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# Integrated Monitoring and Surveillance System Demonstration Project

## Phase I Accomplishments

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## Abstract

We present the results of the Integrated Monitoring and Surveillance System (IMSS) demonstration project Phase I efforts. The rationale behind IMSS development is reviewed and progress in each of the 5 basic tasks is detailed. Significant results include decisions to use Echelon LonWorks networking protocol and Microsoft Access for the data system needs, a preliminary design for the plutonium canning system glovebox, identification of facilities and materials available for the demonstration, determination of possibly affected facility documentation, and a preliminary list of available sensor technologies. Recently imposed changes in the overall project schedule and scope are also discussed and budgetary requirements for competition of Phase II presented. The results show that the IMSS demonstration project team has met and in many cases exceeded the commitments made for Phase I deliverables.

## Table of Contents

## 1.0 Introduction

Argonne National Laboratory (ANL) and Lockheed Martin Idaho Technologies (LMITCO) have been tasked to develop design, and test a prototype integrated system, pursuant to the requirements set forth in the Integrated Surveillance System (ISS) Phase I Report issued by the Plutonium Focus Area (PFA) of the United States Department of Energy Idaho Operations Office (USDOE-ID), for the surveillance and monitoring of stabilized plutonium and plutonium-bearing materials in interim storage. The product of this effort will be a baseline Integrated Monitoring and Surveillance System (IMSS) design that allows for efficient intra- and inter-facility data and information synthesis based on standardized system requirements. The baseline system will then be installed in an operational nuclear material vault at ANL-W. The use of standardized requirements will aid individual sites in the selection of sensors that best suit their needs while the prototype IMSS will provide a means of comparing and contrasting sensor performance against a baseline integrated system, demonstration of system capabilities, and testing of new hardware and software designs before purchase and installation in vaults within the DOE complex. In providing a means of evaluating technologies, requirements, and guidelines against an integrated system, the IMSS prototype will allow individual sites the opportunity to choose the most efficient and effective sensor systems and thus conserve available resources. The proposed system will also advance the objective of the PFA working group to propose standardized practices and equipment systems that promote system integration and interfacing for cost effective plutonium remediation, stabilization, and disposition preparation options and provide a means of future cost savings for sites within the DOE complex. With efforts currently underway to repackage and store a substantial quantity of plutonium and plutonium-bearing material within the DOE complex, this is an opportune time to invest in an IMSS prototype.

The proposed system will integrate the various tasks and technologies necessary to ensure material stability and package integrity, material control and accountability, proper environmental, safety, and health control, and extensive data acquisition and analysis capabilities. The prototype will be designed in a standardized form such that equivalent systems may be utilized throughout the DOE complex while being monitored simultaneously at a central location. A great degree of flexibility will be designed into the prototype such that, as experience is accumulated and as new technologies emerge, potential system modifications can be rigorously tested and characterized before being installed full-scale. Such flexibility may also allow the same or a slightly modified system to be used for surveillance of Pu packaged in containers other than the DOE-STD-3013 cans.

In keeping with the standardized nature of the proposed IMSS prototype, proven existing technologies, e.g. sensors, detectors, etc., from both government and industry sources will be utilized to the greatest extent possible. These sensors will be integrated into an existing reporting system and also networked to a central information hub capable of monitoring numerous facilities simultaneously. System design and operations will incorporate consideration for material stabilization and package constraints, thus minimizing necessary assay and verification measurements, increasing system fidelity, and optimizing system operations and performance. Once designed, the integrated safeguards and security system will be installed in a special nuclear material (SNM) vault at the Argonne National Laboratory - West (ANL-W) site and extensively tested for robustness and reliability under normal and transient conditions.

The IMSS demonstration project is divided into 5 phases. Included in Phase I are commitments to define sensor system requirements, identify existing sensor technologies, establish data system requirements, identify suitable ANL facilities for plutonium packaging and IMSS prototype demonstration, and review and modify facility documentation to accommodate packaging and storage of prototype materials in 3013 cans. Subsequent phases will involve hardware/software procurement, installation and testing and system demonstration.

Section 2 includes a summary of Phase I activities related to general project maintenance while the Phase I accomplishments are detailed in Section 3 below. Section 4 summarizes the expenditures to date followed by a list of IMSS publications in Section 5. Section 6 presents funding requirements necessary to complete Phase 2 of the IMSS project including both hardware/software purchases and effort. A summary of the Phase I accomplishments is the presented in Section 7.

## 2.0 Project Maintenance

A substantial part of the Phase I effort has involved activities necessary to begin and maintain technical progress in the IMSS demonstration. A management plan was formulated and accepted by PFA management and included a description of reporting structure, division of responsibility among the involved parties, and a description of the 5 basics tasks associated with IMSS development and demonstration. Basic project maintenance has also included developing technical teams to address sensor evaluation, facility engineering, data system design, plutonium packaging system design and installation, plutonium assay system requirements, and other IMSS demonstration needs.

Originally, the Management Plan called for the submission of weekly as well as monthly reports to the PFA committee that summarized progress to date. However, it was later established that submission of a detailed monthly report summarizing progress and issues related to each of the primary IMSS tasks was sufficient. Thus, weekly reporting is performed on an as needed, verbal basis at the weekly PFA committee meeting.

Recently, an opportunity has developed to combine a project for the performance testing of 3013 container surveillance devices, headed by B. Polk, with the IMSS demonstration project. Polk's project is tasked with evaluating the performance of container surveillance systems including the Los Alamos National Laboratory (LANL) "IVS", Oakridge National Laboratory (ORNL) "CAVIS", and Randtec "VersaTag" systems for inventory extension. In addition to generating the greatest value for each development dollar, combining the two projects would also enhance the testing of the IMSS prototype by providing an avenue to contrast and compare various sensors, i.e. IVS, CAVIS, and/or VersaTag, against a baseline system, the IMSS. Doing so would require a modification to the original performance testing proposal and thus requires the approval of that project's sponsor. A letter detailing the potential benefits to each program and the requisite modifications to the original performance testing proposal was drafted and sent to the performance testing project sponsor. It is anticipated that agreement can be reached and the performance testing project will be merged with the IMSS project.

The bagless transfer system is an important link in the successful demonstration of the IMSS and its use as a test bed. This is because in order to evaluate sensor and data systems against a baseline system in a credible fashion, i.e. use the IMSS prototype as a test bed, it is necessary to have plutonium packaged to DOE-STD-3013 requirements. Ideally, this would include plutonium in both oxide and metal form dispersed in various matrices to cover the range of possibilities that may be encountered at facilities throughout the DOE complex. Thus, installing a credible IMSS demonstration system requires on-site plutonium canning capabilities, i.e. a bagless transfer system, that meet DOE-STD-3013-96 requirements with the resulting packages closely resembling those to be found at DOE plutonium storage facilities. An initial analysis performed on the two bagless transfer systems that are available has necessitated redefinition of the scope and schedule commitments of the IMSS demonstration project. This redefinition of scope will allow the IMSS project to procure the best available bagless transfer system next fiscal year and thus strengthen overall IMSS prototype credibility.

Based on the initial system study (including cost estimates) detailed in Section 3.4.4, it was determined by PFA management that acquisition of the BNFL bagless transfer system would be the best choice for IMSS purposes. Because of budget and time constraints, it was then decided to forgo purchase of the bagless transfer system until September 1997. This then necessitates the use of surrogate 3013 packages for the IMSS demonstration in September. The project will then be extended past September to accommodate purchase, installation, and operation of the bagless transfer system and subsequent use of the standard 3013 packages in the IMSS test bed. In doing so, the IMSS prototype is greatly enhanced through the use of a set of "standard" packages.

## 3.0 IMSS Phase I Accomplishments

A detailed description of progress to date, broken down by major task and sub-task as outlined in the program management plan, is contained below.

## 3.1 Progress in Sensor System Design

### 3.1.1 Form Requirements

The Plutonium Focus Area (PFA) Integrated Surveillance System (ISS) Final Draft, dated September 1996, was initially reviewed. The ISS mission statement was drafted and approved by PFA program management. This mission statement reads "The purpose of the Integrated Surveillance System is to perform monitoring and surveillance of DOE-STD-3013-96 containers of stabilized plutonium residues during interim storage, collecting and recording data to ensure the physical condition, safety, and security of these containers." Note that this is the ISS mission statement, not a statement of objectives for the IMSS demonstration, which are detailed in Section 1.0.

The five documents that had been used to produce the Final Draft document were reexamined with the new mission statement in mind. The document numbers and names of these 5 documents are included in Table 1. Of the 302 requirements identified in the original PFA Phase I Final Draft, 146 were readily eliminated as not applicable under the scope defined within the mission statement. An additional 52 requirements have been redefined as assumptions or criteria. The remaining 114 requirements are being further scrubbed to separate lower level requirements and combine duplicates. An additional 10 requirements have been identified from the 5 documents and were added to the database. At the same time, an additional 9 applicable DOE documents, the numbers and names of which are also included in Table 1, were identified and reviewed to identify ISS requirements.

**Table 1: Documents Reviewed for IMSS Requirements**

| Document # | Title | Date |
|---|---|---|
| **Documents Reviewed for PFA Phase I Report and IMSS Requirements** | | |
| PFA-TM-121A | Research and Development Plan | 11/95 |
| PFA-TM-144A 94-1 | PFA Baseline Research and Development Technical Requirements Document - Final Draft | 4/25/96 |
| DOE-STD-3013-96 | Criteria for Safe Storage of Plutonium Metals and Oxides | 9/96 |
| PFA-TM-346 | Interim Safe Storage Criteria | 1/25/96 |
| DE-AC03-96SF20948 Attachment II | Performance Specification, Stabilization, and Packaging System (SPS) of Plutonium Metals and Oxides at Rocky Flats Environmental Technology Site Building 707 | 7/22/96 |
| **Additional Documents Reviewed for IMSS Requirements** | | |
| DOE/EH-O526T | DOE Radiological Controls Manual | N/A |
| PNL-6534 | Health Physics Manual of Good Practices for Plutonium Facilities | 5/88 |
| DOE -420.1 | Facility Safety | 11/16/95 |
| DOE -5660.1B | Management of Nuclear Facilities | 5/26/94 |
| DOE/DP-0123T | Assessment of Plutonium Storage Safety Issues | N/A |
| LA-12999-MS | Plutonium Dioxide Storage | N/A |
| DOE-5480.24 | Nuclear Criticality Safety | N/A |
| DOE-5633.3B | Control and Accountability of Nuclear Materials | 9/7/96 |
| Draft Document | Minimal Safeguards Practices for Plutonium Materials for Long-Term Storage per DOE-STD-3013 | N/A |

Table A.1 of Appendix A details the IMSS system requirements as determined through the review of the documents listed in Table 1. These requirements can be classified into 7 basic functional groups including:

- Sense container/vault conditions
- Monitor environmental, health, and safety compliance

- Control and account for nuclear material
- Monitor material stability
- Monitor container integrity
- Transfer signals and data
- Store, manipulate, and analyze data

One additional functional area, "Site Specific", appears in the classification. However, due to the nature of these functions, they are not grouped with the seven listed above. A detailed system requirement review involving various laboratories and facilities will be held in the near future.

