilted window is not indicated. Item #7 is not applicable to the design.



## 11.0ATTACHMENT 2

Below is a layout drawing of the facility. The conveyor section in blue is to be supplied.