Mock Nuclear Processing Facility

Safeguards Training Requirements

Philip Gibbs, BNL
Tim Hasty, SRNL
Russell Johns, PNNL
Gregory Baum, SNL

January 2015

BNL-105958-2014 / 86771
Revision 1

U.S. DEPARTMENT OF
ENERGY

Office of
Science

Notice: This manuscript has been authored by employees of Brookhaven Science Associates, LLC under Contract No DE-SC0012704 with the U.S. Department of Energy. The publisher by accepting the manuscript for publication acknowledges that the United States Government retains a non-exclusive, paid-up, irrevocable, world-wide license to publish or reproduce the published form of this manuscript, or allow others to do so, for United States Government purposes.

BNL-105958-2014/86771

***Mock Nuclear Processing Facility
Safeguards Training Requirements***

Philip Gibbs
Brookhaven National Laboratory

Tim Hasty
Savannah River National Laboratory

Russell Johns
Pacific Northwest National Laboratory

Gregory Baum
Sandia National Laboratory

January 2015

**Nonproliferation and National Security Department
Safeguards and Nonproliferation Policy Group**

Brookhaven National Laboratory

**U.S. Department of Energy
National Nuclear Security Administration
Office of International Material Protection and Cooperation NA-25**

Notice: This manuscript has been authored by employees of Brookhaven Science Associates, LLC under Contract No. DE-SC0012704 with the U.S. Department of Energy. The publisher by accepting the manuscript for publication acknowledges that the United States Government retains a non-exclusive, paid-up, irrevocable, world-wide license to publish or reproduce the published form of this manuscript, or allow others to do so, for United States Government purposes.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or any third party's use or the results of such use of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Contents

LIST OF FIGURES	II
REVISION.....	1
1.0 INTRODUCTION.....	2
2.0 GOALS.....	2
3.0 FACILITY AND PROCESS DESCRIPTIONS.....	3
4.0 PROCESS DESCRIPTIONS.....	4
5.0 TRAINING GOALS AND EQUIPMENT NEEDS BY PROCESS AREA	8
6.0 ACRONYMS AND DEFINITIONS.....	21
7.0 REFERENCES.....	21
ATTACHMENT 1 - PRELIMINARY MAJOR EQUIPMENT LIST	22

List of Figures

Figure 1 – Generic Process Flow Diagram for PUREX and MOX Processes.....	4
Figure 2 – Generic Process Flows and Material Categorization.....	5
Figure 3 – Technical Area V PUREX Demonstrations.....	6
Figure 4 – Technical Area V MOX Demonstrations.....	7
Figure 5 – Hot Cell Equipment Configuration.....	8
Figure 6 – Glovebox Area Equipment Configuration.....	15

REVISION

Revision	Date	Comments
0	08/12/2014	Initial issue
1	1/16/2015	Bring into alignment with final concepts

1.0 INTRODUCTION

This document outlines specific training requirements in the topical areas of Material Control and Accounting (MC&A) and Physical Protection (PP) which are to be used as technical input for designing a mock Integrated Security Facility (ISF) at Sandia National Laboratories (SNL). The overall project objective for these requirements and the mock facility is to enhance the ability to deliver training on Material Protection Control and Accounting (MPC&A) concepts with respect to bulk processing facilities.

Currently, the existing training facilities at SNL and other DOE facilities are able to address most MPC&A concepts related to item inventories. Bulk processes where foreign nationals are allowed access are only abstractly and poorly represented. However, bulk processing facilities present a greater challenge for deterring and detecting the insider threat than item facilities. When nuclear material is processed and changes chemical or physical form, additional MPC&A measures should be employed to detect and deter not only abrupt theft but protracted theft, as well. The Insider threat becomes more problematic in a bulk processing facility where a theft or diversion could be concealed by measurement uncertainties and the inventory difference. Thus, the objective is to create a mock bulk process at a level that will support training in such MPC&A programs as Process Monitoring, Measurement Control, and Integrated Security Design.