### 3.1.2 System Design

Existing system designs are being reviewed and conceptual design of the IMSS prototype is being discussed. As part of the IMSS Phase II work, existing technologies will be evaluated against the IMSS requirements as determined during Phase I of this project.

### 3.1.3 Research Baseline Technology

Contact has been initiated with numerous individuals within the DOE community to solicit information on vault monitoring sensors and data systems currently in use. A survey form was developed to solicit information on current technologies in use and was distributed to individuals at Pacific Northwest National Laboratory (PNNL), Argonne National Laboratory (ANL), Lawrence Livermore National Laboratory (LLNL), Sandia National Laboratory (SNL), the Savannah River Site (SRS), ORNL, and the Rocky Flats Environmental Technology Site (RFETS). This initial contact also serves to inform potential users and suppliers of the scope and potential benefits of the IMSS project. Currently, response is incomplete or in many cases the initial contact has refereed the IMSS team to another contact.

Table 2 contains the status and/or comments received from each site contacted. Table 3 contains a cross reference of (preliminary) available sensor technologies determined to date, monitoring function, and requirement(s) that may be satisfied, in part, through use of the sensor. This is a preliminary assessment and further input is expected from several laboratories and/or sites. However, in order to maintain the tight schedule, only responses received before late February 1997 will be considered in development of the baseline system.

**Table 2: Site Contacts Regarding Sensor Systems in Use**

| Laboratory | Contact | Status |
|---|---|---|
| ANL | #1 | Performing test and evaluation of sensors and systems developed by SNL and installed at ANL. Sensors include motion, fiber optic, video, and vault access monitoring devices. Systems include PAMTRAK and Remote Monitoring systems. |
| INEL | | N/A |

**Table 2: Site Contacts Regarding Sensor Systems in Use**

| Laboratory | Contact | Status |
|---|---|---|
| PNNL<br><br>Field Office | #2, #3<br><br>#4 | Current system monitors bulging at the bottom of the can and ambulant temperature within the can. Proximity switches are used to indicate presence of the can. Developed by SNL, but system has undergone substantial changes. Sensors report to a centralized system. Referred to Field Office. |
| LANL | #5<br><br>#6 | Per G. Sheppard no existing technologies available. Pursuing other contacts, i.e. Dave Harwell.<br><br>Waiting for response. |
| LLNL | #7 | No input at this time. |
| SNL | #8 | Two systems: Remote Monitoring System (RMS), currently upgrading to MIMS version 1.0. This will be a multi-tasking system under Windows NT. StraightLine (SL) currently under test and evaluation at Pantex. Primary difference between RMS and SL, SL has several layers of security or access, allowing multiple users to access different levels of data. Sandia is also compiling a similar list of sensors for the IAEA Remote Monitoring Task Force. |
| SRS | #9<br>#10 | Referred to second party<br>No plans to monitor vault. |
| ORNL | #11 | Nothing to add at this time. |
| Y-12 | #12 | Discuss the Continuous Automated Vault Inventory System (CAVIS) - may be available for IMSS use. |
| Rocky Flats | #13 | Using IAEA type TID in vault. Seals are not real-time but intelligent enough to record date/time of tamper. Has not developed any sensors for monitoring/surveillance. Current NDA practices (oxide) Calorimeter to measure thermal, gamma spectroscopy to measure isotopic distribution, routinely use a neutron coincidence counter. |

### 3.1.4 Perform Trade Studies

Prerequisites for this study, such as research of the baseline technology and determination of IMSS requirements, are part of the Phase I commitments. As part of Phase II, identified existing technologies will be evaluated against identified IMSS requirements as part of a detailed trade study.

### 3.1.5 Procure Sensors

No progress to report.

### 3.1.6 Test Sensors

No progress to report.

**Table 3: Available Vault and Material Monitoring Sensors[a]**

| | ACCESS | | | MOTION | | | PRESSURE | | |
|---|---|---|---|---|---|---|---|---|---|
| **Sensor** | **Deployed At** | **Dev. By** | **Function** | **Deployed At** | **Dev. By** | **Function** | **Deployed At** | **Dev. By** | **Function** |
| Video Camera (RMS) | SNL ANL-W SRS Y-12 KIRRC | SNL | Monitor Container Integrity ID 180, 047 | N/A | N/A | N/A | N/A | N/A | N/A |
| Video Camera (IVS) | ANL-W SRS ICPP | LANL | Monitor Container Integrity ID 180, 047 | N/A | N/A | N/A | N/A | N/A | N/A |
| Fiber Optic | SNL ANL-W SRS Y-12 KIRRC | SNL | Monitor Container Integrity ID 180, 047 | N/A | N/A | N/A | N/A | N/A | N/A |
| WATCH | N/A | N/A | N/A | SNL ANL-W SRS Y-12 KIRRC | SNL | Monitor Container Integrity ID 180, 047 | N/A | N/A | N/A |
| Active Seal Sys-tem | ORNL Y-12 | ORNL Y-12 | Monitor Container Integrity ID 180, 047 | N/A | N/A | N/A | N/A | N/A | N/A |
| Proximity Switch | N/A | N/A | N/A | N/A | N/A | N/A | PNNL | PNNL | Monitor Material Stability ID 233, 511,040 |

## Table 3: Available Vault and Material Monitoring Sensors[a]

| | RADIATION | | | TEMPERATURE | | | WEIGHT | | |
|---|---|---|---|---|---|---|---|---|---|
| **Sensor** | **Deployed At** | **Dev. By** | **Function** | **Deployed At** | **Dev. By** | **Function** | **Deployed At** | **Dev. By** | **Function** |
| Capacitive Proximity Detector | N/A | N/A | N/A | ORNL Y-12 | ORNL Y-12 | Monitor Material Stability ID 216, 012 | ORNL Y-12 | ORNL Y-12 | Monitor Material Stability ID 142, 513 |
| Gamma Ray Detector (2 types) Cd-Zn-Te Silicon | ORNL Y-12 | ORNL Y-12 | Monitor Container Integrity ID 042 043, Monitor ES&H ID 103 | N/A | N/A | N/A | N/A | N/A | N/A |
| Neutron Detector | ORNL Y-12 | ORNL Y-12 | Monitor Container Integrity ID 042,043 Monitor ES&H ID 103 | N/A | N/A | N/A | N/A | N/A | N/A |
| Rad-Couple | ORNL Y-12 | ORNL Y-12 | Monitor Container Integrity ID 042,043 Monitor ES&H ID 103 | N/A | N/A | N/A | N/A | N/A | N/A |
| Fiber Optic Gamma Ray | ORNL Y-12 | ORNL Y-12 | Monitor Container Integrity ID 042,043 Monitor ES&H ID 103 | N/A | N/A | N/A | N/A | N/A | N/A |

**Table 3: Available Vault and Material Monitoring Sensors[a]**

| | RADIATION | | | TEMPERATURE | | | WEIGHT | | |
|---|---|---|---|---|---|---|---|---|---|
| Sensor | Deployed At | Dev. By | Function | Deployed At | Dev. By | Function | Deployed At | Dev. By | Function |
| Fiber Optic Weight | N/A | N/A | N/A | N/A | N/A | N/A | ORNL Y-12 | ORNL Y-12 | Monitor Material Stability ID42, 513 Monitor Container Integrity ID 512 |

a. Acronyms:

| | |
|---|---|
| ANL-W | Argonne National Laboratory West |
| PNNL | Pacific Northwest National Laboratory |
| KIRRC | Kurchatov Institute Russia Research Center |
| RFETS | Rocky Flats Environmental Technology Site |
| LANL | Los Alamos National Laboratory |
| SNL | Sandia National Laboratory |
| ORNL Y-12 | Oakridge National Laboratory Y-12 |
| SRS | Savannah River Site |
| ICPP | Idaho Chemical Processing Plant |
| IVS | Image Video System |
| RMS | Remote Monitoring System |

### 3.1.7 Develop Pre-Installation Report

No progress to report.

## 3.2 Data System Design

### 3.2.1 Sensor Interface

#### 3.2.1.1 Form Requirements

Based on a system engineering review of the IMSS mission/requirements and engineering expertise, the following lower level specifications have been defined for configuration of a Local Sensor Network. The purpose of the Local Sensor Network is to provide an industrial standard hardware/software configuration for networking and system integration of sensors. The sensor types will be selected, as required, for monitoring and surveillance of stabilized plutonium-bearing materials in interim storage. Design requirements for the Local Sensor Network include:

1) The Network should be based on a commercial and industrial standard.

2) The local sensor network should provide data integrity features, including:

- Sender authentication
- Priority transmissions
- Collision avoidance
- Error detection & recovery

3) The local sensor network should be designed for reliability and incorporate the following provisions:

- Reliable delivery should be assured by true end-to-end acknowledgments (most protocols can only guarantee that a packet was successfully transmitted, not that it was actually received by the application).
- Data integrity should be guaranteed by the fact that all packet transmissions incorporate via a full 16-bit error polynomial.
- Transceivers for difficult media (i.e., low bandwidth, high noise and attenuation) should incorporate forward error correction, and be able to detect and correct single bit errors without retransmission.
- The distributed control processors should incorporate diagnostic features including a continuous EEPROM memory corruption check.

4) The network must provide security features including:

- All network operations (including network management) should incorporate full "sender authentication".
- The network should support the implementation of security fire walls.
- The network should have access control.

5) The control network should support product inter-operability, including:

- The ability to integrate products from multiple sources without the need for extensive custom development.
- Control network should be based on an open architecture.
- The network should be medium-independent.

6) The control network should support the following transceivers types:

- Transformer-coupled twisted pair (to 1.25 Mbits/s)
- Free topology twisted pair (supporting any random wire topology)
- Link powered twisted pair (node power & communication over the same two wires)
- Spread spectrum power line (FCC & CENELEC compliant),
- Narrow band power line (FCC & CENELEC compliant)
- Radio (2.4 GHz spread spectrum, 900 MHZ spread spectrum, 450 MHZ, 49

MHZ, etc.)

- Coaxial cable (with & without multiplexed video)
- Optical fiber
- Infrared

7) Commercial interface products must be available to interface with multiple processor types and control standards including embedded controllers, desktop PCS, programmable logic controllers (PLCs), etc. The control network should support connectivity to the following environments:

    - Gateways for joining the sensor network to a variety of industrial environments, including: Ethernet, T1, X.25, Bitbus, Profibus, CAN, Modnet, SINEC, Grayhill, Opto22 (digital), OptoMux, Modbus, ISA bus, STD32 bus, PC/104 bus, VME bus, and EXM bus.
    - Support serial and PC adapters (allowing EIA-232 and PC-based devices to become network nodes).

8) The control network should support host-based environments such as a full Windows-based PC system that communicates with the network via a serial channel or PC adapter board. Such applications are often appropriate and necessary when connecting operator consoles, alarm monitors, or providing centralized control. It is preferred that the network server should enable Windows-based application programs to communicate with the network, using the Microsoft Dynamic Data Exchange standard.

