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Redefining Design Criteria
for Pu-238 Gloveboxes

Abstract: Enclosures for confinement of special nuclear materials(SNM) have evolved into the design of "**gloveboxes**". The words box and or boxes shall refer to gloveboxes, dropboxes and introductory boxes. During the early stages of glovebox technology established practices and process operation requirements **defined** design criteria. Proven boxes that performed and met or exceeded process requirements in one group or area, often could not be duplicated in other areas or processes, and still achieve the same success. Changes in materials, fabrication and installation methods often only met immediate design criteria. Standardization of design criteria took a big step during creation of "Special-Nuclear Materials R&D Laboratory Project, Glovebox standards". The standards defined design criteria for every type of process equipment in its most general form. Los Alamos National Laboratory (LANL) then and now has had great success with Pu-238 processing. However with ever changing Environment Safety and Health (ES&H) requirements and TA-55 Facility Configuration Management, current design criteria are forced to explore alternative methods of glovebox design fabrication and installation. **Pu-238** fuel processing operations in the **Power Source Technologies Group** have pushed the limitations of current design criteria. More than half of Pu-238 gloveboxes are being retrofitted or replaced to performed the specific fuel process operations. Pu-238 glovebox design criteria are headed toward process designed single use glovebox and supporting line gloveboxes. Gloveboxes that will house equipment and processes will support TA-55 Pu-238 fuel processing needs into the next century and extend glovebox expected design life.

Los Alamos National Laboratory(LANL), Plutonium Facility TA-55, Power Source Technologies Group(Background)

The Plutonium Facility opened in late 1978 as a state of the art nuclear facility. Since then TA-55 has maintained its technological superiority in the nuclear community. The Power Source Technologies Group is the Pu-238 fuel processing group. Pu-238 projects include fabricating the general purpose heat source (GPHS), light weight radioisotope heater unit (LWRHU).

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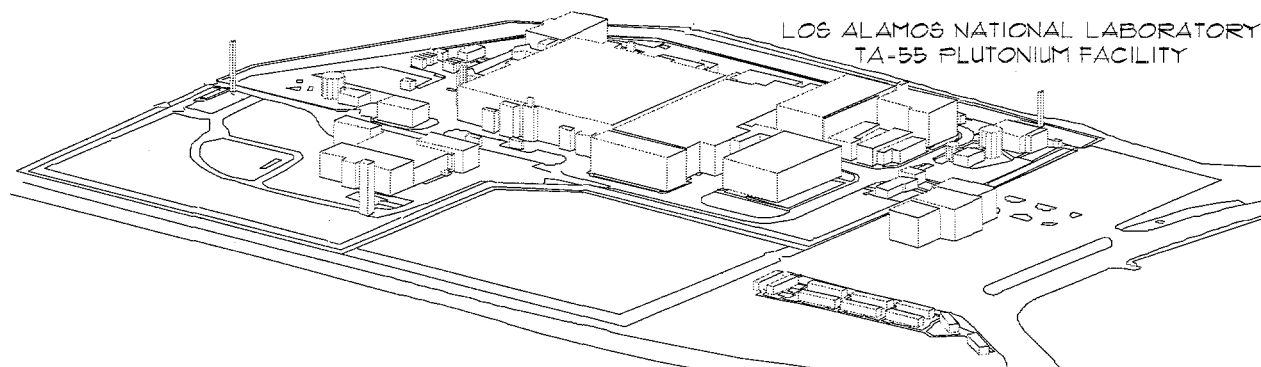
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TA-55 Pu-238 Gloveboxes

The Pu-238 gloveboxes are primarily used for fuel processing operations. Fuel processing operates in an argon atmosphere to prevent back exchange of oxygen which increases the neutron emission rate of the fuel. Ceramic fuel processing includes several mechanical and thermal treatment steps.

