PTFE Filter Destruction project glove-box purchase specification

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The revision history of the document is available in the DocMan System

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List of Acronyms & Abbreviations

The following acronyms and abbreviations are used in this document:

AGS	American Glovebox Society
CCDS	Controlled Constant Depression System
CDFS	Constant Depression Fan System
DG	Design Guide
EPDM	Ethylene Propylene Diene Monomer
FAT	Factory Acceptance Test
SAT	Site Acceptance Test
HEPA	High Efficiency Particulate Air
HPE	High Pressure Extract
NW	Nuclear waste
OEM	Original Equipment Manufacturers
Pa	Pascal
PTFE	Polytetrafluoroethylene
RA	Radio Active
RFQ	Request for Quotation
RIB	Resistive Air In-Bleed
SAPR	Self Acting Pressure Regulator
VXA	Vortex Amplifier

1 INTRODUCTION

PTFE candle filters (PCF`s) have previously been used in Necsa's pilot and semi-commercial uranium enrichment plants. These filters are contaminated with enriched uranium and are classified as a radioactive waste. There is a need to safely dispose of this waste to reduce Necsa's nuclear liability and to recover the uranium values locked into the matrix of the PCF`s.

Uranium will be recovered from these contaminated PTFE candle filters by means of depolymerisation inside an inductively heated reactor. PCF`s will be depolymerized inside a depolymerisation reactor at a temperature of 800 °C[1]. The produced fluorocarbon gases will be destroyed inside the plasma reactor which will be positioned very close to the depolymerisation reactor in order not to allow the gas to cool down.

The glove-box is required for nuclear waste PTFE filters pre-preparation to contain hazardous substance such as radioactive materials, before the PTFE filters are prepared and shredded in preparation for treatment.

The purchase specification (this document) will be used together with tender documents, glove-box drawings and data sheet at procurement stage. Successful bidder will be required to design, fabricate, assemble, deliver (at Necsa in Pelindaba), install, perform functional (FAT & SAT), and commission the glove-box.

2 PURPOSE

The purpose of this purchase specification is to provide details of the requirements for glove-box design, order materials, fabricate, assemble, deliver (at Necsa in Pelindaba), install, perform functional and site test (FAT & SAT) and commission the glove-box, along with all its accessories. This equipment is required for containing radioactive nuclear waste, and this Purchase specification will detail the scope of supply expected to be met by the suppliers.

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[1] A.T. Grunenburg, J.T. Nel, G.G. Maluleke, O.S.L. Bruinsma, The Continuous Depolymerisation of Filled Polytetrafluoroethylene With a Continuous process, J. Appl. Polymer Science, 109 (1) 264 – 271, 2008.

3 SCOPE OF SUPPLY

The scope includes glove-box design, ordering materials, fabricate, assemble, deliver, install, functional test (FAT & SAT) and commissioning the glove-box (at Necsa in Pelindaba), along with all its accessories. The glove-box will be manufactured and assembled in accordance to the design drawings shown in ***Appendix A***. The scope also include the supply of critical spares, which must be delivered with the glove-box.

All the requirements mentioned in this document should satisfy and meet all the requirements highlighted in the glove-box ISO standards.

4 GENERAL REQUIREMENTS

The glove-box will be operated at a slightly negative pressure (-50 to -1 500 Pa), to contain radioactive and toxic components of the NW feed and thereby protecting the operating personnel when they perform their tasks inside the glove-box without breaking containment.

The glove-box will be connected to a facility/building ventilation system, through an appropriate filter (HEPA filter) and blower, in such a way that it can operate independently (meaning that it must not be reliant on the facility utilities).

The glove-box will be used as primary containment system, and the ventilation of the glove-box will take precedence over the facility/building ventilation system. The glove-box will be supplied with a drain point that will drain any possibility of liquid that may be contained in drums full of PTFE filters. The drain point will be fitted with a mesh that will prevent clogging of the drain point. The drain point will also be fitted with a nipple and a drain valve below the glove-box, where a liquid container will be positioned. The left hand side of the glove-box will have a 250mm (10 inch) diameter opening, which will be used to feed PTFE filters, via a flexible bellow. The bellow will be attached underneath the glove-box to cover the opening, and directly connected to the top of the shredder. The shredder will be positioned directly underneath the opening.