9) The network should have sufficient Development tools to support configuration and implementation, without the requirement for highly technical resources.

Table 4 provides a cross-reference of the 7 functional areas (and site specific requirements), requirements number (as detailed in Table A.1 of Appendix A), and whether or not the requirement affects the data system design.

**Table 4: Data System Requirements[a]**

| Item # | Requirement ID # | Function | Data System Requirement |
|---|---|---|---|
| 1 | 225 | MC&A | Required |
| 2 | 264 | MC&A | Required |
| 3 | 263 | MC&A | Not Applicable |
| 4 | 510 | MC&A | Required |
| 5 | 189 | MC&A | Required |
| 6 | 057 | MC&A | Not Applicable |
| 7 | 229 | Container Integrity | Not Applicable |

**Table 4: Data System Requirements[a]**

| Item # | Requirement ID # | Function | Data System Requirement |
|---|---|---|---|
| 8 | 236 | Container Integrity | Not Applicable |
| 9 | 136 | Container Integrity | Not Applicable |
| 10 | 180 | Container Integrity | Required |
| 11 | 512 | Container Integrity | Required |
| 12 | 042 | Container Integrity | Required |
| 13 | 043 | Container Integrity | Required ( ) |
| 14 | 047 | Container Integrity | Required ( ) |
| 15 | 103 | ES & H | Not Applicable |
| 16 | 181 | ES & H | Required |
| 17 | 216 | Material Stability | Required ( ) |
| 18 | 233 | Material Stability | Required ( ) |
| 19 | 142 | Material Stability | Required ( ) |
| 20 | 513 | Material Stability | Required |
| 21 | 511 | Material Stability | Required |
| 22 | 012 | Material Stability | Required |
| 23 | 040 | Material Stability | Required (req. needs eval.) |
| 24 | 041 | Material Stability | Required |
| 25 | 218 | Sense Cond. Xfer | Required |
| 26 | 210 | Site Specific | Not Applicable |
| 27 | 219 | Site Specific | Not Applicable |
| 28 | 244 | Site Specific | Not Applicable |
| 29 | 270 | Site Specific | Required |
| 30 | 274 | Site Specific | Required |
| 31 | 291 | Site Specific | Required |
| 32 | 505 | Site Specific | Not Applicable |
| 33 | 115 | Site Specific | Required |
| 34 | 117 | Site Specific | Required ( ) |

**Table 4: Data System Requirements[a]**

| Item # | Requirement ID # | Function | Data System Requirement |
|---|---|---|---|
| 35 | 106 | Site Specific | Required |
| 36 | 107 | Site Specific | Required |
| 37 | 108 | Site Specific | Required |
| 38 | 109 | Site Specific | Required |
| 39 | 134 | Site Specific | Not Applicable |
| 40 | 137 | Site Specific | Required |
| 41 | 509 | Site Specific | Not Applicable |
| 42 | 153 | Site Specific | Required |
| 43 | 144 | Site Specific | Not Applicable |
| 44 | 175 | Site Specific | Required ( ) |
| 45 | 182 | Site Specific | Required |
| 46 | 501 | Site Specific | Required (General) |
| 47 | 034 | Site Specific | Not Applicable |
| 48 | 035 | Site Specific | Not Applicable |
| 49 | 036 | Site Specific | Not Applicable |
| 50 | 037 | Site Specific | Not Applicable |
| 51 | 039 | Site Specific | Required (General) |
| 52 | 046 | Site Specific | Required (General) |
| 53 | 049 | Site Specific | Required (General) |
| 54 | 050 | Site Specific | Required |
| 55 | 038 | Site Specific | Required |
| 56 | 122 | Data Analysis | Required |
| 57 | 124 | Data Analysis | Required |
| 58 | 124 | Data Analysis | Required |
| 59 | 125 | Data Analysis | Required |
| 60 | 128 | Data Analysis | Required |
| 61 | 129 | Data Analysis | Required |

**Table 4: Data System Requirements[a]**

| Item # | Requirement ID # | Function | Data System Requirement |
|---|---|---|---|
| 62 | 130 | Data Analysis | Required |
| 63 | 131 | Data Analysis | Required |
| 64 | 132 | Data Analysis | Required |
| 65 | 138 | Data Analysis | Required |
| 66 | 119 | Data Analysis | Required |
| 67 | 506 | Data Analysis | Required |
| 68 | 123 | Data Analysis | Required |
| 69 | 127 | Data Analysis | Required |
| 70 | 507 | Data Analysis | Required |
| 71 | 133 | Data Analysis | Required |
| 72 | 121 | Data Analysis | Required |
| 73 | 126 | Data Analysis | Required |
| 74 | 048 | Data Analysis | Required |
| 75 | 051.3 | Data Analysis | Required |
| 76 | 051.5 | Data Analysis | Required |
| 77 | 051.6 | Data Analysis | Required |
| 78 | 051.7 | Data Analysis | Required |
| 79 | 051.9 | Data Analysis | Required |
| 80 | 051.12 | Data Analysis | Required |
| 81 | 051.13 | Data Analysis | Required |
| 82 | 051.14 | Data Analysis | Required |
| 83 | 051.15 | Data Analysis | Required |
| 84 | 051.2 | Data Analysis | Required |

a. () As Determined

#### 3.2.1.2 System Design

Monitoring and surveillance of Pu storage areas requires an intelligent and expandable data acquisition system. Current sensor systems do not use a standardized protocol. In addition, the I/O capability of the sensor network must be expandable to accommodate growth in the number of vaults necessary for interim plutonium storage.

The following steps are required for the design of the IMSS prototype. An overview of the IMSS configuration is shown in Figure 1.

**1) Configuration of the Sensor Local Network/Control System.**

Based on a system engineering approach the Echelon LonWorks distributed control technology was selected as the basis for the IMSS system. The sensor network will be located in the special nuclear material (SNM) vault area, providing direct linkage to all sensors. Appropriate communication nodes will be configured to allow remote data logging and monitoring of the sensors. A diagram of the proposed local sensor configuration is shown in Figure 2.

**2) Configuration of a Central Information Data System.**

The local sensor-network will transfer pertinent data to the remote central information system via a leased phone line or if high speed transfer rates are required, through the Internet. The central information system will log data and provide report and status generation. A diagram of the proposed Central Information Data System is shown in Figure 3.

**3) Specification and Selection of Sensors.**

Vault and material monitoring and surveillance sensors will be chosen following a review of overall IMSS requirements and available technologies.

**4) Perform Modifications to Sensors to Ensure Network Compatibility**

Sensors will be modified with Echelon connectivity modules to make them plug n' play compatible on an as needed basis. This design approach will make it possible to integrate sensors into a sensor network and provide a standardize configuration that can be easily duplicated at other sites.

**5) Implementation of the Local Sensor Network**

The following design steps will be followed to implement the conceptual design of the Local Sensor Network for installation into the IMSS demonstration.

- Install a local-area-network trunk line. This will serve as the communication backbone for the sensor network.
- Implement and attach commercial I/O control modules to the trunk. I/O control modules provide intelligent and user configured interfacing to multiple sensor products.
- Select and configure appropriate transceivers and protocols for attaching sensors

to the network. Off the shelf transceivers are available to handle all available industrial standards. Transceivers will be selected based on the protocol requirements of the sensors.

- Evaluate and demonstrate a Network Interface Gateway for interfacing to Legacy non-Echelon compatible monitoring and surveillance systems.
- Configure a Serial Network Interface for remote access/monitoring of the Local Sensor Network. Initial remote demonstration will be done using a modem/phone line configuration.
- Build the local sensor network. Specific network building steps include: a) Program the nodes as required with distributed intelligence, data pre-processing, etc., b) Assign addresses to the nodes, c) Bind the network variables (setup network variables, tables), and d) Configure and tune the network.
- Install a Windows based Graphical Control Environment - based on ICELAN commercial software that will concurrently support, multi-tasking, data acquisition and report generation.
- Design a graphical user screen for monitoring/control of network sensors. Use ICELAN User Screen Run Tools. The major goal is to provide a user friendly software interface that allows someone with minimal technical training to monitor/operate the IMSS system.
- Optimize the network's graphical control environment with project-specific functions such as sample rate and analysis requirements.
- Perform bench testing of the local sensor network.
- Install and test the local sensor network at ANL-W.

### 6) Design Remote Monitoring and Central Information Hub Prototype

As previously noted, the local sensor-network will transfer pertinent data to the remote central information system. The central information system will log data and provide report and status generation and may be configured to support database management of multiple special nuclear material (SNM) vaults. Specific tasks include:

- Procure a Pentium class PC and configure it for remote monitoring/database archiving.
- Configure modems and dedicated lines for a remote data link.
- Specify and configure a Serial Gateway for attaching the remote system to the Local Sensor Network.
- Develop host application program interfaces and communication software for remote linking to the network.
- Design a Graphical User Interface for monitoring and accessing the sensor data.
- Demonstrate ability to remotely monitor data from the Sensor Network.

### 7) Installation, Testing, and Demonstration of System at ANL.

The integrated safeguards and security system will be installed at the SNM vault at the ANL-W site. Test plans will be developed to ensure the system operates reliably under various normal and transient conditions.