Two nuclear material processes have been selected for modeling. They are a fuel reprocessing facility based on the Plutonium Uranium Redox Extraction (PUREX process) and mixed oxide (MOX) fuel fabrication facility. There are three reasons for selecting these two processes as well. First, the process steps (e.g., type of process, equipment, material form) match to the training objectives. Second, these are the types of facilities that are being built and/or operated and will need to be protected. Third, there are studies and documents cited in the references that describe and model such facilities in detail which are already in the public domain and can be used in the training effort.

2.0 GOALS

Including “hands on” demonstrations and activities during training courses and workshops are a proven means of enhancing the learning ability. The development of the mock facility processes can be used to provide such activities without the additional operational, safety and security concerns of hosting workshop participants at an operating nuclear facility. Although such a mock facility will enhance training in a variety of MPC&A concepts, there are two main MC&A topical areas and one main PP topical area which can be greatly enhanced utilizing such a mock facility:

In the MC&A topical area of Measurement Control, the goals are to:

- Demonstrate process tank calibration
- Demonstrate liquid sampling/mixing study
- Demonstrate solid sampling/mixing study

- Demonstrate process tank measurements related to inventory
- Demonstrate process tank measurements related to material transfers
- Demonstrate scale error estimates and control charts

In the MC&A topical area of Process Monitoring, the goals are to:

- Demonstrate the selection of process units for process monitoring boundary definition
- Introduce the concepts of solution process monitoring
- Demonstrate the concept of monitoring around a fuel fabrication process
- Demonstrate the effectiveness of process monitoring in detecting protracted theft scenarios in similar processes
- Demonstrate the relationship of process monitoring goals versus operational goals

In the PP topical area of Integrated Security Design, the goals are to:

- Target Characterization and how it affects security - Illustrate different security postures for different categories of materials
- Demonstrate safeguards concepts for protecting against protracted theft scenarios
- Illustrate PP systems / designs for these types of process contrasting their impact/effect on security and operations.
- Demonstrate the relationship between MC&A and PP
- Demonstrate the relationship of security goals versus operational goals

Additionally, once established the facility will allow for hands on training activities in other courses and workshops. This includes, but is not limited to:

- Insider Treat Analysis
- Vulnerability Assessment
- Performance testing
- Domestic Surveys/Inspections
- Tamper Indicating Device Program
- MC&A Plan Development
- Security by Design

3.0 FACILITY AND PROCESS DESCRIPTIONS

The facility process descriptions and MC&A concepts for the mock facility are based on the following two documents:

IAEA - Walter R. Kane and Ming-Shih Lu. *STR-185 - Detailed Description of an SSAC at the Facility Level for Mixed Oxide Fuel Fabrication Facilities*. Report, Upton, NY: IAEA, 1985

IAEA, Walter R. Kane and Ming-Shih Lu. *STR-193, Detailed Description of an SSAC at the Facility Level for Irradiated Fuel Reprocessing Facilities*. Report, Upton, NY: IAEA, 1986.

The reason for basing the design on the International Atomic Energy Agency (IAEA) Safeguards Technical Reports (STRs) 185 and 193 is that actual facility process flows and accounting information typically results in classification and/or export control issues. However, these documents adequately represent the processes and are publicly available to any current or future participant in training of this type. Additionally, the facilities processes described in the documents are typical of those that are being built and or utilized, and thus in need of safeguarding.

Furthermore, these two processes change material attractiveness and categorization as materials moves through the process. Material starts at a low category level (not much security required), is converted a higher category level, and then back to a lower category level. Thus, MC&A and PP applications to these processes using a graded safeguards approach to having different category levels in the same area can be demonstrated.

4.0 PROCESS DESCRIPTIONS

Figure 1 shows line diagram of the two processes and how they are related to each other.

Figure 1 – Generic Process Flow Diagram for PUREX and MOX Processes

The first process is the PUREX process which is designed to take spent fuel and recover the uranium and plutonium from other byproducts in the irradiated materials. The process first chops the fuel rods into pieces and then dissolves the nuclear material into a solution. The solution is measured and then goes through a series of extraction processes that separate the plutonium and uranium from the other irradiated materials, and then from each other. The resulting streams of uranium and plutonium are then converted into oxides.