The glovebox will be supplied with a drum lifting device capable of lifting up to 50kg of 160 to 210L drums.

The glove-box will be fitted with two pairs of gloves. One set of gloves will be fitted on the right hand side of the glove-box. This set of gloves will be used to empty PTFE filters from drums into the glove-box. The second pair of gloves will be used to load PTFE filters from the glove-box into the shredder.

5 DESIGN

- The Glovebox 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:
  i. Application of Linings to Glove-boxes #AGS-G003-1998 or latest revision.
  ii. Gloves for Gloveboxes #AGS-G005-2003 or latest revision.
  iii. Design and Fabrication of Nuclear - Application Gloveboxes #AGS-G006-2005 or latest revision, to ensure all issues are considered.
- Assembly drawings: shell drawing (weldment) showing windows; glove-port locations, and other openings with welded appurtenances; miscellaneous details; dimensioning; tolerance; parts list; and shop drawings.
- Safety, human factors, appurtenances, cleanliness, maintenance, and other interfaces must be considered when designing a glove-box shell.
- Formed from sheet, Coved corners, 16 mm R. is standard, Coved corners, 16 mm R. is standard, and sloped front.
- Adhere to Occupational Health and Safety Act 85

- Utilize the applicable nuclear industry related ISO standards:-
  - 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
  - ISO 11933-3: Components for containment enclosures Part 3
  - ISO 11933-4: Components for containment enclosures Part 4
  - ISO 11933-5: Components for containment enclosures Part 5

- ISO 146447-7: Clean rooms and associated controlled environments Part 7
- ISO 17873: Nuclear facilities - criteria for the design and operation of ventilation systems other than nuclear reactors.

5.1 Shell and shell joints

- Shells shall be fabricated from formed 300 series austenitic stainless steel sheet; 304L or 316L shall be utilized for corrosion resistance concerns.
- Design should minimize contamination traps created by sharp corners, cracks and crevices.
- Shell must be continuously welded, and all internal shell welds are ground flush.
- Shells are polished to a #4 finish per ASTM A480 (150 grit sand paper).
- Shell welds are dye penetrant tested to find all pits and cracks.
- Flanged joint is commonly used, and Avoid "3-way" joints, keep all sealed connections on a single plane.
- 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.

5.2 Windows.

- Windows provide the primary means of viewing inside the glovebox. Common types of window materials include laminated safety glass, tempered glass and polycarbonate.
- Work station windows (zipper Window and the clamped window) tilted at 10° to 15° for improving visibility in the glovebox and minimizing back strain on the operator.
- Select material based on transparency, and resistance to abrasion, corrosion, and breakage, as necessary.
- Maximize size to optimize visibility, with the goal of eliminating blind spots.

5.3 Weld studs & fasteners

- Capacitor Discharge (CD) weld studs should be used whenever possible to eliminate holes through the containment boundary.
- Acorn nuts to be used to eliminate contamination traps. Galling can be a problem with stainless steel fasteners, an anti-galling compound should be used.

5.4 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 1/8 inch to 1/4 inch.

5.5 Glove-ports and gloves

- 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 natural latex, neoprene, hypalon, butyl rubber, and loaded neoprene.
- 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.
- Clamping devices shall be installed to house gloves when not in use.
- Provide adequate spacing for glove-hand and finger clearance.
- Glove height should be adequate for extended usage by an operator.

5.6 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.

5.7 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.

5.8 Lighting

- Lighting mounted outside to minimize maintenance inside the glove-box. 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.
- Provide luminaries with baffles to diffuse light, and ensure light tube is not directly visible to a user's eye.
- Provide flat, matte finishes on interior surface of the glove-box to reduce glare and avoid glossy finishes, which induce glare.

5.9 Feedthroughs

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

5.10 Supports and stands

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.

5.11 Instrumentation considerations

- Differential Pressure Gauge shall be fitted - to monitor the glove-box internal pressure.
- Differential Pressure Gauge shall be fitted - to monitor supply and exhaust filter pressure drop.

- Pressure control loop (pressure transmitter and Pressure control valve) to control the pressure inside the glove-box.
- An exhaust blower must be connected to the filter housing to provide uninterrupted ventilation.
- Exhaust Duct Airflow Monitor shall be fitted- to monitor exhaust air flow from glovebox.
- Provide simplistic labels for quick identification and interpretation of any controls and displays

5.12 Electrical considerations

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

5.13 Testing

- Incorporate key features in the design to support the type of leak testing specified for the glove-box system.