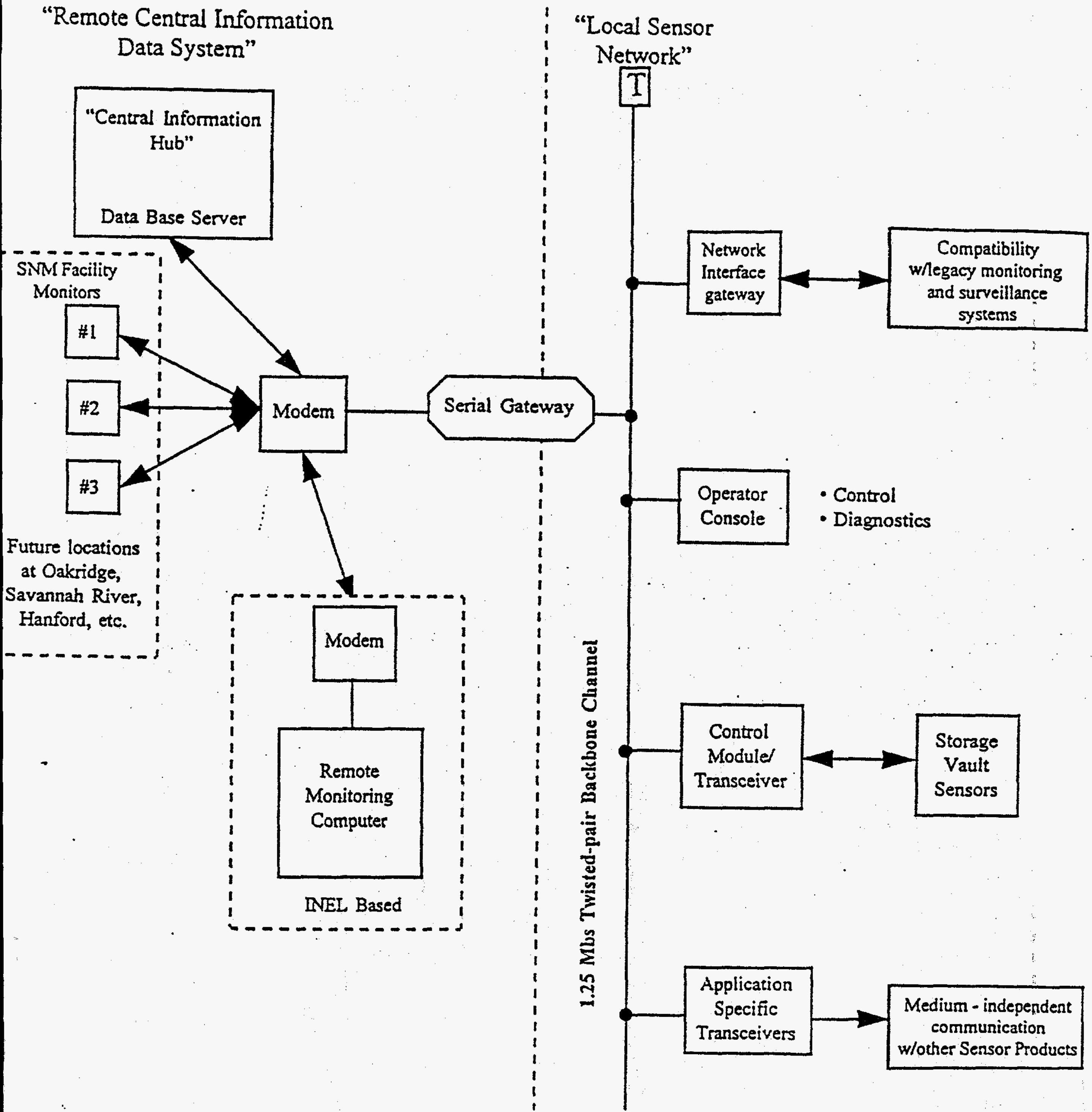


Figure 1. Proposed Data System (Sensor Interface) Design

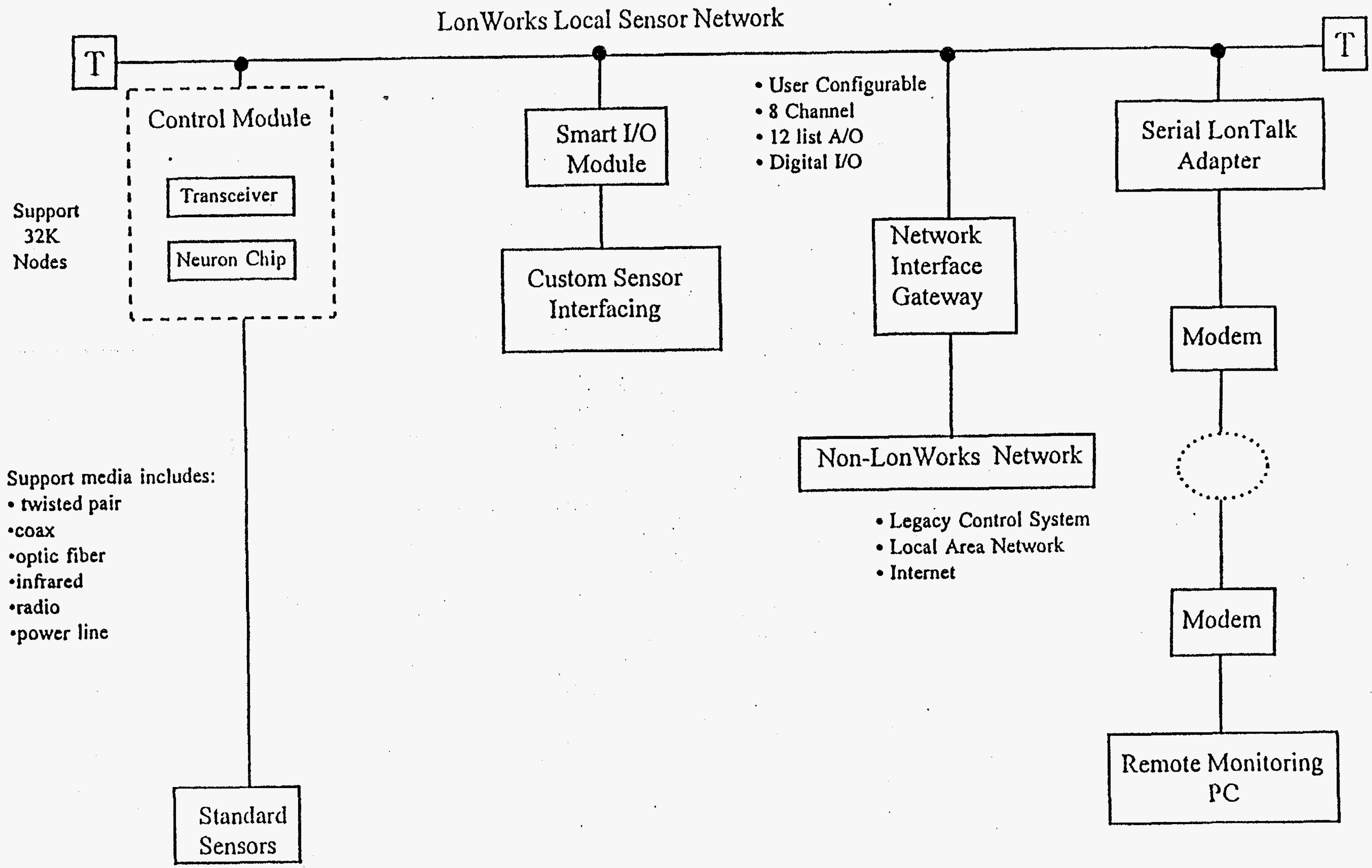


Figure 2. Local Sensor Network Configuration

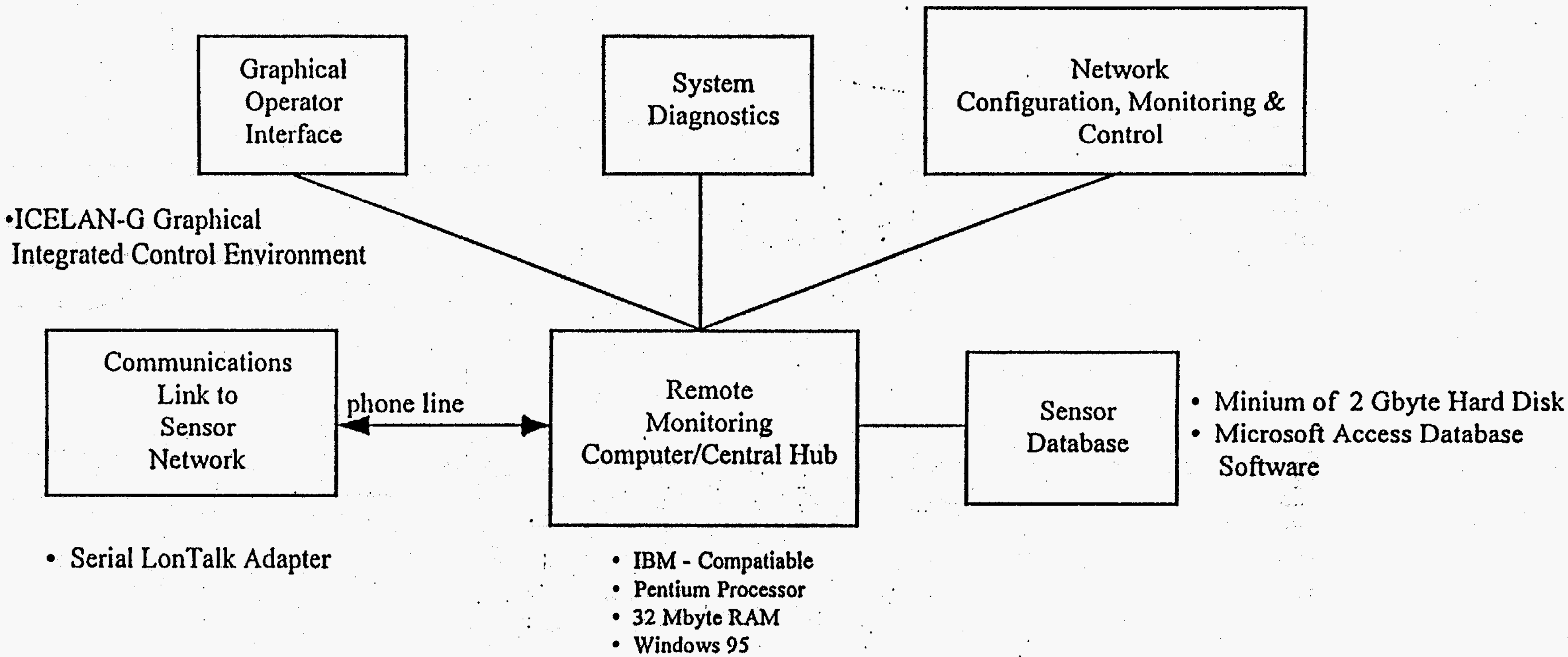


Figure 3. Central Information Data System Configuration

#### 3.2.1.3 Research Baseline Technology

Three types of network structures, namely Business, Control, and Device, were evaluated for implementation of the IMSS system. In addition, PC-bus based data acquisition hardware was evaluated. Details concerning each system are provided below.

#### 3.2.1.4 Perform Trade Studies

Based on system requirements a technology comparison was made. The results are summarized in Table 5. Below is a summary of each network type and projected merits/limitations when employed in a SNM monitoring scenario.

**1) Business Network**

The internet (i.e. TCP/IP ethernet) is becoming a standard for business networks. The internet is the familiar Local Area Network (LAN) which allows information to be shared between desktop workstations, such as PCs. It supports multiple clients, allows data transfer between different hosts types, and has excellent data throughput. However, interface hardware is relatively expensive and must be tailored to the bus structure of the host computer. Each "drop" on the network requires a PC with an appropriate interface board. Due to the extensive hardware requirements a business network is not well suited for control and device applications where data acquisition requirements may require interfacing to hundreds of sensors. Due to the open accessibility of the internet, security control may also be compromised.

**2) Control Networks**

Control networks connect separate host controllers, such as PLCs, to each other using a network protocol such as Modicon's Modbus. The host controller is required to provide inter-operability between sensors/device on the network. A true distributed control architecture does not exist in these applications. The host controller adds system overhead and greatly impacts the performance of the network/sensor data throughput.

**3) Device Networks**

An industrial standard Device Network is LonWorks. LonWorks allows intelligent devices to communicate directly with each other in a true distributed control environment. LonWorks control networks have filled the void to provide the infrastructure or "infranet" for communications within a control environment. Sensor and actuator-level data are managed locally within the infranet, but can be shared with higher level data networks through intranets and other networking platforms.