The second process is the MOX fuel fabrication process which utilizes the plutonium oxide recovered from the PUREX process and mixes the oxide with natural uranium oxide. The oxide is blended to provide homogeneity, and then pressed into fuel pellets. The pellets are sintered and ground to specific geometry and then loaded into fuel rods.

Figure 2 illustrates how these two processes change material attractiveness and categorization as materials moves through the process. Material starts at a low attractiveness level (not much security required) at the beginning of the PUREX process and is converted to a higher category level at the end of the PUREX process. The material begins the MOX process at a high attractiveness level and is converted back to a lower category level at the end of each process. Thus, MC&A and PP applications to these processes using a graded safeguards approach to having different category levels in the same area can be demonstrated.

Figure 2 – Generic Process Flow with Material Categorization

Process Flow with Material Categorization

Red – Category I (high attractiveness)
Green – Cat III or IV (low attractiveness)

The ability to replicate all aspects of these two processes is not feasible for obvious reasons, cost being the foremost. Figure 3 and Figure 4 illustrate the key portions of the PUREX and MOX processes which can be demonstrated in the mock facility. The additional process systems not duplicated can be discussed in the classroom.

Figure 3 – Technical Area V PUREX Demonstrations

Figure 4 – Technical Area V MOX Demonstrations

5.0 TRAINING GOALS AND EQUIPMENT NEEDS BY PROCESS AREA

Because it is not feasible to reproduce every processing unit in these two operations only select pieces of equipment will be fabricated. However, the key MPC&A concepts can still be taught using the process flow diagrams shown and the proposed equipment.

- 5.1 *PUREX Process – The mock facility shall have the capability to represent select processing units for a simulated PUREX process in the hot cells within the area. Specifically, the mock facility will focus on liquid handling operations including tank calibration, liquid transfers, tank sampling, and in process inventories. In addition solid product handling will also be addressed in Hot Cell 5. The process will be demonstrated in four hot cells (Note Hot Cell 1 will only be used for introducing equipment and is not considered part of the process). Figure 5 is a line representation of the hot cell equipment configuration.*

Figure 5 – Hot Cell Equipment Configuration

- 5.1.1 *Hot Cell 2 – Hot Cell 2 will represent the operations in MBA 1 shown in Figure 3. However, as mentioned this portion of the mock facility will only be focused on liquid operations. Thus, the chop/leach operations shown in Figure 3 will be demonstrated/discussed in the classroom setting. Hot Cell 2 will have the following equipment:*

- 5.1.1.1 A 50 liter clear slab tank to represent the accountancy tank that includes baffles.
- 5.1.1.2 The tank shall have a sloped bottom with the tank outlet to be near the top of the slope (this will help demonstrate liquid hold up issues)
- 5.1.1.3 The accountancy tank must have capacitance probe liquid level system
- 5.1.1.4 The tank must have a method of mixing such as an agitator bubbler system or equivalent.
- 5.1.1.5 Piping must be established to allow the solution in the tank to be recycled and/or to be pumped to the next hot cell
- 5.1.1.6 Piping must also include an input funnel where different solutions or solids can be added
- 5.1.1.7 A sample port near the bottom of the tank needs to be installed.
- 5.1.1.8 The tank needs to be connected to a water addition header
- 5.1.1.9 The tanks needs to have ability to be completely emptied such as a bottom drain valve
- 5.1.1.10 The tank needs to transfer contents to tanks in both hot cell 3 and hot cell 4
- 5.1.1.11 The tank should have an in-line pH meter (OPTIONAL)
- 5.1.1.12 Auxiliary equipment includes
 - 5.1.1.12.1 A pH meter to measure pH of sample
 - 5.1.1.12.2 A 2 liter prover vessel is need to prepare jug-in calibration solution

This hot cell will be used to demonstrate the following MC&A concepts:

- Calibration issues associated with slab tank volumes using a capacitance probes
- Mixing and sampling studies, including error calculations associated with slab tanks
- Process hold-up issues in liquid
- Process monitoring issues