5.14 Ergonomics

Refer to the anthropometric data in ***Appendix B*** for human factors.

5.15 Packaging, loading and shipping

- Design the glove-box system to disassemble into smaller sections to ease handling, crating, and shipping.
- Designs should include lifting lugs on large tanks, gloveboxes, and equipment to facilitate handling.
- Verify that the system can pass through the doorways and hallways required to reach the installation site.

6 TECHNICAL SPECIFICATION

Parameter	Specification
Dimension	Length =1880 mm Height = 800 mm Volume - 1.292 m^3 *Note.: Refer to **Appendix A** for details*
Material of construction	Series 300 austenitic stainless steel type 304L as per ASTM A240 for plates or 316L and ASTM A312 for pipes. Only seamless pipes shall be used during construction. Flow piping and fittings shall be of SS304L. (Mill test certificate shall be submitted).
Design Code	The glove box shall be designed by ASME Boiler and Pressure Vessel Code (B&PV Code) Section VIII, division-1
Fabrication	The fabrication of the box shall comply with requirements of Section IX of ASME B&PV Code. Inner surface of the chamber shall be electro polished for low outgassing rate.
Loading and unloading	Loading will be achieved by emptying NW drums into the glove-box. Drums will be lifted via a quarter circular rack mechanism driven by an appropriate device, to lift drums from a vertical position to a 135^0 angle, to allow easy emptying of drums into the glove-box. This should be done through an appropriate airlock to minimise contamination. Non-compliant NW (liquids, non-compressible solids) will be removed. Liquid waste will be drained into a drain tank, and the solids moved by hand to a vertically positioned drum attached and sealed to the bottom of the glove-box to remove solid waste.
Hand gloves	Rubber gloves resistant to radioactivity and toxicity will be fitted, extending inside the glove-box, and sealed to the hand holes cut on transparent propylene panels. The gloves must be abrasion and cut resistant.
Vacuum System	The bidders are also requested to separately quote for the optional Gas Purification System for closed cycle operation to

	regulate, monitor and control oxygen and moisture, fitted with appropriate filter system, blowers and valves adoptable to the offered glove box for future upgrade. Pneumatically operated isolation valve, vent valve. Pirani gauge shall be mounted for pressure measurement. All joints shall qualify helium leak tightness better than 1 x 10-6 mbar.l/s.
Flow piping and fittings	Should be made out of stainless steel.
Surrounding environment	21 to 40 ^{0}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	Spare gloves: 2pair, Spare O Rings, seals and Gaskets: 5 each

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

7 FABRICATION AND ASSEMBLY REQUIREMENTS

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

7.1 Normal Working and design pressure

The glove-box will be used to handle radioactive and toxic material, and it will operating under a negative pressure of -50 Pa. The glove-box should however designed for a pressure of between +250 to -500Pa. It must be manufactured and assembled to withstand the specified design pressure.

7.2 Proof Test Pressure

This is the maximum negative and positive test pressure the glove-box will be designed and tested to and it should take account of identified fault scenarios. The ventilation and any pressure relief systems should be fitted to retain the glove-box within the proof test pressure with a suitable margin of safety.

7.3 Leak Rate

The normal leakage standard for the glove-boxes will be 0.05 to 0.5 % box volume leakage per hour at ±1000 Pa.

7.4 Emergency Breach Flow Velocity.

When a glove-box suffers a breach it loses its differential pressure and has a protective flow of gas through the breach. It is recommended that the optimum design breach velocity be 1.0 m/sec through an open glove port.

7.5 Flow rates

The glove-box might be operated with moist to wet feed. The air changes will be between 10 & 15 volume changes per hour to prevent condensation.

7.6 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 attach are selected and used.

7.7 Glove-box Filters

The first extraction filter must be fitted after the breach flow control device, to prevent the breach flow devise from becoming dirty. The open glove port inflow velocity is designed for an initial flow of 1.4 m/sec with clean filters. This will allow some filter blockage until a minimum flow of 0.5 m/sec is obtained. Filter blockage needs to be monitored at inlet flow volumes, which by definition are much smaller than the required breach flow. A pre-filter before the HEPA filter should be considered.