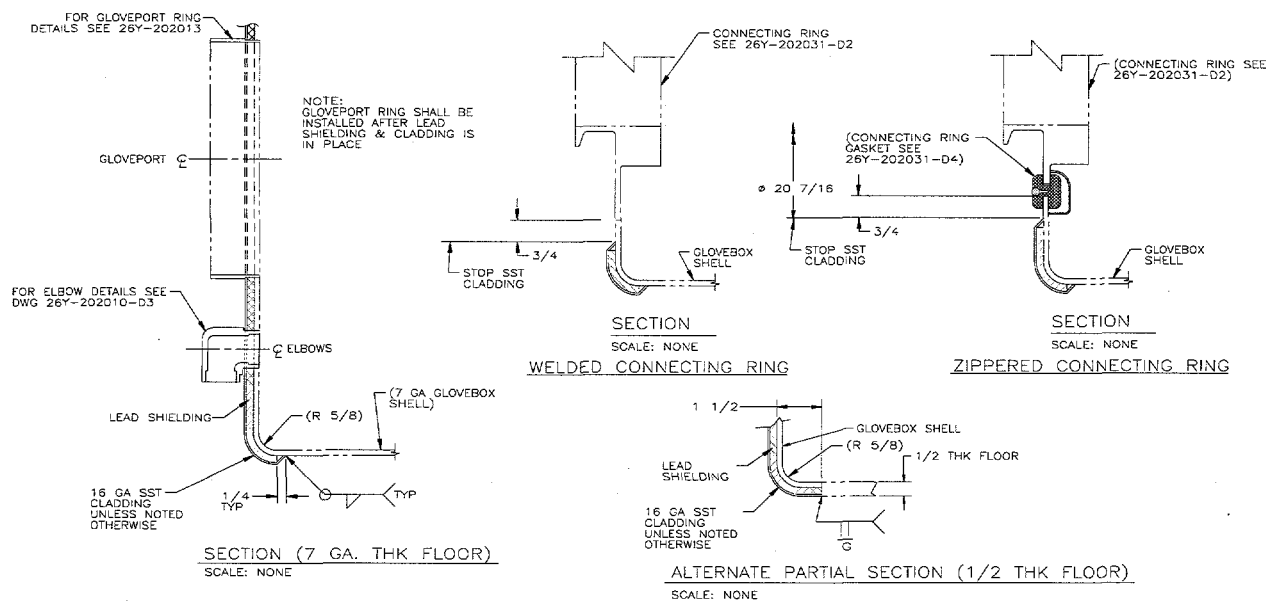
Welding operations in gloveboxes are performed in a controlled inert atmosphere environment. Final deliverable heat sources are encapsulated in specially designed tantalum or iridium containers. Heat source container welds must pass a varying leak detection tests.

High temperature furnaces are used for fuel processing to configure the pellet micro structure size. Platinum boats are used to hold the fuel inside the furnace during sintering.

Hot presses are used to fabricate Pu-238 heat source fuel pellet. The hot presses comprise a hydraulic vacuum system with an induction heating system. An argon atmosphere glovebox houses the hot press and vacuum chamber control; cabinet electrical feed transformers are located as close to the glovebox as possible.

Glovebox Fabrication

All boxes are fabricated from 4'x10' 304 type 7 gauge stainless steel sheets of weld construction. The sheets are cut, bent, drilled and polished, and the number of welds is kept to a minimum. The boxes are lead shielded (refer to glovebox lead shielding detail) and use ASTM B-29 grade 1/4" lead. No gaps are permitted between joints not to exceed 1/8" either through welding, peening or fusion.