5.1.2 Hot Cell 3 - Hot Cell 3 will represent the 1st stage extraction operations in MBA 2 shown in Figure 3. Although such operations would typically include feed storage tanks, extraction columns and “product” storage tanks, for simplicity only a bank of storage columns will be used to

represent this operation. Vertical storage columns were chosen reflect a different configuration that may be present in some facilities. The equipment will include recycling and sampling capabilities to demonstrate the differences in measuring slab tanks (in Hot Cell 2) and column tanks. One column will include a flange with an orifice to demonstrate errors that could be associated with plugging in a column. Hot Cell 3 will have the following equipment:

- 5.1.2.1 A series of 3 clear vertical pipes connected in parallel that each have a capacity to hold 16 liters to represent the accountancy tank and/or the 1st extraction system
- 5.1.2.2 The accountancy tank must have capacitance probe liquid level system
- 5.1.2.3 Piping must be established to allow the solution in the tank to be recycled and/or to be pumped to the next hot cell
- 5.1.2.4 Piping must also include an input funnel where different solutions or solids can be added.
- 5.1.2.5 A sample port near the bottom of the tank needs to be installed.
- 5.1.2.6 The tank needs to be connected to a water addition header
- 5.1.2.7 The tanks needs to have ability to be completely emptied such as a bottom drain valve
- 5.1.2.8 The tank needs to transfer contents to tanks in hot cell 4
- 5.1.2.9 One pipe must have flange that will allow an orifice to be installed that can simulate a plugged line.
- 5.1.2.10 The tank should have an in-line pH meter (OPTIONAL)

This hot cell will be used to demonstrate the following MC&A concepts:

- Calibration issues associated with vertical tank volumes using a capacitance probes
- Mixing and sampling studies, including error calculations associated with vertical tanks
- Channeling and plugged column effects
- Process hold-up issues in liquid
- Process Monitoring issues

5.1.3 *Hot Cell 4 - Hot Cell 4 will represent the 2nd extraction operations in MBA 2 shown in Figure 3. Similar to Hot Cell 3, such operations would typically include feed storage tanks, extraction columns and “product”*

storage tanks, for simplicity only a bank of storage slab tanks will be used to represent this operation. The slab tanks will be smaller in total volume than both the tanks in Hot Cell 2 and Hot Cell 3 to demonstrate the effects of transferring to a different configuration system. This equipment will not have sampling and recycle capabilities to help demonstrate in process inventory and hold-up issues. Hot Cell 4 will have the following components:

- 5.1.3.1 Two 30 liter clear slab tanks connected in parallel to represent the 2nd extraction cycle tanks that includes baffles.
- 5.1.3.2 The tanks shall have a flat bottom with the tank outlet at the bottom of the tank
- 5.1.3.3 The tank must have a sight glass liquid level system
- 5.1.3.4 The tank needs to be connected to a water addition header
- 5.1.3.5 The tanks needs to have ability to be completely emptied such as a bottom drain valve into the waste header

This hot cell will be used to demonstrate the following MC&A concepts:

- Material transfer measurement differences and errors
- Volume calibrations using sight glass for level indication
- Process hold-up issues in liquid
- Process Monitoring issues

5.1.4 *Hot Cell 5 - Hot Cell 5 will represent the calcination and packing operations for the plutonium product in MBA 2 shown in Figure 3. The calcination equipment will not be part of the Hot Cell equipment but can be discussed in the classroom setting. This hot cell will focus on the batching and measurement of the solid Pu oxide being recovered from the PUREX process. Hot Cell 5 will have the following equipment:*

- 5.1.4.1 Two 8" round cake pans each with ~ 1 kg red sand to represent precipitated/calcined plutonium oxide.
- 5.1.4.2 There shall be a scale with a range of up to 6 kg readable to 0.1 g and calibration weights of 1 kg and 5 kg.
- 5.1.4.3 One 1/2 half gallon paint can to be used for the product container moved to the vault. The container will be:
 - 5.1.4.3.1 Tare weighed to nearest gram prior to filling

- 5.1.4.3.2 Have affixed a label with unique container ID, control/batch ID designation and tare weight.
- 5.1.4.4 One Rectangular funnel for pouring the sand/oxide from the pan into the container
- 5.1.4.5 Rubber mallet to secure paint can lid
- 5.1.4.6 Upon removal from the hot cell the ½ gallon paint can will have 2 TID's applied and then be placed into a plastic bag that is taped closed prior to transport to the storage vault. This is to simulate contamination control practices