HEPA filter, with associated pre-filter, redundancy should be considered.
An inlet dust filter should be incorporated to prevent unnecessary blockage of the HEPA filters.

7.8 Heat dissipation

Under normal operation the expected flows through the glove-box will be fairly low with the flow required to remove any significant amounts of heat. Normally heat generated within a glove-box is rejected through the fabric of the glovebox and not through the exhaust flow. To provide any substantial heat removal, i.e. above that which can be dissipated through the box structure, the change rate may need to be increased substantially e.g. 30 ACH or more.

8 QUALIFICATION OF BIDDER

The original equipment manufacturers (OEM) and their authorized representatives are eligible to participate in the bid. In case of authorized dealer, a recent and valid authorization certificate from the OEM for the supply of glove box must be attached with the offer. Essential qualification criteria for the bidder are as following:

- It is desirable that the OEM to be ISO 9001: 2008 / ISO 9001: 2015 quality management system certified or its equivalent for design and manufacture of vacuum vessel or glove boxes.
- The OEM shall have at least five years of experience in design and manufacturing of glove box.
- The bidder shall also submit the list of names of organizations where the OEM has supplied the glove boxes. Offers not meeting these requirements will be treated as technically incomplete and may be rejected.

9 GLOVE-BOX TEST

9.1 Factory Acceptance Test (FAT) at vendor 's site

A pre dispatch factory acceptance test will be carried out in the presence of purchaser's engineers as follows:

- Verification of all the documents as listed in article of this specification on information management.

- Verification of traceability of raw materials and components used in the glove-box.
- Helium leak testing of the glove-box to satisfy leak rate of the system < 1x 10-6 mbar lit/sec.
- The glovebox vacuum system shall be tested for working vacuum of 1x 10-2 mbar in empty chamber.
- The manufacturer shall perform all the above checks / testing / verification on their own and send the test report to Engineering Services prior to calling Engineers for pre-dispatch factory acceptance test.