GLOVEBOX LEAD SHIELDING

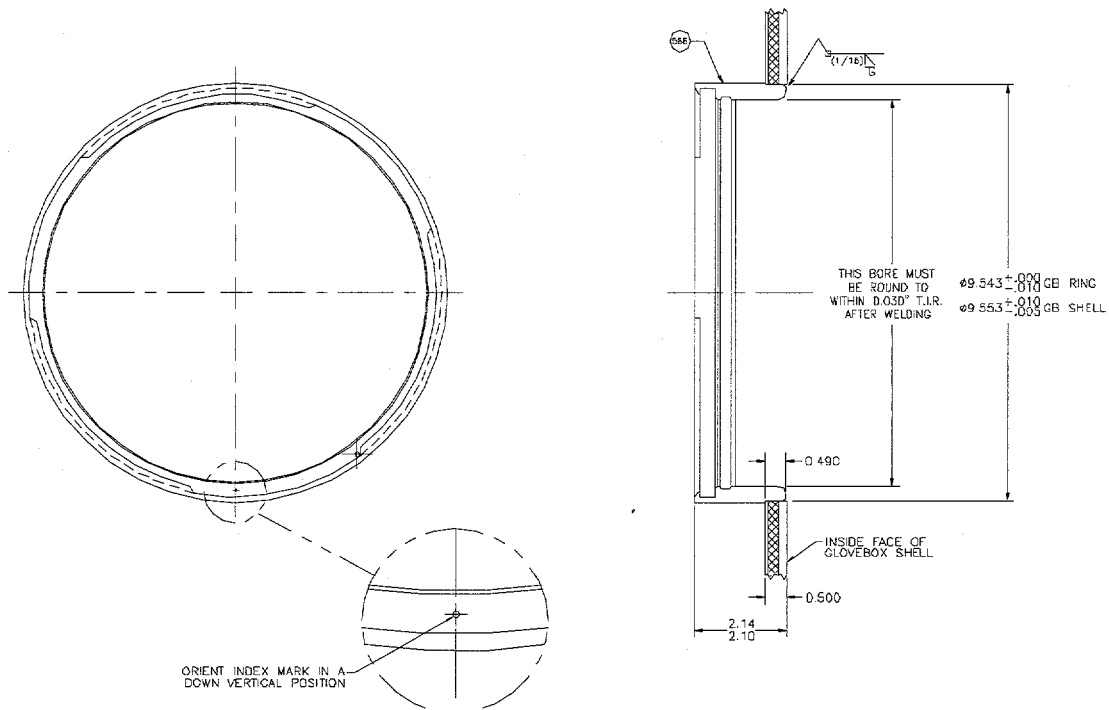
Glovebox Surface Finish

All welds are grounded and polished parallel to weld to a 32 microinch (roughness height) surface finish and blended with adjacent material. Surface texture symbols are in accordance with ANSI 46.1. Ground welds must not be thinner than the parent material. Grinding and polishing should be limited to the damaged area by welding, interior and exterior not to exceed a 2" diameter. Damaged surfaces are re-polished to a No.4 finish. The extent of refinishing is limited to the immediate damaged area. The original stainless steel surface is protected as long as possible. All inside radii at box corners are 5/8" unless noted or shown otherwise. All bends are minimum radius (thickness of material). All threads must be retapped and cleaned after welding and grinding. Threaded plugs in each threaded shell penetration and all service panel couplings are stainless steel 300 series (#150 rating). Where inside threads are used on a penetration the plugs are installed inside the box. Plugs have a recessed hex hole or allen wrench or external hex head. All threaded fasteners and washers that are not welded to the box are stainless steel 300 series, Welding symbols in accordance with ANSI Y32.3/ AWS 2.4. Remove all burrs and break all sharp edges (.01-.03 approx. radius). Interior and exterior surface area of glovebox must be cleaned and degreased before final inspection.

Glovebox Machining Tolerancing

Dimensions and positional tolerancing is in accordance with ANSI Y14.5M-1982 and is never cumulative. Overall shell dimension tolerances are 0-36"=±1/16", 36-60"±1/8", and over 60"=±3/16". All exterior surfaces must be flat after welding to ±1/8 in any 2 ft. length, and not to exceed ±1/4" over the entire length of the box. Surfaces surrounding cutouts (1" inch beyond round cutouts and 3/4" inch beyond square or rectangular cutouts) must be flat to ±.030 per foot and not to exceed .060 total warpage on gloveboxes. Areas surrounding

window cutouts are flat ± 0.015 per foot and .030 total. Locating dimensions of individual box cutouts must be held to $\pm 1/8$ " unless noted otherwise. Cutout dimensions are held to $\pm 1/32$ " and must be square to $\pm 1/16$ ". Connecting rings as welded on gloveboxes are checked for centerline alignment. Connecting ring faces are perpendicular to the floor of the glovebox within $\pm 1/16$ ". Where two connecting rings exist on the same centerline, their faces must be parallel to $\pm 1/16$ " as measured at the face of connecting rings (refer to gloveport ring assembly C-39546). Gloveboxes use favorable (with respect to nuclear criticality) geometry, being basically rectangular in shape. All interior opposite faces must be parallel to $\pm 1/4$ " and adjacent right angle faces perpendicular to $\pm 1/4$ " over the entire length. Fractional dimensional tolerances are $\pm 1/8$ " unless noted otherwise. Decimal dimensional tolerances are: .X = ± 0.1 , .XX = ± 0.03 , .XXX = ± 0.010 unless noted otherwise. Angular dimensional tolerances are held to $\pm 2^\circ$, unless noted otherwise.