**4) PC-Bus Data Acquisition**

Several data acquisition products exist and are generally built around personal computer/ work station bus standards (PC/104, PCMCIA, ISA, VXI, etc.) or use micro-controller and programmable logic (PLC) technology. As noted in Table 5, PC data acquisition technology is extremely limited in a multi-client, networked environment and thus is not suitable in a dynamic local sensor network configuration.

From the results of Table 5 it is apparent that the architecture of choice is a Control or Device Network. A more extensive system study was made comparing industrial standard Device level networks. It was found that industrial I/O networking is a growth business and that several companies are competing for the defacto standard. Table 6 provides a direct technical comparison of the major contenders in the device "field bus" application environment. Please note that some of the specifications are still a subject of vendor interpretation. However, all attempts have been made to compare the various applications on an equivalent basis.

**Table 5: Baseline Technology Comparison - Data Acquisition/Sensor Control Networks**

| | Lon-Works | Ethernet | ISA Bus Control | PC/104 | PLC Controller | Modcon | VXI Bus Control |
|---|---|---|---|---|---|---|---|
| Proprietary Architecture | N | N | N | N | N | Y | N |
| Supports Multi-clients | Y | Y | N | N | N | N | N |
| Supports Multi-servers | Y | Y | N | N | Y | N | N |
| Supports Distributed Control | Y | N | N | Y | Y | Y | Y |
| Host-Independent Architecture | Y | Y | N | N | Y | N | N |
| Requires Dedicated Wiring | N | Y | Y | Y | Y | Y | Y |
| Data Integrity Features | Y | Y | N | N | N | N | N |
| Limited Network Size | N | N | Y | Y | Y | Y | Y |
| Inter-Operability with Mix/Match Sensors | Y | N | Y | Y | Y | Y | Y |
| Off-Shelf Parts | Y | Y | Y | Y | Y | Y | Y |
| Transparent Connection to LAN | Y | Y | N | N | N | N | N |
| Industrial Standard | Y | Y | Y | Y | N | Y | Y |
| Cost Factor | L | H | M | L | L | M | M |
| Security Control | Y | Limited | Limited | Limited | N | Limited | Limited |

**Table 5: Baseline Technology Comparison - Data Acquisition/Sensor Control Networks**

| | Lon-Works | Ethernet | ISA Bus Control | PC/104 | PLC Controller | Modcon | VXI Bus Control |
|---|---|---|---|---|---|---|---|
| **Local Intelligence** | Y | N | Y | Y | Y | Y | Y |
| **Multiple Media Options** | Y | Limited | Limited | Limited | N | Limited | Limited |
| **Topology Options** | Y | Y | N | N | N | N | N |
| **Packet Size Restricted** | N | N | Y | Y | Y | Y | Y |
| **Throughput Limited** | N | N | Y | Y | Y | Y | Y |

Based on a system study comparing industrial standard device level networks, the following conclusion were reached Conventional central-host architectures are in the process of becoming obsolete and are being replaced with "truly" distributed control architectures which involve autonomous I/O in peer-to-peer networking configurations. In a peer-to-peer configuration the LonWorks technology best meets the IMSS system specifications. Features that led to the selection of the Echelon LonWorks technology include:

1) The selected technology is provided with a full range of off the shelf hardware and software products to support the development, installation and management of intelligent, open and inter-operable control networks. There are more than 2,500 application developers and over 2.5 million LONWORKS based devices installed worldwide.

2) Expandability and support of additional sensors/devices is a key decision point. The IMSS will be based on a peer-to-peer architecture that can start with just two devices and expand to tens of thousands. It will be an open system that allows one to mix and match components from different manufacturers. It will be based on a technology that lets you add new control functions as monitoring and surveillance requirements expand. LonWorks will support up to 32,000 devices; greatly exceeding the network size capabilities of competing technologies.

**Table 6: I/O Network Comparisons**

| | Interbus-S | Device Net | AS-I | Fieldbus | IEC/SP50 | WorldFIP | Lon-Works | SDS |
|---|---|---|---|---|---|---|---|---|
| **Developer** | Phoenix | Allen Bra-dley | AS-I Con-sortium | Fieldbus Founda-tion | ISA | WorldFIP | Echelon Corp | Honeywell |
| **Mature Solution** | 1984 | 1994 | 1994 | 1995 | being defined | 1988, min-imal tools | 1991 | 1994 |
| **Chip Cost** | low | low | medium | high | N/A | high | low | medium |
| **Maximum Devices** | 256 | 64 | 31 | 240 | 128 | 256 | 32,000 | 64 |

**Table 6: I/O Network Comparisons**

| Communication Method | Master/ slave | Master/ slave | Master/ slave with poll | Client/ server | Client/ server | peer to peer | Master/ slave peer to peer | Master/slave peer to peer |
|---|---|---|---|---|---|---|---|---|
| Transmission | 500kbps | 500kbps | N/A | 2.5Mbps | 5Mbps | 2.5 Mbps | 1.25 Mbps full duplex | 1Mbps |
| Data Transfer Size | 512 bytes | 8 bytes | 31 slaves | 16.6 M objects/ device | 64 octets | 128 bytes | 228 bytes | 8 byte |
| Arbitration | None | Carrier-Sonac | Master/ Slave with poll | Determin-istic | Scheduler | Central Arbitration | Carrier Sense | Carrier-Sonac |
| Error Checking | 16 bit CRC | CRC check | Manches-ter | 16-bit CRC | 16-bit CRC | 16-bit CRC | 16-bit CRC | CRC |
| Topology | Segmented | trunkline with branch | Bus, nng, star, tree | Multidrop | star, bus | bus | Bus, nng, loop, star | Trunkline |
| Media | t-pair, fiber | t-pair | t-pair | t-pair | t-pair, radio | t-pair, fiber | t-pair, fiber, power line, radio | t-pair |
| Max. Distance | 400m/seg | 500m | 100m | 1900m @31.25kbps | 1700m @31.25kbps | N/A | 2000m @78kbps | 500m |
| Cycle Time: 128 Analog, 16 Nodes, with 8 I/O | 7.4ms | 10ms | not possible | 8 ms @2.5Mbps | N/A | 5 ms | 5ms | 1 ms per event |
| Block Transfer of 128 bytes | 140ms | 4.2ms | not possible | 8ms | N/A | 5ms | 5ms | 1 ms per event |

3) The IMSS system will be designed with control and transceiver products that enable information to be sent over a variety of media, including: Locally powered or low voltage twisted pair; Star, bus, or ring topology; Fiber optic or RF; Even send signals over the power line. LonWorks supports each of these considerations. This approach allows the mix and match of topologies or media in the same network. Where the cost of putting in dedicated wiring is too expensive or too difficult, the ability to use previously installed power lines rather than dedicated wiring is critical.

4) This technology approach will provide the platform for standardization of both sensor and data acquisition networks. It is based on an open architecture where sensor integrators can build communications, intelligence, and network compatibility into their products. The technical approach is well suited for after market enhancements to make sensors "plug and play" capable. This approach will make it possible for sensor developers across the DOE complex to buy development tools, software, and hardware off the shelf and add inter-operability to their products without having to develop the enabling technology themselves. In direct contrast, vendors of the many closed architectures and proprietary protocols must create custom solutions for each new application. An open architecture, such as Echelon, is mandatory to enable products from different manufacturers and

different facilities to work together. For example, the security system from one maker and the radiological alarm system from another can be easily networked.

5) Cost per node is a major factor when considering the requirement to instrument each 3013 container. LonWorks is very affordable at approximately $5 per node.

6) Local intelligence. Because each point in the network has intelligence, systems can be designed with no central point of failure, i.e. Echelon LonWorks incorporates local intelligence.

Key questions that were asked in the evaluation include: Even if the installation is small today, how big can it grow? How easily? Are there network routers for setting up multiple channels to improve throughput? Is the maximum packet size so small that it will only work with the simplest devices? Can we live with a network running on a single medium? Will we want to add fiber or RF in the future? Can a master/slave architecture that requires polling keep up?

In all cases LonWorks best supports expendability, data transfer throughput, and media options. Based on the system study the technology of choice is Echelon LonWorks.

#### 3.2.1.5 Procure Hardware/Software

Purchase requisitions for necessary computer systems and software have been written. These will be submitted when a funding commitment for Phase II has been obtained.

#### 3.2.1.6 Develop Necessary Software

As detailed above, the prerequisites necessary for software design including definition of requirements, have been developed as part of Phase I. Any necessary software will be procured/ developed in subsequent phases of the project.

#### 3.2.1.7 Test Hardware/Software

No progress to report.

#### 3.2.1.8 Develop Pre-Installation Report

No progress to report.

### 3.2.2 Data Acquisition/Archival System

#### 3.2.2.1 Form Requirements

To ensure nuclear material control and accountability all material stored must be continually tracked and records logged and updated on a periodic basis. In part, the following documentation is generated in the packaging and storage of the material. Pertinent data will be compiled together into a database package unique for each container. Proposed database fields include, but may not be limited to, the following:

- Container fabrication data record on all welds
- Helium leak test data record for inner and outer cans
- Transaction data including where/when container was moved to storage, source of material, identification of personnel involved.
- Unique container identifications codes - such as barcodes
- Initial gross material weight
- Material description including chemical form, element and isotopic content
- Date when plutonium was last separated
- Fill gas composition
- Package configuration including number of containers in package
- Date of packaging
- Initial radiation field readings (gamma/neutron, alpha check)
- Location of stored material
- Surveillance testing frequency
- Identify of any tamper indicating device applied to the container
- Real-time weight information, including instrument used, data and time of measurement
- Real-time measurement data used to confirm the presence of the item

Based on a best engineering assessment, specific database language specifications and requirements were derived. They include:

- Software product must be based on a recognized standard and capable of operating on an industry standard personal computer.
- The software product must have internationally available technical support.
- The software manufacturer should be well established and have a proven stability of the technology through at least 10 years of marketing of database products.
- The chosen database software should provide connectivity to other software applications, including word processor and spreadsheet in order to support data formatting and report generation.
- Third party commercial enhancements, tools, and accessories should be available to minimize custom development efforts.
- The technology should be based on an object oriented database.
- The database product should support custom creation of objects such as reports and forms.
- The database should have integrated tools for maintenance of the database files.
- The database should provides utilities for validation of data.
- The database product should provides utilities for archiveing/backup of data.
- The database product should supports links to other programming languages, such as "C" and Visual Basic. This will allows implementation of application specific tasks.
- The database product should operates in a 32 bit Windows Environment
- Must be able to run on a PC Pentium class computer with <32 Mb RAM

#### 3.2.2.2 System Design

The database will be configured to log and track multiple parameters as defined by requirements documents. Specific design tasks include:

- Configure Central Information Hub PC with database tools.
- Specify database structure.
- Design an object orient database.
- Provide a controlled user access software front-end.
- Generate software code for filtering and handling sensor data.
- Create custom reports and forms.
- Demonstrate ability to load and interrogate the database.

The database will be designed to handle both structured as well as text data, allowing users to define hierarchies and lookup tables to assist in the generation of custom report. Indexing mechanisms will make it possible to support extremely fast retrieval from data collections in the millions of records.