Appendix A

Glove-box Model

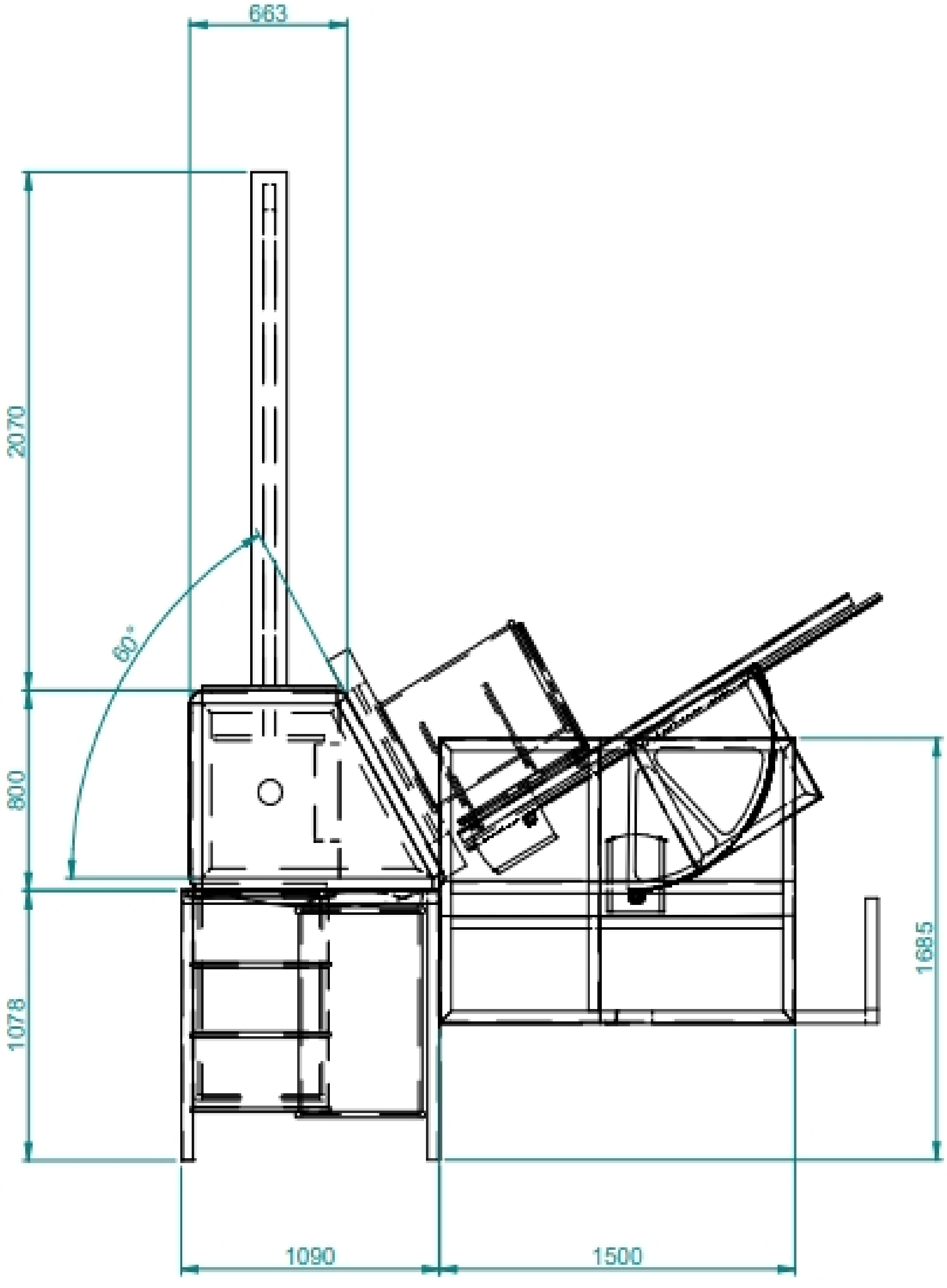

Figure 1: Glove-box drawing side view

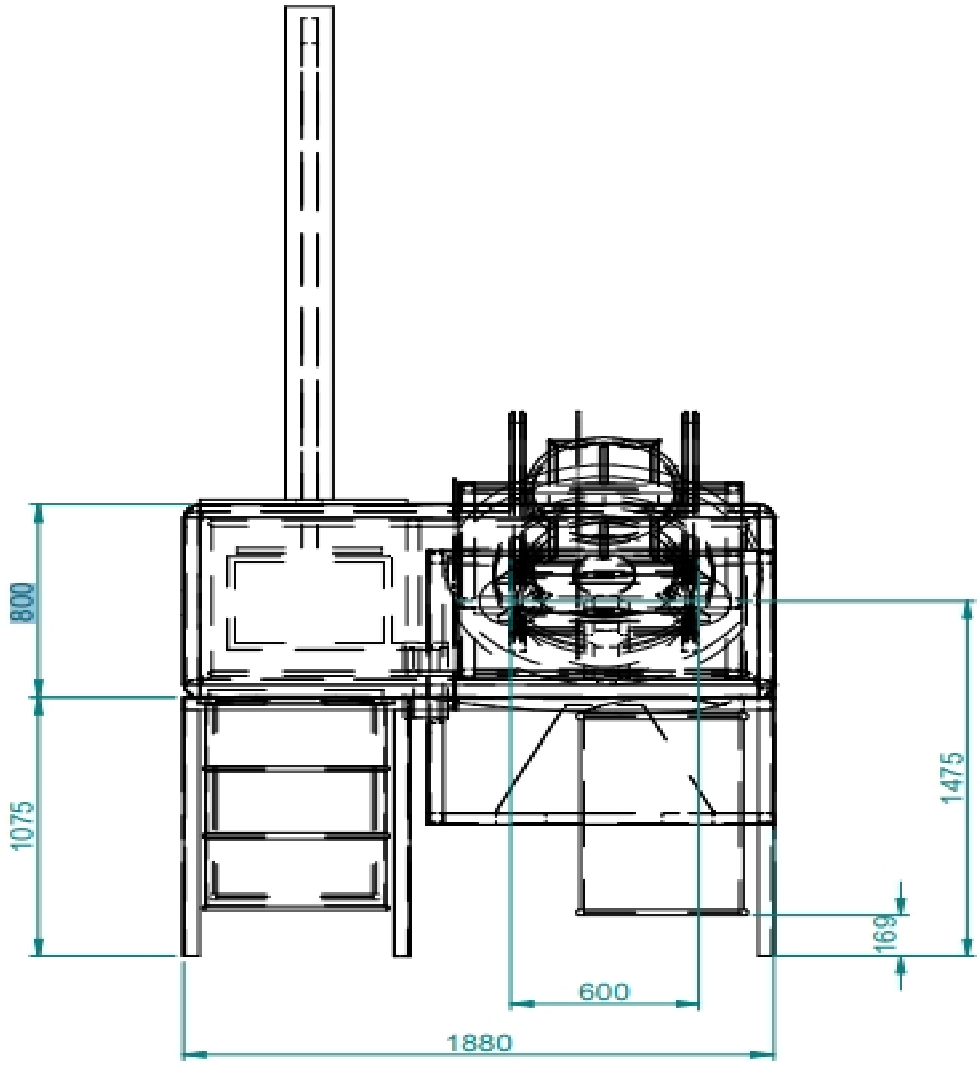

Figure 2: Glove-box drawing front view

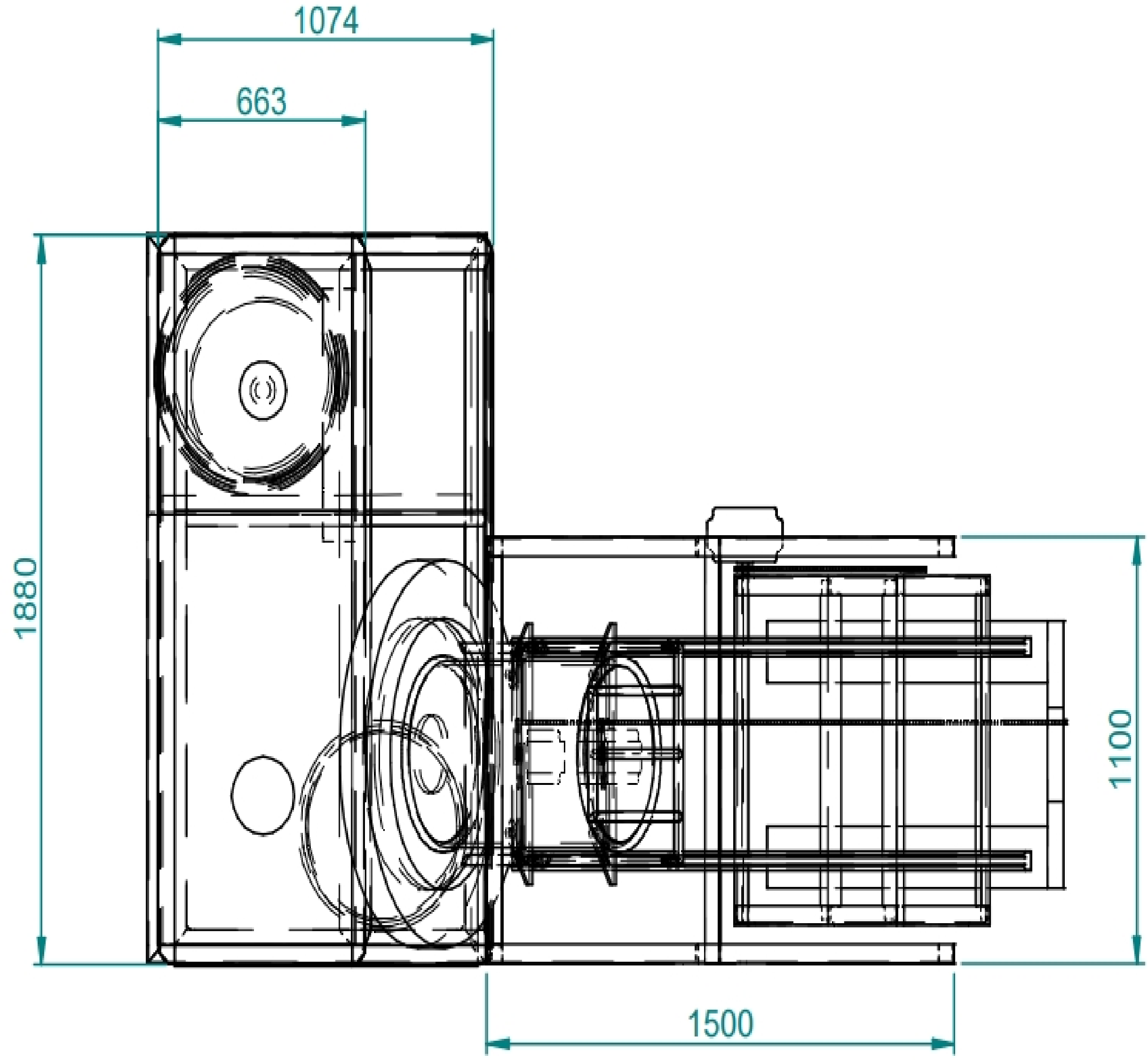

Figure 3: Glove-box drawings top view

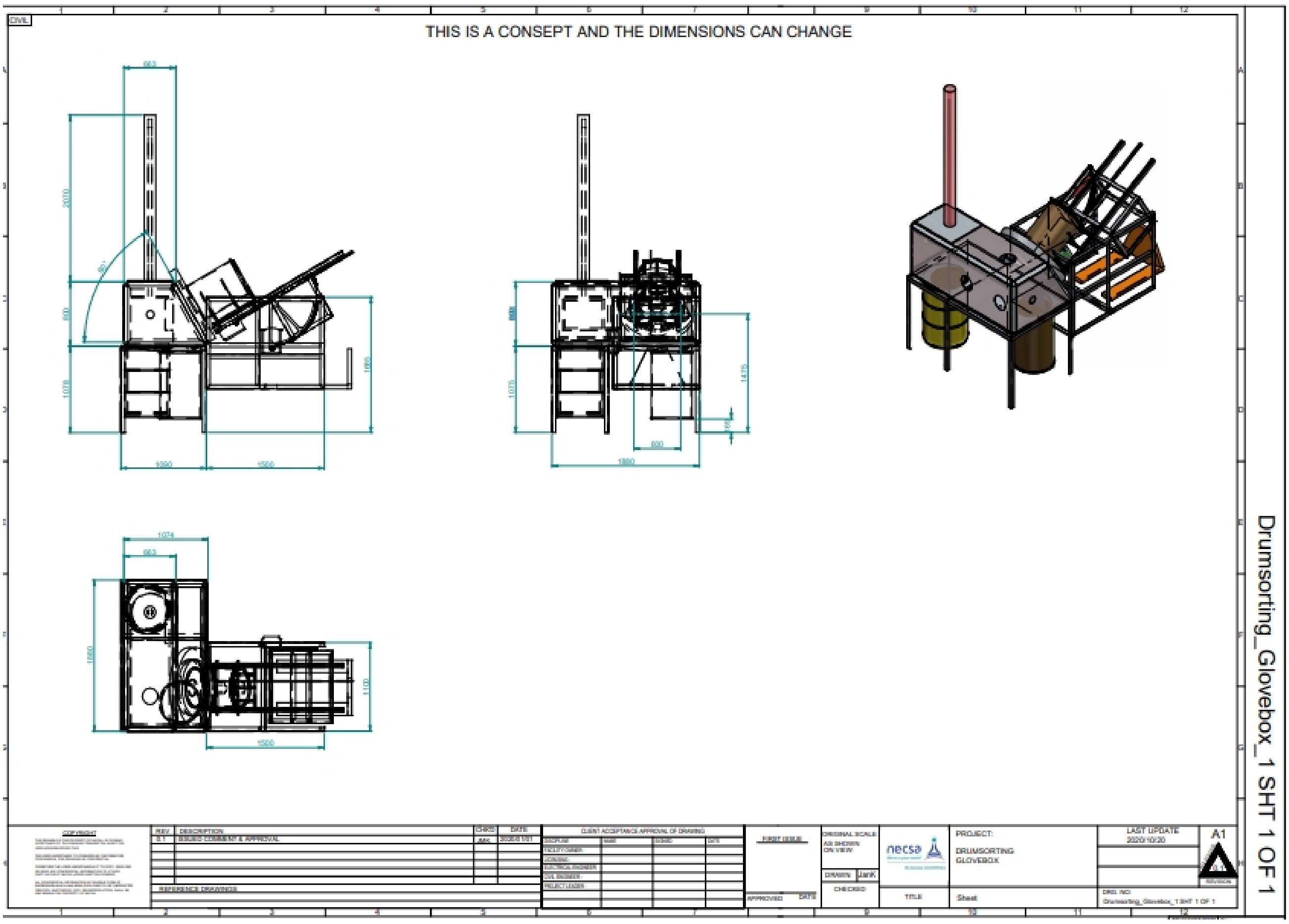

Figure 4: Glove-box general arrangement drawing

Appendix B

Table 1: Anthropometric Data and human factors

Measures - Inches	Males				Females			
	5th	50th	95th	1 S.D.	5th	50th	95th	1 S.D.
1. Stature	64.6	69.1	73.6	2.8	59.8	64.0	68.1	2.5
2. Eye Height	62.8	67.3	71.9	2.8	55.9	60.0	64.2	2.5
3. Shoulder Height	52.4	56.7	61.0	2.6	48.2	52.2	56.1	2.4