This hot cell will be used to demonstrate the following MC&A and PP concepts:

- Change in category levels within a defined process
- Difference in protection strategy for different operations within the same processing line
- Measurement control issues associated with solid operations in a hot cell
- Process monitoring issues
- Protracted theft issues

5.2 *Feed Storage Vault (Existing) - The mock facility shall have the capability to represent a Category I storage vault. This vault will be the primary storage location for the building and be used for storage of all shipments and receipts to and from the building with the exception of fuel rods as well as transfers between the PUREX MBA and MOX Fuel MBA. Fuel rods will be stored in a separate vault. Waste containers will be stored in a separate location. The Feed Storage vault will have the following equipment:*

- 5.2.1 Twenty (20) one-gallon paint containers with lids representing U oxide feed containers. Each container will:
 - 5.2.1.1 Be tare weighed to nearest gram prior to filling:
 - 5.2.1.2 Containers will be filled with white sand to a variety of net weights from a range of 4,500 grams to 5,500 grams
 - 5.2.1.3 Two Tamper Indicating Device applied
 - 5.2.1.4 Have affixed a label with unique container ID, control/batch ID designation and tare weight.
- 5.2.2 Ten (10) one-half gallon paint containers with lids representing PuO₂ containers. Each container will:
 - 5.2.2.1 Be tare weighed to nearest gram prior to filling:

- 5.2.2.2 Containers will be filled with red sand to a variety of net weights from a range of 1,800 grams to 2,200 grams
- 5.2.2.3 Two Tamper Indicating Device applied
- 5.2.2.4 Have affixed a label with unique container ID, control/batch ID designation and tare weight.
- 5.2.2.5 Be enclosed in a plastic bag that is taped closed.
- 5.2.3 Two (2) one-pint paint containers with lids representing mixed-oxide scrap containers. Each container will:
 - 5.2.3.1 Be tare weighed to nearest gram prior to filling:
 - 5.2.3.2 Containers will be filled to net weights of approximately 110 and 1000 grams
 - 5.2.3.3 One Tamper Indicating Device applied
 - 5.2.3.4 Have affixed a label with unique container ID, control/batch ID designation and tare weight.
- 5.2.4 Two (2) ten-gallon containers with lids representing uranium storage containers from PUREX. Each container will:
 - 5.2.4.1 Be tare weighed to nearest gram prior to filling
 - 5.2.4.2 Containers will be filled close to capacity.
 - 5.2.4.3 Two Tamper Indicating Device applied
 - 5.2.4.4 Have affixed a label with unique container ID, control/batch ID designation and tare weight.
- 5.2.5 There shall be a scale with a range of up to 6 kg readable to 0.1 g
- 5.2.6 There shall be a scale with a range of up to 60 kg readable to 0.1 g
- 5.2.7 Calibration weights of 1 kg, 5 kg, and three (3) 20 kg
- 5.2.8 A storage rack with ~ 40 positions. The rack shall have shelf and position identifier for each position.
- 5.2.9 Physical Protection Requirements (Category I vault)
 - 5.2.9.1 BMS
 - 5.2.9.2 Motion Sensors
 - 5.2.9.3 Access control

This vault will be used to demonstrate the following MC&A and PP concepts:

- MC&A transfers requirements
 - Item checks
 - Confirmatory weights
 - TID checks
- Transfers within the same MAA but to different MBA
- Confirmation measure programs
- Measurement Control elements
 - Linearity checks

- Control charting
 - Out of Control conditions and response
- Process monitoring anomaly resolution
- Proper application of PP systems
- Performance tests of
 - Measurement systems
 - Accounting records
 - Surveillance (TPR)
 - PP systems
 - Transfer procedures
 - TID program elements
 - Physical inventory taking

5.3 *MOX Process – The mock facility shall have the capability to represent a simulated MOX fuel fabrication process. There will be three glove boxes and a table used to represent this process as illustrated in Figure 6. Equipment such as the pellet press, sintering furnace, grinder, etc. will not physically be installed. However, “black boxes” will be used to represent these processes with the inputs and outputs from these black boxes being represented in similar form as in an operating facility. Figure 6 is a line representation of the glovebox area equipment configuration.*