#### 3.2.2.3 Research Baseline Technology

An Internet literature search was performed on database technologies and experts in the field have been surveyed. Similar database applications are in the process of being evaluated for potential adaptation to the IMSS They include:

1) DOE-NN21, Modular Integrated Monitoring (MIMS) Program, Sandia National laboratory. SNL's Bob Corbell has provided a technical evaluation of their approach. The technology is based on a Data Logger Node attached to a Echelon LonWorks Network. The basis of the software is a IEC Corporation product written in the Microsoft Access environment. A graphic user interface is being developed to provide user friendly data review. The software runs on a Personal Computer NT platform.

2) INEL database technologies used at the Sensor System Evaluation Center (SSEC) sponsored by DOE NN-20. LMITCO's Evan Filby is evaluating the IEC Corporation Access database tools for future development efforts. Their technological approach is based on Echelon LonWorks.

3) Argonne National Laboratory database technologies currently in use in FMF. A technical review was provided by ANL's Dr. Tom Ewing. The database was based on Microsoft Access 95 operating on a Pentium Pro 32 Mb RAM computer. Ewing highly recommends the Access software and commends the object oriented structure, extensive tools for maintaining the database, and visual basic front end which allows tailoring the database for specific applications.

4) Sandia's Personnel and Material Tracking System (PAMTRACK), using Straight-Line, provides security control. Further evaluations are in the process of being arranged with SNL's John Matter.

#### 3.2.2.4 Perform Trade Studies

A preliminary baseline study, based on database system requirements, shows that the Microsoft Access Software meets all specifications. This software will allow multiple databases to be easily linked to access information about a related sensor parameter. The actual data may reside in a separate database and/are on a remote IMSS data logger. The linking of data can be transparent to the user of the central information hub database.

Trade studies will continue during Phase II of the project.

#### 3.2.2.5 Procure Hardware and Software

No progress to report.

#### 3.2.2.6 Develop Necessary Software

No progress to report.

#### 3.2.2.7 Test Hardware/Software

No progress to report.

#### 3.2.2.8 Develop Pre-Installation Report

No progress to report.

## 3.3 Plutonium Assay System Design

### 3.3.1 Form Requirements

The requirements for nondestructive assay measurements of the 3013 containers are wrappedup in the overall IMSS system requirements detailed in Section 3.1.1. Phase II of the IMSS project will determine precision to be expected in various materials characterization and measurement schemes such as gamma ray spectroscopy, calorimetry, neutron coincidence counting, and gross gamma/neutron measurements. During Phase II of the IMSS project, plutonium assay system design and procedures will be developed to meet overall IMSS system requirements.

### 3.3.2 System Design

No progress to report.

### 3.3.3 Procure Hardware/Software

No progress to report.

### 3.3.4 Develop Pre-Installation Report

No progress to report.

### 3.3.5 Installation/Testing

No progress to report.

## 3.4 Plutonium Packaging System

### 3.4.1 Identify Test Facilities

Facilities for plutonium packaging have been identified. The ZPPR workroom will house the glovebox and bagless transfer system (canning system) used in plutonium packaging.

### 3.4.2 Identify/Perform Facility Modifications

Representatives from the ZPPR facility have been included in the project team. As the design of the glovebox and bagless transfer systems are firmed, necessary facility modifications can be identified and performed.

### 3.4.3 Update/Review Facility Safety Documentation

An extensive review is underway to determine if IMSS canning activities will remain within the envelop of existing ZPPR safety documentation. Major components of a modification/installation package necessary to install the bagless transfer system and associated glovebox in the ZPPR workroom include:

- Engineering package
- Design review
- Safety analysis
- Safety review and approval (review by division SRC and approval by division office)
- Environmental checklist and approval
- USQ determination
- Installation procedures
- Operating procedures
- Maintenance procedures
- Emergency procedures

An initial determination of facility and/or site documents that will need to be reviewed is detailed in Table 7.

**Table 7: Facility/Site Documentation of Interest for Installation of Packaging System in ZPPR Workroom**

| Description | Document |
|---|---|
| Guidance documents for modifications and new activities | Nuclear Safety Procedures Manual<br><br>ANL-W Engineering Procedure/ZPPR Modification Procedure<br><br>ANL-W Health and Safety Manual<br><br>Engineering Division Management Plan |
| Documents likely to be affected and require some level of revision | Vault 64 MBA Procedures and User Rules - F00000-0144-AP<br><br>ZPPR Criticality Hazards Control Statement<br><br>ZPPR Emergency Plan and Procedures |
| Documents not likely to be affected but should be considered | ZPPR FSAR (Currently scheduled for review and revision).<br><br>ZPPR Derived Technical Specifications for Standby Operations |

### 3.4.4 Procure Canning System and Glovebox

As noted in Section 2.0, installation of a credible IMSS demonstration system requires on-site plutonium canning capabilities that meet DOE-STD-3013-96 standards with the resulting packages closely resembling those to be found at DOE plutonium storage facilities. Bagless transfer systems from two different vendors, the Savannah River Site (SRS) and British Nuclear Fuels Limited (BNFL), are available. Substantial differences between the two designs include the mode of welding and cutting (both laser in the case of BNFL and TIG welding and cutter wheels for the SRS design) and the system seal type (BNFL uses a fluidic seal while SRS uses a sequence of rubber O-rings). Preliminary quotes from both suppliers were solicited and received. The quotes were originally made to LLNL, who are acquiring a bagless transfer system very similar to that which we require. A meeting with SRS representatives was arranged in early January to discuss the attributes, cost and delivery schedule for the SRS system. Primarily because of the cost of the laser, the base cost of the BNFL system is considerably larger than the SRS system, ~$1.2 M compared to ~$650 K for the SRS system.

Although the base price of the SRS system appears to be substantially lower, several significant additional costs would be incurred if this system were to be used for the IMSS demonstration. The

SRS system does not use the qualified BNFL inner can. The SRS inner can is ~4in. tall compared to ~9in. height of the BNFL inner can. Because the 4in. height is undesirable for our purposes, a new SRS-compatible inner can would need to be designed, qualified and fabricated. Use of the SRS would also necessitate the use of the BNFL outer cans which are currently only qualified for laser welding using the BNFL system. Thus, a TIG weld would need to be qualified for the BNFL outer can. A conservative estimate for qualifying the weld and a new inner can would be $75 K while shipping and installation is another secondary cost that would require an additional ~$50 K. Thus, the total cost of the SRS bagless transfer system is ~$775 K or conservatively, $800 K.

In addition to cost, one must also consider that the BNFL system is developing into the complex-wide standard for plutonium packaging equipment. Because the IMSS is being developed in part as a test bed to evaluate sensor and data systems before purchase and installation in nuclear material vaults complex-wide, it is very important for the credibility of these evaluations that the material and packaging being monitored closely represent that which is found complex-wide. Therefore, it is preferable to acquire a BNFL system for IMSS demonstration purposes.

Because of the strong case for acquiring and using the BNFL bagless transfer system, the overall scope of the IMSS demonstration has been changed to accommodate its purchase and installation. Instead of having the bagless transfer system operating by mid-September, this acquisition will be delayed until September. Because of this, the IMSS demonstration will be initiated using surrogate material packages, as detailed in Section 2.0.

A conceptual design of the glovebox to house the bagless transfer system has been developed. The design of choice would consist of three 4 ft. gloveboxes with a pass-through Ar environment. In sequence from contaminated to clean, the first glovebox would be used for convenience can loading followed by a decontamination glovebox and ending with a glovebox used for loading the convenience can into the inner can, i.e the bagless transfer system. An existing glovebox at ANL-W was evaluated to determine if it was suitable for this project but was determined to require too much modification and thus its use would not be cost effective. A glovebox supplier, Vacuum Atmosphere, was contacted regarding our requirements and will be solicited for a formal bid in Phase II of the project. The supplier indicated a 60-90 day delivery from time of requisition.

### 3.4.5 Procure 3013 Cans

A source for 3013 outer and inner cans has been identified. The cost of each set of cans (outer and inner) is ~$1000 and has a delivery date of June 1997 if the order is placed by February 1997. It is planned to order 25 to 30 can sets.

### 3.4.6 Acquire Test Materials

Because of the aggressive schedule associated with the IMSS project, it is desirable to use materials currently available at ANL-W for demonstration purposes. Available materials include Pu/Al metal plates containing 6% Pu-240, U-Pu-Mo metal plates containing 20-28% Pu and 11-12% Pu-240, Pu metal containing 11-18% Pu-240, U-Pu-Zr scrap containing 8-28% Pu, mixed oxide ZPPR rods, and oxide, carbide, metallic, and Pu bearing scrap. It is anticipated that at least one of the demonstration cans will contain ZPPR Pu fuel plates clad in Al, a very easy material to handle.

### 3.4.7 Package Test Materials

No progress to report.

### 3.5 System Demonstration

### 3.5.1 Develop Test Plan

Discussions are underway to design a set of normal and off-normal events that will adequately test the attributes of the IMSS. Effort will continue in this area as system designs are firmed and requirements are reviewed.

### 3.5.2 Identify Test Facilities

The SNM vault at the Fuel Manufacturing Facility (FMF) will be used to house the IMSS test bed. The FMF vault is particularly well suited for this demonstration in part because it is very clean (radiologically) and has much of the mechanical and electrical infrastructure necessary to install container monitoring equipment.

### 3.5.3 Identify/Perform Facility Modifications

Facility modifications at FMF are not expected to be substantial. The 3013 container storage racks are planned to be placed against the south wall of the vault and will require some movement of materials currently stored in that location and the installation of an appropriate storage rack. The FMF vault also has a counting room in which the container assay equipment will be placed and radiographic capabilities which may be used, if needed, for the IMSS demonstration.

### 3.5.4 Update Facility Safety Documentation

Facility and documentation reviews for the IMSS demonstration in FMF should not be as laborious as that required for the installation of the bagless transfer system in ZPPR. The FMF Security Plan will need to be reviewed and an OPSEC assessment performed.

### 3.5.5 System Installation

No progress to report.

### 3.5.6 System Demonstration

To maximize the benefit of the IMSS as a test-bed, it is desired to monitor a package or packages which intentionally exhibit off-normal conditions that might occur during the storage of Pu-bearing materials. Transient conditions can be simulated either by using suitably degraded packaging or non-stabilized plutonium or by simulating the transients mechanically using surrogate 3013 cans.

Although the packaging system described in the 3013 standard is extremely robust, potential problems can occur during prolonged storage of Pu metal and oxide. The storage behavior of these materials is extensively discussed in Assessment of Plutonium Storage Safety Issues at Department of Energy Facilities (DOE/DP-0123T). There are three main issues: pressurization of storage cans due to gas generation from Pu oxide, breaching of cans leading to oxidation of Pu metal, and excessive temperature loads on the 3013 package. Metal oxidation by water vapor can further lead to formation of pyrophoric hydride compounds and metal fines, generation of explosive hydrogen gas mixtures, and gross breach of containment due to volumetric expansion upon transformation from metal to oxide. Knowledge of these failure mechanisms and the requirements of the 3013 storage standard enable the potential off-normal conditions to be identified.