4. Elbow Height	40.2	43.5	46.9	2.1	37.2	40.2	43.1	1.9
5. Hip Height	32.9	36.0	39.2	2.0	29.9	32.9	35.8	1.8
6. Knuckle Height	27.6	30.1	32.7	1.6	26.4	28.7	31.1	1.5
7. Fingertip Height	23.4	26.0	28.5	1.5	22.2	24.8	27.4	1.6
8. Sitting Height	33.7	36.0	38.4	1.4	31.5	33.9	36.2	1.4
9. Sitting Eye Height	29.1	31.5	33.9	1.4	27.2	29.5	31.9	1.4
10. Sitting Shoulder Height	21.5	23.6	25.8	1.3	20.1	22.2	24.4	1.3
11. Sitting Elbow Height	7.7	9.6	11.6	1.2	7.3	9.3	11.2	1.1
12. Thigh Thickness	5.3	6.3	7.3	0.6	4.9	6.1	7.3	0.7
13. Tailbone-Knee Length	21.7	23.6	25.6	1.2	20.7	22.6	24.6	1.2
14. Tailbone-Popliteal Length	17.5	19.7	21.9	1.3	17.3	19.3	21.3	1.2
15. Knee Height	19.5	21.7	23.8	1.3	18.1	19.9	21.7	1.1
16. Popliteal height	15.6	17.5	19.5	1.1	14.2	15.9	17.7	1.1
17. Shoulder Breadth (bideltoid)	16.7	18.5	20.3	1.1	14.2	15.7	17.3	1.0
18. Shoulder Breadth (biacromial)	14.4	15.7	17.1	0.8	13.0	14.2	15.4	0.7
19. Hip Breadth	12.2	14.2	16.1	1.2	12.2	14.8	17.3	1.5
20. Chest (Bust) Depth	8.7	10.0	11.4	0.9	8.3	10.0	11.8	1.1
21. Abdominal Depth	8.7	10.8	13.0	1.3	8.3	10.2	12.2	1.2
22. Shoulder-Elbow Length	13.0	14.4	15.7	0.8	12.0	13.2	14.4	0.7
23. Elbow-Fingertip Length	17.5	18.9	20.3	0.8	15.7	17.1	18.5	0.8
24. Upper Limb Length	28.7	31.1	33.5	1.4	25.8	28.1	30.5	1.4
25. Shoulder-Grip Length	24.2	26.4	28.5	1.3	22.0	24.0	26.0	1.2