Figure 6 – Glovebox Area Equipment Configuration

5.3.1 *Glovebox 1 – Glovebox 1 will represent the batch make-up and blending operations. The glovebox will simulate the measuring of both Pu and U oxides to make up batches of MOX consisting of approximately 60 grams Pu and 540 grams U. The material will be blended in a rotating device to demonstrate the blending of the solid oxide (sand) into a homogenous mixture. Glovebox 1 will have the following equipment:*

- 5.3.1.1 There shall be a scale with a range of up to 6 kg readable to 0.1 g and calibration weights of 100gms, 1 kg and 5 kg.
- 5.3.1.2 There shall be a blender that will rotate 360 degrees and holds a 1 liter bottle
- 5.3.1.3 One (1) clear one liter largemouth bottle with lid. The lid will have a funnel (with stem removed) attached to the inside of the lid to assist in the blending operation within the bottle
- 5.3.1.4 The glovebox floor will be marked to indicate storage location of the paint cans and blending can.
- 5.3.1.5 The glovebox will be attached to Glovebox 2 with a transport portal to allow the blending bottle to be manually be passed to Glovebox 2
- 5.3.1.6 One (1) one gallon empty paint can labelled waste

This glove box will be used to demonstrate the following MC&A and PP concepts:

- Process monitoring issues
- Scale error estimates and control charts
- Two person rule
- Physical protection strategy
- Insider threat
- Solid mixing and sampling issues
- Bulk processing inventory issues

5.3.2 *Glovebox 2 – Glovebox 2 will represent the pellet press operations. The glovebox will have a “black box” that will represent the approximately 600 grams of MOX material being loaded into a processing unit and 59 rough fuel pellets, each weighing approximately 10 grams being generated as an output. Glovebox 2 will have the following equipment:*

- 5.3.2.1 A two (2) drawer plastic storage bin.
 - 5.3.2.1.1 Top of the bin to be modified to allow contents of blending container (MOX material) to be poured into the top drawer.
 - 5.3.2.1.2 The bottom drawer will have a 6 x 10 removable position pellet trays
 - 5.3.2.1.3 Fifty-nine (59) simulated fuel pellets. Fuel pellets will be 8mmD x 12mmL and made from tantalum.
- 5.3.2.2 One (1) empty pint paint container with lid representing an empty mixed-oxide scrap collection container. The container will:
 - 5.3.2.2.1 Be tare weighed to nearest gram prior to filling:
 - 5.3.2.2.2 Container will have process pellets, pieces and sand placed in it
 - 5.3.2.2.3 Have affixed a label with unique container ID, control/batch ID designation and tare weight.
- 5.3.2.3 The glovebox will be attached to Glovebox 1 with a transport portal to allow the blending bottle to be manually be passed to Glovebox 1
- 5.3.2.4 The glovebox will be attached to Glovebox 3 with a transport portal to allow the pellet tray to be manually be passed to Glovebox 3

This glove box will be used to demonstrate the following MC&A and PP concepts:

- Process monitoring issues
- Two person rule
- Physical protection strategy
- Insider threat
- Protracted theft concepts
- Bulk processing inventory issues

5.3.3 Glovebox 3 – Glovebox 3 will represent the pellet sintering and grinding operations. Similar to Glovebox 2, the glovebox will have a “black box” that will represent these operations with the input being the pellet tray and 59 pellets from Glovebox 2 and the output being a similar tray with <55 whole pellets, and scrap (broken pellets and oxide). Glovebox 3 will have the following equipment:

- 5.3.3.1 A two drawer plastic storage bin
- 5.3.3.2 A 6 x 10 position pellet tray filled to <55 pellets (this is in addition to the tray being passed through from Glovebox 2)
- 5.3.3.3 Approximately 110 grams of broken pellets and powder to represent scrap materials resulting from the operation
- 5.3.3.4 There shall be a scale with a range of up to 6 kg readable to 0.1 g and calibration weights of 100gms, 1 kg and 5kg
- 5.3.3.5 One (1) empty pint paint containers with a lid representing an empty mixed-oxide scrap container. The container will:
 - 5.3.3.5.1 Be tare weighed to nearest gram prior to filling:
 - 5.3.3.5.2 Container will have process pellets, pieces and sand placed in it
 - 5.3.3.5.3 Have affixed a label with unique container ID, control/batch ID designation and tare weight.
- 5.3.3.6 The glovebox will be attached to Glovebox 3 with a transport portal to allow the pellet tray to be manually be passed to Glovebox 3