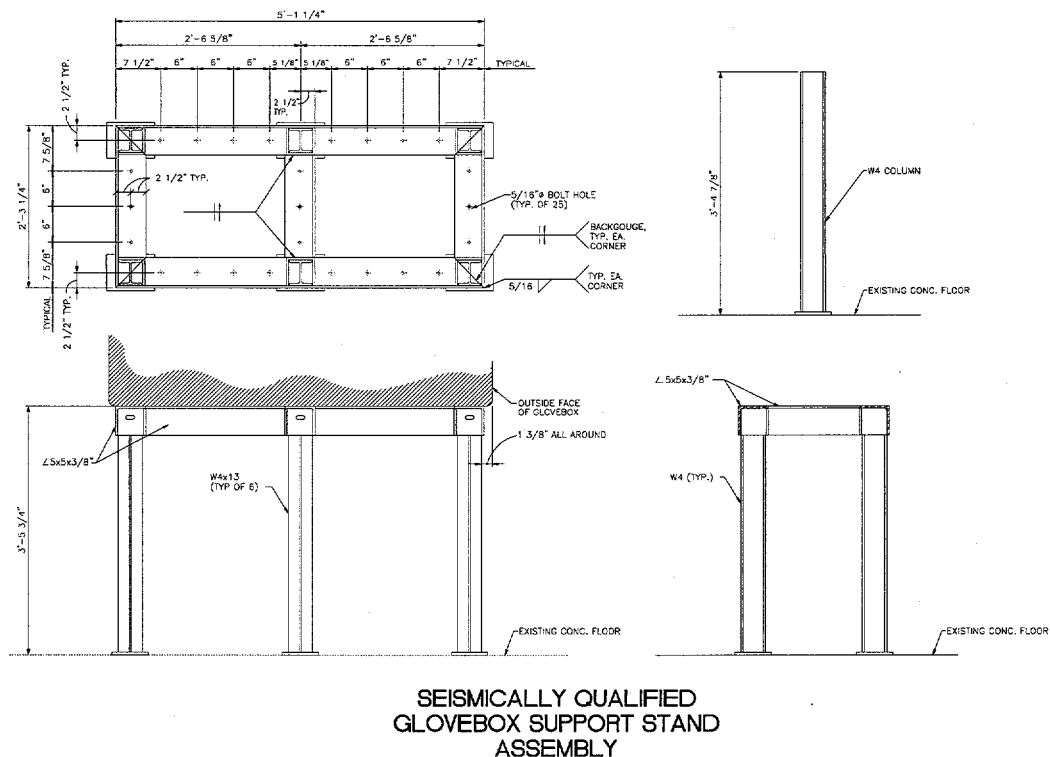
CRL GLOVEPORT RING ASSEMBLY-C-39546

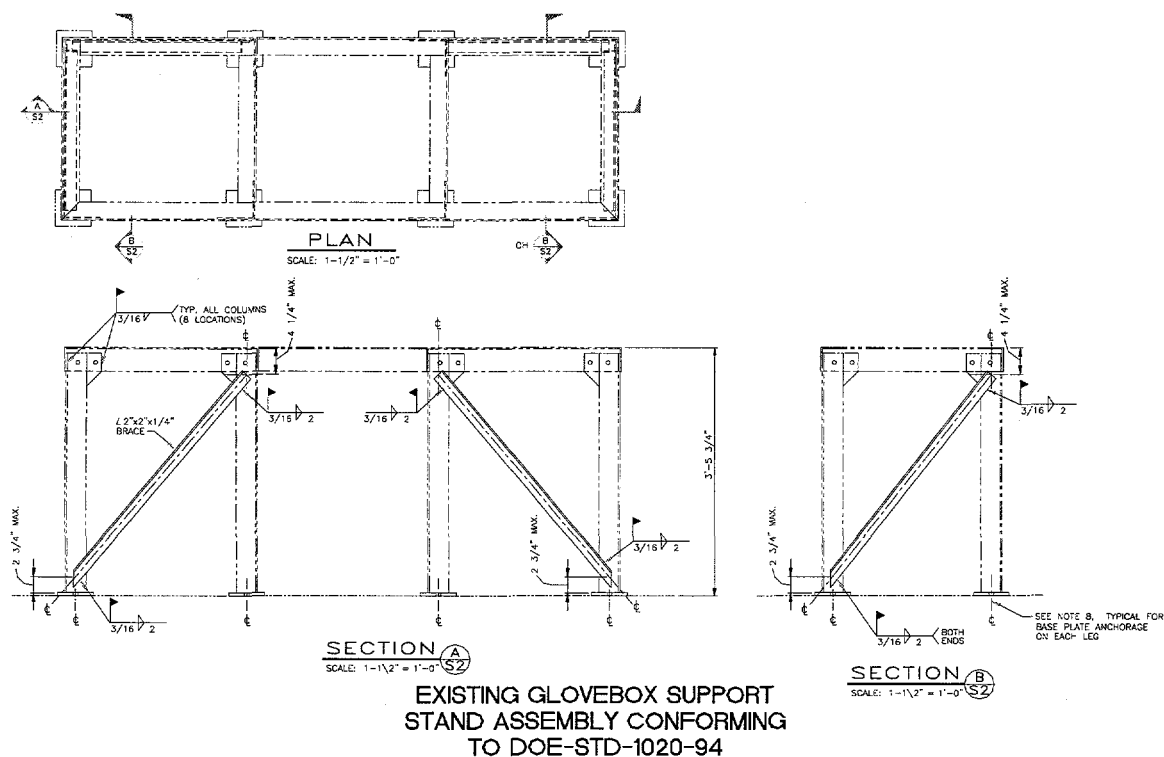
Installation (Glovebox and Related Equipment)