26. Head Length	7.1	7.7	8.3	0.3	6.5	7.1	7.7	0.3
27. Head Breadth	5.7	6.1	6.5	0.2	5.3	5.7	6.1	0.2
28. Hand Length	6.9	7.5	8.1	0.4	6.3	6.9	7.5	0.4
29. Hand Breadth	3.1	3.5	3.9	0.2	2.6	3.0	3.3	0.2
30. Foot Length	9.4	10.4	11.4	0.6	8.7	9.4	10.2	0.5
31. Foot Breadth	3.5	3.9	4.3	0.2	3.1	3.5	3.9	0.2
32. Span	65.7	71.3	76.8	3.3	59.3	64.0	68.7	2.9
33. Elbow Span	34.4	37.6	40.7	1.9	31.1	33.9	36.6	1.7
34. Vertical Grip Reach (Standing)	76.8	81.9	87.0	3.1	71.1	75.8	80.5	2.9
35. Vertical Grip Reach (Sitting)	45.5	49.4	53.3	2.4	42.1	45.7	49.2	2.2
36. Forward Grip Reach	28.5	30.9	33.3	1.4	25.8	28.0	30.1	1.3
37. Body Weight *(in pounds)*	121.0	171.6	224.4	30.8	90.2	143.0	195.8	33.0