For Pu metal, off-normal conditions may be created by having a breach in the packaging which allows access of ambient atmosphere to the metal. The breach could be a result of leaking seal welds, corrosion of the cans, or puncture/cracking due to handling accidents. All of these scenarios are extremely unlikely, especially considering the redundant nature of the two-can packaging system. Such breaches would lead to: (i) oxidation of the metal by reaction with oxygen and water vapor; (ii) a measurable weight gain of the can due to incorporation of oxygen into the solid; and (iii) the potential creation of a hydrogen-rich gas inside the can. A breach could be easily simulated by leaving a gap in the seal welds or by creating a hole in the package using a drill. Such an intentionally breached can containing Pu metal could not be stored without additional containment such as a glovebox. As such it could not be stored in the FMF vault with the other containers and would need its own monitoring system, defeating the purpose of the ISS demonstration. An alternative would be to use a non-radioactive surrogate metal which would also oxidize appreciably in ambient conditions. Cerium might be a good candidate if metal in suitable amounts can be easily obtained. The use of powder would greatly accelerate ambient oxidation by presenting a high surface area for reaction.

Off-normal conditions for Pu oxide powder result in pressurization of sealed storage cans. The pressurization could be from two principal sources: radiolytic decay of moisture adsorbed on the oxide surface and helium generation due to alpha decay. The 3013 standard requires thermal stabilization of any oxide to remove adsorbed moisture and limits Pu-238 isotopic content to minimize helium generation. An off-normal condition could be created by packaging high surface area Pu oxide which had been exposed to a moist environment, simulating a worst-case of unintentional packaging of unstabilized material. The hazards created by such a simulation are considerable, and, as with the Pu metal case, such a storage package would need to be stored and monitored in an area with additional containment. Further safeguards against can rupture would also be required.

It is more difficult to envision a means of simulating a pressurized can of Pu oxide. Ideally, the can should be pressurized slowly and continuously over a period of time to test the limits of pressure detection. The set-up should also not interfere with other detection equipment, such as mass readings. The best situation would be to have a self-contained device with a known, slow rate of gas generation packaged inside the storage can. Gas pressure could also potentially be applied from a source external to a specially modified can, however this should not interfere with other sensors.

The ISS project will also be considering Pu-bearing residues as potential stored materials. The broad range of Pu contents and material types in this category leads to a number of problem storage scenarios to consider and prevent. A DOE working group met on this subject with the intention of producing a storage standard similar to the 3013 standard. The end product turned out to be storage criteria ("Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials") issued as an addendum to the DOE implementation plan for DNSFB Recommendation 94-1. The primary requirement for storage packages as defined in these criteria is resistance of mitigation of pressure build-up. This can be accomplished either by design to limit and resist pressure (similar to 3013), or by inclusion of a filtered vent to release pressure. There are no criteria for prevention of oxidation of metals. Hence in the case of residues the off-normal event of interest is pressurization of a storage package, which can be simulated in the same manner as for Pu oxides stored in the 3013 standard.

Because of the safety and efficiency concerns associated with introducing transients stemming from actual material and package degradation, it is desirable to design and construct surrogate 3013 cans that can simulate transients such as pressurization, mass increase, and temperature change. This effort will be undertaken as a part of Phase II of the project.

### 3.5.7 Develop Demonstration Report

No progress to report.

## 4.0 Expenditures

### 4.1 Effort

Argonne National Laboratory has invested approximately 8.0 man-months effort while LMITCO has invested approximately 4.5 man-months effort since project inception. Project funding to date includes:

- $171,160 to ANL-W
- $114,107 to LMITCO

### 4.2 Hardware / Software Purchases

None to date.

### 4.3 Travel

Steven E. Aumeier traveled to Washington D.C. December 18 and 19 to brief M. Seites and C. Purdy on the IMSS project.

## 5.0 Publications

None to date.

## 6.0 Funding Requirements for Phase II

Phase II of the IMSS demonstration project includes selection and procurement of vault and material monitoring sensors, identification of requirements for package and material assay and verification, identification and procurement of plutonium and/or plutonium-bearing materials for the demonstration, procurement of 3013 cans, procurement of canning system glovebox and data system hardware and software. Phase II will also involve further identification of necessary facility modifications and continued development of a test plan and data system design.

## 6.1 Effort

Resources required to support Phase II effort are $240 K and cover effort to be expended from January 15, 1997 through March 15, 1997. The effort total includes approximately 8 MM allocated to both ANL and LMITCO.

## 6.2 Hardware/Software Procurement

A substantial number of long-lead time procurements will need to be made during Phase II of the IMSS demonstration project and are detailed below.

- Glovebox - $75 K
- 30 inner/outer 3013 cans - $35 K
- Data system hardware/software - $50 K
- Sensors - $100 K
- Transient test cans - $25 K

Total Procurement Costs: $285 K

Thus the total funding commitment necessary to complete Phase II is $525 K.

## 7.0 Summary

Substantial progress has been made in the initial phase of the IMSS demonstration project. A preliminary set of system requirements was determined from pertinent DOE and facility documentation. Although extensive, this list is not yet final and will most likely be further reduced. The condensation of hundreds of assumed requirements to the list presented in Appendix A should be a great benefit not only for the IMSS demonstration but also for other facilities required to monitor materials under the 3013 standard.

Initial contacts were made throughout the DOE complex to solicit information regarding vault and material monitoring sensors in-use and/or available. Although not all sites have responded, there was enough of a response to develop a preliminary list of available sensor technologies, which is included in Section 3. A more complete response is expected by mid-February at which time a decision will be made regarding what sensors to include in the IMSS demonstration.

Conceptual design of the data system, including the sensor interface and data acquisition/archival system has been completed. Based on a survey of available networking and database technologies, a decision was made to use the Echelon LonWorks network protocol and Microsoft

Access. A review of the conceptual data system design will be completed as part of Phase II efforts.

A decision was made to use ANL's FMF nuclear material vault as the site for the prototype IMSS while plutonium packaging will take place in ANL's ZPPR workroom. Numerous materials available for packaging were also identified. Facility documentation that may be affected was also identified and appropriate facility reviews will continue through Phase II of the project.

A significant change in project scope and schedule resulted from the trade studies relating to the plutonium packaging system. It was determined that, in order to develop a convincing IMSS prototype and use it as a monitoring sensor test bed, a plutonium packaging system of BNFL design would be required. Because the cost of this system exceeded current IMSS budget constraints, PFA management agreed to accept an initial demonstration of the IMSS using surrogate 3013 packages. The BNFL system will then be purchased in late September, 1997 and 3013 standard packages of plutonium canned for IMSS use. Project scope will also be modified due to the incorporation of a sensor demonstration project, described in Section 3, with the IMSS project.

Following an initial feasibility analysis, it was decided to pursue transient event simulation, e.g. temperature changes, pressure changes, mass increase, radiation increase, using "instrumented" cans to simulate the events mechanically. For obvious reasons, this approach is preferred over introducing failed containers and/or unstable nuclear materials into the IMSS demonstration area.

Progress from project inception to January 15, 1997 has met and in many cases exceeded the commitments made in the IMSS proposal. Significant progress is also expected to be made during Phase II of the project.

# Appendix A.

## Table A.1: Preliminary IMSS Requirements

| ID | Function | Text | Source Name | Source # | Source Date | Paragraph # |
|---|---|---|---|---|---|---|
| 225 | Control and Account for Material | A permanent marking/ encoding system shall be used on all containers | Performance Specification -Stabilization and Packaging System (SPS) of Plutonium Metals and Oxides >50% at Rocky Flats Environmental Technology Site (RFETS) Building 707 94-1 PFA Baseline Research & Development Technical Requirements Document (BRD TRD) | DE-AC03-96SF20948 , Att. II | 07-22-96 (Rev. 5) | 4.2.6 |
| 264 | Control and Account for Material | Balances shall have the capability to interface with remote recording equipment. | Performance Specification -Stabilization and Packaging System (SPS) of Plutonium Metals and Oxides >50% at Rocky Flats Environmental Technology Site (RFETS) Building 707 | DE-AC03-96SF20948 , Att. II | 07-22-96 (Rev. 5) | 4.2.7 |
| 263 | Control and Account for Material | Balances shall meet the requirements of Reference 2.2.7 [DOE Order 5633.3B, "Control and Accountability of Nuclear Materials"] for accuracy and repeatability. | Performance Specification -Stabilization and Packaging System (SPS) of Plutonium Metals and Oxides >50% at Rocky Flats Environmental Technology Site (RFETS) Building 707 | DE-AC03-96SF20948 , Att. II | 07-22-96 (Rev. 5) | 4.2.7 |
| 510 | Control and Account for Material | To meet DOE-STD-3013-94 requirements for the long-term storage of plutonium metals and oxides, a permanent marking system must be developed and successfully demonstrated | 94-1 PFA Baseline Research & Development Technical Requirements Document (BRD TRD) | PFA-TM-144A (incorporates PFA-TM-121A) | 03-25-96 | RDP 5.4.1.3 |

## Table A.1: Preliminary IMSS Requirements

| ID | Function | Text | Source Name | Source # | Source Date | Paragraph # |
|---|---|---|---|---|---|---|
| 189 | Control and Account for Material | The results of statistical studies and environmental testing shall be used to select successful marking methods and encoding algorithms. | 94-1 PFA Baseline Research & Development Technical Requirements Document (BRD TRD) | PFA-TM-144A (incorporates PFA-TM-121A) | 03-25-96 | RDP 5.4.1.3.2 |
| 057 | Control and Account for Material | A storage package that experiences an incident shall be inspected to ensure that package integrity has been maintained. | Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials | PFA-TM-346 | 11-95 | App. 4.3.4 |
| 229 | Monitor Container Integrity | The inner container shall be sealed and remain leak-tight as defined in Reference 2.5.4 [ANSI N14.5, Standard for Radioactive Material - "Leakage Tests on Packages for Shipment," 1987], during the 50 year storage period. | Performance Specification -Stabilization and Packaging System (SPS) of Plutonium Metals and Oxides >50% at Rocky Flats Environmental Technology Site (RFETS) Building 707 | DE-AC03-96SF20948, Att. II | 07-22-96 (Rev. 5) | 4.2.6.1.1 |
| 236 | Monitor Container Integrity | The outer container, after receiving the inner container, shall be filled with helium for leak testing, sealed, and shall remain leak tight as defined in Reference 2.5.4 [ANSI N14.5, Standard for Radioactive Material - "Leakage Tests on Packages for Shipment," 1987] for the duration of the 50 year storage period. | Performance Specification -Stabilization and Packaging System (SPS) of Plutonium Metals and Oxides >50% at Rocky Flats Environmental Technology Site (RFETS) Building 707 | DE-AC03-96SF20948, Att. II | 07-22-96 (Rev. 5) | 4.2.6.2.1 |
| 136 | Monitor Container Integrity | Essential procedures and processes covered by QA and QC requirements shall include (but will not be limited to) leak testing procedure used for certifying that containers are leak-tight. | Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage | DOE-STD-3013-96 | 9-96 | 4.5.4.d |