TA-55 Facility Management Group has a Configuration Management Program to which all designs and/or retrofitting of gloveboxes equipment and supporting services must be approved before proceeding with construction. During pre-design meetings a design is given a Design Change Package(DCP) number. This number is used to track the design during reviews and more importantly during construction. After a design is completed a set of drawings is turned into the Facility Management Group for review. The DCP undergoes a series of rigorous facility specific reviews in the areas of mechanical, electrical, HVAC, data

& communications and seismic design evaluation. Gloveport ring assembly has undergone extensive changes with a redesign (by the manufacturer and TA-55 facility) of a special, TA-55 facility standard gloveport ring assembly C-39546 (refer gloveport ring assembly C-39546) The new gloveport ring assembly is multi-purpose; its features include: a port-plug system, plug bulk head fitting system and a manipulator arm from the same manufacturer which can easily be attached. While, no longer a facility wide (TA-55) standard, it will remain a Pu-238 glovebox standard.

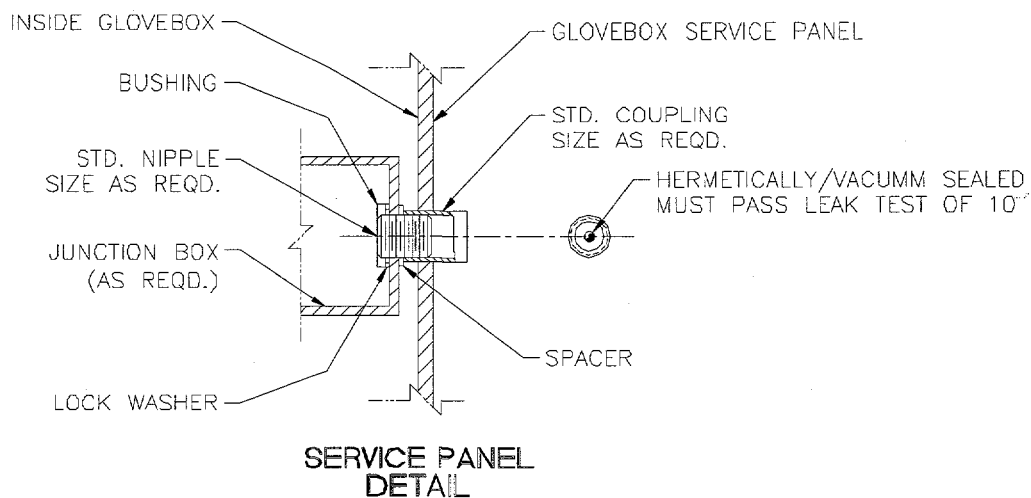
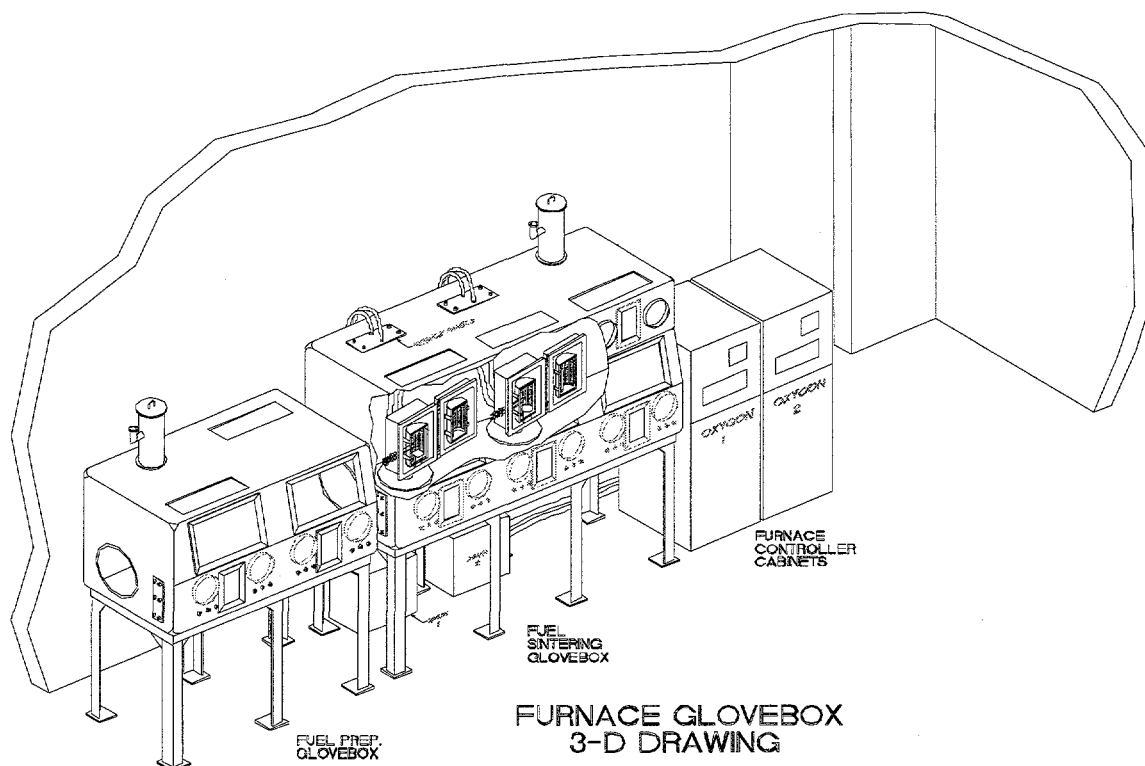
Seismic evaluation perhaps more than any other discipline has undergone the most change in recent years and has affected other disciplines as well. In April of 1994 The U.S. Department of Energy Washington, D.C. issued DOE-STD-1020-94 Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities. The TA-55 Plutonium Facility Building 4 has been placed in Performance Category 3 (PC-3) as safety significant. PC-3 is defined as the site specific response spectra tied to a peak ground acceleration (horizontal & vertical) of 0.31G. The structure spectra analytical requirements for PC-3 applies to structure systems and its related components. New glovebox design support stand assemblies must be fabricated in accordance with the latest provisions of the American Institute of Steel Construction (AISC). All steel shapes, bars and plates must be in accordance with ASTM-A36, tube columns-ASTM-A500, grade B, with a minimum $F_y=46,000\text{PSI}$. All welding must be performed in accordance with the Structural Welding Code, ANSI/AWS D1.1, and all welding electrodes must be type E70XX (refer to seismically qualified glovebox support stand assembly details). Existing glovebox support stand assemblies must also conform to DOE-STD-1020-94. This is currently done with diagonal bracing on each side of the legs depending on the calculated weight of the glovebox and its overall height, width & depth size.