This glove box will be used to demonstrate the following MC&A and PP concepts:

- Process monitoring issues
- Two person rule
- Physical protection strategy

- Insider threat
- Protracted theft concepts
- Bulk processing inventory issues

5.3.4 Rod Load Station – The Rod Loading Station will represent the packing of the pellets from Glovebox 3 into fuel rods. The cleaning and welding operations which would normally follow the packing operations will not be represented. However, the station will include a weighing operation and transfer of the fuel rod to the Fuel Rod Storage Area. The Rod Load Station will have the following equipment:

- 5.3.4.1 Three simulated empty fuel tubes. Made from Zirconium metal with an ID on 8.25mm and length of 500mm. Each empty tube will:
 - 5.3.4.1.1 Be labeled with a unique identification number
 - 5.3.4.1.2 Have a mechanism to seal end of loaded tube
- 5.3.4.2 A flat surface such as a workbench or table upon which to weigh components and insert pellets into the tube.
- 5.3.4.3 There shall be a scale with a range of up to 6 kg readable to 0.1 g and calibration weights of 100gms, and 1 kg

This station will be used to demonstrate the following MC&A and PP concepts:

- Process monitoring issues
- Two person rule
- Physical protection strategy
- Insider threat
- Protracted theft concepts
- Bulk processing inventory issues

5.3.5 Physical Protection Requirements for the Glovebox Area – Since the glovebox area involves simulating operations with a Category I quantity present, physical protection systems will be needed for the entire area. Additional physical protection needs on the gloveboxes are intentionally omitted to facilitate discussions on such during the applicable course/workshop. The glovebox area will have the following equipment:

- 5.3.5.1 Portable physical barrier between hot cell and glovebox areas (to simulate separation of the material balance areas while providing flexibility of operation in the area when not in use for training)
- 5.3.5.2 Door plus access control at entry point into glovebox area
- 5.3.5.3 BMS on all doors (including emergency exits)
- 5.3.5.4 Motion sensors
- 5.3.5.5 Video surveillance

This entire area will be used to demonstrate the following MC&A and PP concepts:

- Two person rule
- Physical protection strategy
- Insider threat
- Protracted theft concepts
- Differences in protection strategy for Category I areas versus Category III areas

5.4 *Rod Storage Vault – The Rod Storage Vault will be used to show the final fuel rods being stored in an area separate from the feed (Pu oxide and U oxide) materials. The rod storage vault will have the following equipment:*

- 5.4.1 Five (5) loaded tubes and storage shelf.
 - 5.4.1.1 Each loaded tube will be labeled with a unique identification number
- 5.4.2 Physical Protection Requirements
 - 5.4.2.1 Access control

Attachment 1 contains a more detailed listing of major equipment needed as specified in Section 5.1-5.4 above.

5.5 *MC&A Requirements – Additional to the physical protection requirements there are several overarching MC&A needs associated with the maintaining material control and accountancy in all MBAS. The MBAs will need the following equipment:*

- 5.5.1 An accounting “system” or database which has the following information on each container:
 - 5.5.1.1 Container ID
 - 5.5.1.2 Control/Batch ID

- 5.5.1.3 TIDs applied
- 5.5.1.4 Container Gross, Net and Tare weights
- 5.5.1.5 Element Concentration
- 5.5.1.6 Element weight
- 5.5.1.7 Isotope concentration
- 5.5.1.8 Isotope weight
- 5.5.1.9 Location
- 5.5.1.10 Container type
- 5.5.1.11 Material type
- 5.5.2 Transfer sheets
- 5.5.3 Mylar TIDs
- 5.5.4 TID application/removal forms