Recommended Redefined Pu-238 Design Criteria

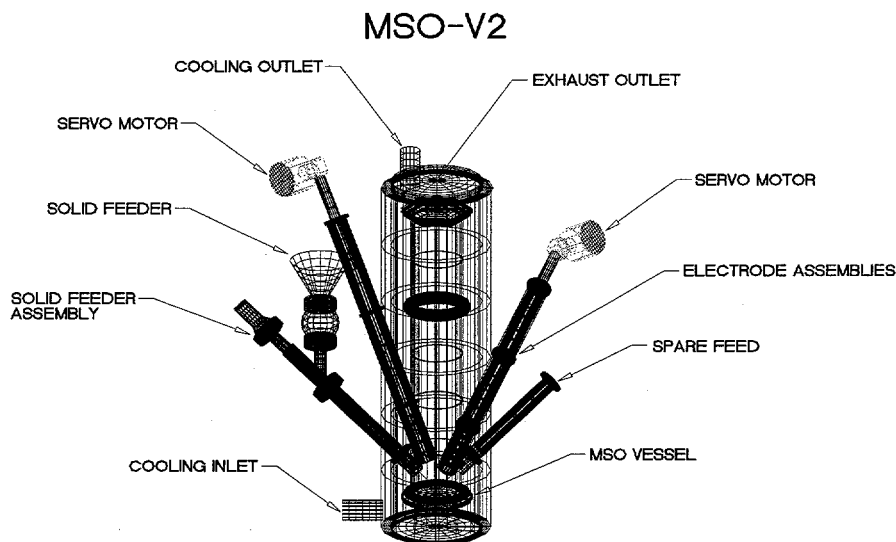
Stringent Environment, Safety & Health requirements (ES&H) and Plutonium Facility Management Group Configuration Management have significantly impacted Pu-238 design criteria. Pu-238 fuel processing operations require specific glovebox design requirements. Special single use equipment is designed for only a specific fuel processing operation, maximum density in a glovebox. Although most new gloveboxes may still have the **standard** shape and size look, other boxes may very well end up with a **special** shape and size, to meet the design requirements criteria. **Smaller** more **efficient** equipment is designed so that it can be introduced through the facility tunnel transition system and more importantly can be removed from service after its design life has been exhausted. These are a few examples of conceptual and newly designed Pu-238 gloveboxes and related equipment:



Sintering Furnaces

Currently several fuel sintering furnaces are being replaced and installed into specially designed gloveboxes fitted with newly designed hermetically sealed couplings in the service panels. All mechanical and electrical feedthroughs require a contamination barrier between the glovebox service panel (refer to service panel detail & glovebox 3-D drawing). The new

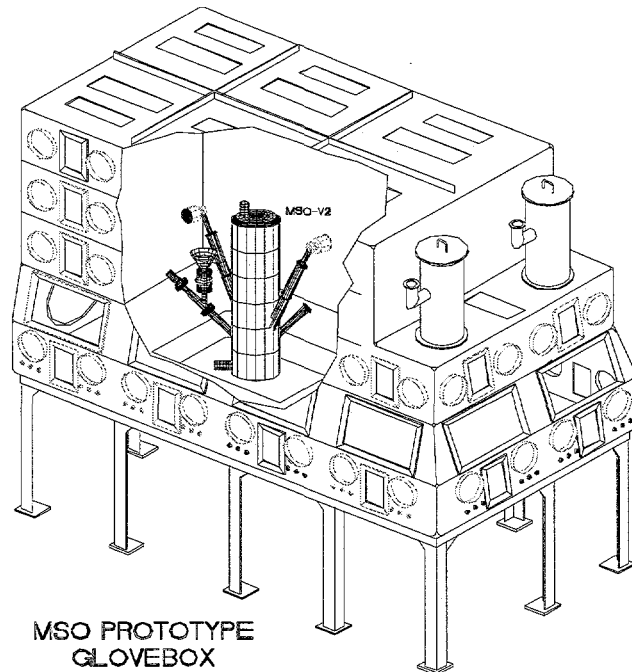
furnaces are smaller, vertical front loading and can be introduced and removed into the box through facility tunnel transition system. The furnaces operate in a wetted argon atmosphere to a maximum temperature of 1600°C during a 6 hr. cycle. The heat chamber element is made of rhodium and is insulated with layered walls of rhodium and tantalum. The heat zone operates at a setpoint setting via alumina sheathed thermocouples. The furnace is controlled by a programmed logic controller (plc) housed in floor mounted control cabinet with a control touch panel and safety over temperature limiter control and chart recorder. The furnaces are powered by a 12kVA 480V, single phase 60 hertz power supply via an air cooled transformer and a main circuit breaker switch. The furnace chamber walls are water cooled through a series of inlet-outlet manifold where water distribution is controlled by ball valves and a master water circuit protected flow switch. Safety feature systems for the furnace include an over temperature thermocouple controller that will shut off the furnace if preset temperature is exceeded. A decrease in cooling water pressure flow supply or return will shut off the furnace automatically.



Molten Salt Oxidation(MSO-V2) Prototype Glovebox

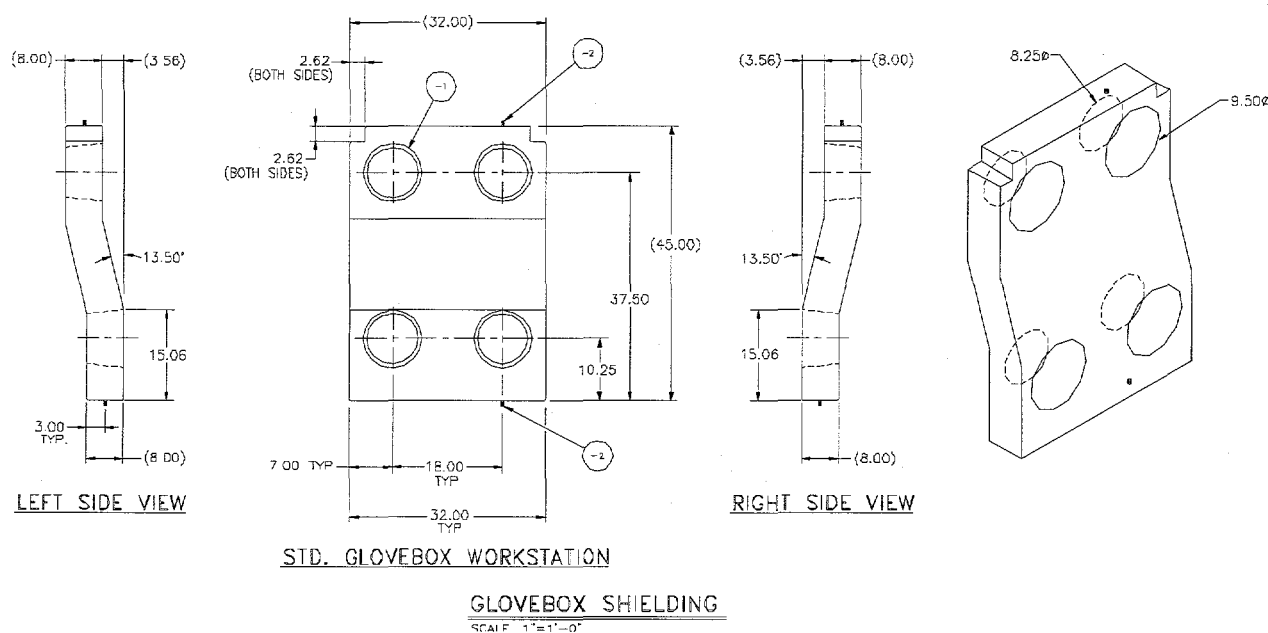
A new conceptual design for a Pu-238 glovebox is currently underway. The MSO-V2 recycling system uses a patented proven destruction process for mixed solid radioactive waste including plastics and cottons (refer to MSO-V2 detail). The basic concept design is a recycling of radioactive waste treatment process, solid feed system. Waste is introduced via a solid feed system with air into a ceramic lined vessel containing a molten salt bath. The Los Alamos, Power Source Technologies Group conceptual design is a prototype designed to operate inside a glovebox (refer to MSO prototype glovebox). The glovebox will have specially designed feedthroughs and penetrations for water cooling supply and return, electrical power requirements, signal communications and hermetically sealed nipples and couplings (refer to service panel detail). It will also have a dedicated redundant vented system. The MSO-V2 glovebox will also have a large lead shielded well in the middle of the

box. This design is expected to have a long design life relative to projected feed rates of the MSO-V2.



Pu-238 Glovebox Roll-up & Permanent Shielding

A prototype roll-up & permanent shielding design for Pu-238 gloveboxes is currently in progress. Initial conceptual design data & calculations indicate that a 6"-8" Plexiglas "shield" filled with borated water will conclusively provide neutron shielding for Pu-238 gloveboxes. Lexan was initially also considered as possible material, however a thickness in excess of 10" would be required to achieve the same results as Plexiglas. The conceptual roll-up design consists of the borated water filled Plexiglas attached to a structural frame and low profile rollers to be rolled up next to the box. The shielded area that the Plexiglas will cover is a TA-55 standard glovebox work station, top & bottom gloveports with small window and the large window. The roll-up design is mobile and the borated water can be easily drained and refilled. The conceptual permanent shielding design will be incorporated into the design of the glovebox with a hinged system that will allow draining and refilling plus glove change out. In addition to the frontal glovebox shielding, the permanent shielding conceptual design will also have glovebox side and leg shielding. Although the box and shielding system will be fabricated separately the two will be structurally bounded together (Refer to glovebox shielding detail).



Conclusion

Enclosures for Special Nuclear Materials (SNM), "gloveboxes" have not changed much in recent years. Pu-238 design criteria have evolved through several stages: necessity, established practices, documented proven process and equipment operations, standardization and administrative controls. Depending on the specific fuel processing operation, some gloveboxes may indeed taken on a special shape and size. Emphasis is placed on smaller and more efficient equipment that can be introduced/removed into the line through the facility tunnel system for maintenance or replacement. The redefined design will require establishing long term relationships with qualified vendors/manufacturers that can meet our stringent group and facility requirements, now and for planning future conceptual fuel process operations.

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NOTE: This paper is intended only to provide a brief overview of current Pu-238 glovebox design criteria and a recommended direction for design criteria for Los Alamos National Laboratory, TA-55, Power Source Technologies Group **only**. The views and opinions expressed in this paper are the author's and may not necessarily reflect those of LANL, TA-55 and the Power Source Technologies Group.

Acknowledgments

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