6.0 ACRONYMS AND DEFINITIONS

IAEA	International Atomic Energy Agency
ISF	Integrated Security Facility
MBA	Material Balance Area
MC&A	Material Control and Accounting
MOX	Mixed oxide – Mixture of Plutonium and Uranium Oxides
MPC&A	Material Protection Control and Accounting
PP	Physical Protection
PuO ₂	Plutonium Oxide
PUREX	Plutonium Uranium Extraction – chemical method for separation
SNL	Sandia National Laboratories
STR	Standard Technical Reference
TID	Tamper Indicating Device

7.0 REFERENCES

IAEA - Walter R. Kane and Ming-Shih Lu. *STR-185 - Detailed Description of an SSAC at the Facility Level for Mixed Oxide Fuel Fabrication Facilities*. Report, Upton, NY: IAEA, 1985

IAEA, Walter R. Kane and Ming-Shih Lu. *STR-193, Detailed Description of an SSAC at the Facility Level for Irradiated Fuel Reprocessing Facilities*. Report, Upton, NY: IAEA, 1986.

Attachment 1 - Preliminary Major Equipment List

Item	Location	Quantity	Vendor Info	Price	Notes
Gallon paint cans	Vault	20	existing		
½ gallon paint cans	Vault	10			
Pint paint cans	Vault	2	existing		
Red sand	Vault	50#			
White sand	Vault	600#			
Paint can storage rack	Vault	1	Existing		
10-gallon containers	Vault	2			Could be plastic
Scale, 6kg	Vault	1			Readable to 0.1 gm
Scale, 60kg	Vault	1			Readable to 0.1 gm
Check weights	Vault	1 set			100gm, 1 kg, 5kg, 3 20 kg
Clear slab tank, 50l	HC 2	1			< 4 inches wide
Liquid level system	HC 2	1			Capacitance probe
Agitator	HC 2	1			
pH meter, local	HC 2	1			Must be movable to HC 3
2 l prover vessel	HC 2/3	1			For use outside of hot cells
2 liter bottles	HC 2/3	30			Calibration solution make-up
Pump	HC 2	1			
Clear column tank, 16l	HC 3	3			Nominal 5" diameter
Liquid level system	HC 3	3			Same as for HC 2

Pump	HC 3	1			
Clear slab tank, 30 L	HC 4	2			< 4 inches wide
Sight glass liquid level system	HC 4	2			
Pump	HC 4				
Water addition system	HC 2/3/4				
Solution collection system	HC 2/3/4				
8" cake pans	HC 5	2			
Scale, 6kg	HC 5	1			Readable to 0.1 gm
½ gallon paint can	HC 5	1			
Funnel	HC 5				
Rubber mallet	HC 5				
Red sand	HC 5	5#			
Check weights	HC 5	1 set			1 kg, 5kg,
Scale, 6kg	GB 1	1			Readable to 0.1 gm
Check weights	GB 1	1 set			100gm, 1 kg, 5kg,
Clear blending container	BG 1	3			1 liter capacity. See section 5.3
Blender	GB 1	1			Rotates 360 degrees, hold 1 liter bottle
Gallon paint container	GB 1	1			For waste collection
Pellet press	GB 2	1			2 drawer plastic storage bin

Pellet tray	GB 2	1			6x10 array
Pellets	GB 2	200			8mm diameter x 12mm long. Made from tantalum
Pint paint container	GB 2	1			For scrap collection
Scale, 6kg	GB 3	1			Readable to 0.1 gm
Check weights	GB 3	1 set			100gm, 1 kg, 5kg,
Sintering furnace	GB 3	1			2 drawer plastic storage bin
Pellet tray	GB 3	1			6x10 array
Fuel tubes	RLS	3			Zr metal, 8.25mm ID x 500mm long. Need "end caps"
Scale, 6kg	RLS	1			Readable to 0.1 gm
Check weights	RLS	1 set			100gm, 1 kg
Rod loading table	RLS	1	Existing		~ 2'x3' or equivalent work space.
Doorway with access control and BMS	GB area				
Portable barrier to separate HC from GB area	GB area				
Fuel tubes	RSV	5			Zr metal, 8.25mm ID x 500mm long. Filled with ~

					490 gms. Need “end caps”
Storage shelf	RSV	1	Existing		
Access control	RSV	1	Existing		