**Table A.1: Preliminary IMSS Requirements**

| ID | Function | Text | Source Name | Source # | Source Date | Paragraph # |
|---|---|---|---|---|---|---|
| 180 | Monitor Container Integrity | Surveillance of packages in storage shall be performed to ensure that container integrity is maintained. | 94-1 PFA Baseline Research & Development Technical Requirements Document (BRD TRD) | PFA-TM-144A (incorporates PFA-TM-121A) | 03-25-96 | RDP 4.5.01 |
| 512 | Monitor Container Integrity | The surveillance system for these materials shall include monitoring for corrosion. | 94-1 PFA Baseline Research & Development Technical Requirements Document (BRD TRD) | PFA-TM-144A (incorporates PFA-TM-121A) | 03-25-96 | RDP 4.5.05 |
| 042 | Monitor Container Integrity | The non-intrusive surveillance program shall include inspection of the outer container for signs of degradation and contamination. | Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials | PFA-TM-346 | 11-95 | 4.4.5 |
| 043 | Monitor Container Integrity | The non-intrusive surveillance program shall include random statistical sampling to assess the condition of inner packaging (e.g., contamination, corrosion, degradation, etc.) | Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials | PFA-TM-346 | 11-95 | 4.4.5 |
| 047 | Monitor Container Integrity | Surveillance testing frequency, sample size, and sample selection shall statistically ensure, to a stated degree of confidence, that package integrity is maintained. | Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials | PFA-TM-346 | 11-95 | 4.4.7 |
| 103 | Monitor Environmental, Safety, and Health compliance | The exterior surface of the inner container shall be free of contamination as defined by 10 CFR 835, Appendix D | Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage | DOE-STD-3013-96 | 9-96 | 4.2.2.c |
| 181 | Monitor Environmental, Safety, and Health compliance | Surveillance of packages in storage shall be performed to ensure that all materials comply with environmental, safety, and health requirements. | 94-1 PFA Baseline Research & Development Technical Requirements Document (BRD TRD) | PFA-TM-144A (incorporates PFA-TM-121A) | 03-25-96 | RDP 4.5.02 |

## Table A.1: Preliminary IMSS Requirements

| ID | Function | Text | Source Name | Source # | Source Date | Paragraph # |
|---|---|---|---|---|---|---|
| 216 | Monitor Material Stability | Calculation of the pressure rise and heat generated in the sealed containers shall be in accordance with Appendix A of Reference 2.3.1 [DOE-STD-3013-94, Criteria for Safe Storage of Plutonium Metals and Oxides] with the exception that the formula used is as follows: $P = P_i (T/T_i) + [(LOI)(m)(T)]/[v - (0.0873m)] + [(1.3 \times 10^{-4} (m)(t)(T)]/[v-0.0873m)]$ Where Ti is the initial temperature in K. | Performance Specification -Stabilization and Packaging System (SPS) of Plutonium Metals and Oxides >50% at Rocky Flats Environmental Technology Site (RFETS) Building 707 | DE-AC03-96SF20948, Att. II | 07-22-96 (Rev. 5) | 3.1.4 |
| 233 | Monitor Material Stability | The inner container shall contain features that will allow for non-destructive indication of a buildup of internal pressure at less than 100 psig (e.g., a pressure deflectable lid or bellows which would be observable using radiography). | Performance Specification -Stabilization and Packaging System (SPS) of Plutonium Metals and Oxides >50% at Rocky Flats Environmental Technology Site (RFETS) Building 707; Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage; 94-1 PFA Baseline Research & Development Technical Requirements Document (BRD TRD) | DE-AC03-96SF20948, Att. II; DOE-STD-3013-96; PFA-TM-144A (incorporates PFA-TM-121A) | 07-22-96 (Rev. 5); 9-96; 03-25-96 | 4.2.6.1.3; 4.3.b; RDP 4.5.05 |
| 142 | Monitor Material Stability | Non-intrusive testing methods may include detection of oxide growth. | Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage | DOE-STD-3013-96 | 9-96 | 4.3.b |
| 513 | Monitor Material Stability | The surveillance system for these materials shall include monitoring for change of form within the container. | 94-1 PFA Baseline Research & Development Technical Requirements Document (BRD TRD) | PFA-TM-144A (incorporates PFA-TM-121A) | 03-25-96 | RDP 4.5.05 |

## Table A.1: Preliminary IMSS Requirements

| ID | Function | Text | Source Name | Source # | Source Date | Paragraph # |
|---|---|---|---|---|---|---|
| 511 | Monitor Material Stability | The surveillance system for these materials shall include monitoring for distortion of containers from pressurization. | 94-1 PFA Baseline Research & Development Technical Requirements Document (BRD TRD); Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials | PFA-TM-144A (incorporates PFA-TM-121A); PFA-TM-346 | 03-25-96; 11-95 | RDP 4.5.05; 4.4.5 |
| 012 | Monitor Material Stability | Decay heat of the stored materials shall not raise the storage temperature to a level that could cause failure of one or more of the contamination barriers. | Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials | PFA-TM-346 | 11-95 | 4.2.3 |
| 040 | Monitor Material Stability | Initial inspection to detect pressure buildup shall be performed on sealed containers between 7 and 15 days following container closure. The surveillance plan shall include provision for initial baseline package inspections within 30 days of closure. | Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials; Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage | PFA-TM-346; DOE-STD-3013-96 | 11-95; 9-96 | 4.4.4; 4.3.3.a |
| 041 | Monitor Material Stability; Monitor Container Integrity | Non-intrusive surveillance of containers shall be performed at prescribed intervals throughout the storage period to determine storage package system integrity and condition of the contents. | Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials | PFA-TM-346 | 11-95 | 4.4.5 |
| 218 | Sense container/ vault conditions; Transfer Signals and Data; Store, Manipulate, and Analyze Data | All equipment and associated components shall be designed to function at ground level elevations ranging from 0 to 8000 feet above sea level (ASL). | Performance Specification -Stabilization and Packaging System (SPS) of Plutonium Metals and Oxides >50% at Rocky Flats Environmental Technology Site (RFETS) Building 707 | DE-AC03-96SF20948, Att. II | 07-22-96 (Rev. 5) | 4.1.4 |

## Table A.1: Preliminary IMSS Requirements

| ID | Function | Text | Source Name | Source # | Source Date | Paragraph # |
|---|---|---|---|---|---|---|
| 210 | Site Specific | The SPS shall include all equipment necessary to: 1) provide radiological containment and shielding at all times; 2) receive and unload existing containers; 3) prepare metals for packaging; 4) prepare metals and oxides for stabilization; 5) perform stabilization; 6) perform packaging of metals and oxides; 7) meet material control and accountability requirements; 8) leak detection; and 9) provide rework capability. | Performance Specification -Stabilization and Packaging System (SPS) of Plutonium Metals and Oxides >50% at Rocky Flats Environmental Technology Site (RFETS) Building 707 | DE-AC03-96SF20948, Att. II | 07-22-96 (Rev. 5) | 1.0 |
| 219 | Site Specific | The Contractor shall comply with the site electrical standards per Reference 2.6.15 and 2.6.16 [Wiring, Rocky Flats Plant Standard, SE-103; Conduit, Rocky Flats Plant Standard SE-112]. | Performance Specification -Stabilization and Packaging System (SPS) of Plutonium Metals and Oxides >50% at Rocky Flats Environmental Technology Site (RFETS) Building 707 | DE-AC03-96SF20948, Att. II | 07-22-96 (Rev. 5) | 4.1.5 |
| 244 | Site Specific | The storage package shall be designed to be remotely handled by a robotic manipulator or other remote handling fixture. | Performance Specification -Stabilization and Packaging System (SPS) of Plutonium Metals and Oxides >50% at Rocky Flats Environmental Technology Site (RFETS) Building 707 | DE-AC03-96SF20948, Att. II | 07-22-96 (Rev. 5) | 4.2.6.3 |
| 270 | Site Specific | The Contractor shall perform requirements analysis and definition tasks as follows:<br><br>b) Define system interface requirements to facilitate modifications or upgrades to the site specific utilities and services. | Performance Specification -Stabilization and Packaging System (SPS) of Plutonium Metals and Oxides >50% at Rocky Flats Environmental Technology Site (RFETS) Building 707 | DE-AC03-96SF20948, Att. II | 07-22-96 (Rev. 5) | 4.3.1 |

## Table A.1: Preliminary IMSS Requirements

| ID | Function | Text | Source Name | Source # | Source Date | Paragraph # |
|---|---|---|---|---|---|---|
| 274 | Site Specific | The Contractor shall develop the appropriate OSHA safety bases. This is to include any associated safety requirements and surveillance actions necessary to ensure the fail safe operation of the SPS in accordance with the applicable IS&H, NFPA, and OSHA requirements of References 2.1.2, 2.5.8 and 2.1.4. [29 CFR 1910, "Occupational Safety and Health Standards",; NFPA Codes and Standards; 10 CFR 835 (Appendix D), "Occupational Radiation Protection, Surface Radioactivity Values"]. | Performance Specification -Stabilization and Packaging System (SPS) of Plutonium Metals and Oxides >50% at Rocky Flats Environmental Technology Site (RFETS) Building 707 | DE-AC03-96SF20948, Att. II | 07-22-96 (Rev. 5) | 4.5.1 |
| 291 | Site Specific | Procedures required for conducting surveillances required by the Technical Safety Requirements or Operational Safety Requirements as applicable shall also be provided. | Performance Specification -Stabilization and Packaging System (SPS) of Plutonium Metals and Oxides >50% at Rocky Flats Environmental Technology Site (RFETS) Building 707 | DE-AC03-96SF20948, Att. II | 07-22-96 (Rev. 5) | 4.7.1.5 |
| 505 | Site Specific | Formal methods and responsibilities shall be documented and maintained for independent review and evaluation | Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage | DOE-STD-3013-96 | 9-96 | 4.3.2 |
| 115 | Site Specific | Safety inspections should be integrated with other required inspections (e.g., Material Control and Accountability) and shall be non-intrusive. | Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage | DOE-STD-3013-96 | 9-96 | 4.3.4 |

## Table A.1: Preliminary IMSS Requirements

| ID | Function | Text | Source Name | Source # | Source Date | Paragraph # |
|---|---|---|---|---|---|---|
| 117 | Site Specific | A schedule shall be maintained for continuing safety and accountability surveillance testing. | Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage | DOE-STD-3013-96 | 9-96 | 4.3.5 |
| 106 | Site Specific | Inspection and surveillance procedures shall be site-specific and shall identify prerequisites. | Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage | DOE-STD-3013-96 | 9-96 | 4.3.a.1 |
| 107 | Site Specific | Inspection and surveillance procedures shall be site-specific and shall identify acceptance criteria. | Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage | DOE-STD-3013-96 | 9-96 | 4.3.a.2 |
| 108 | Site Specific | Inspection and surveillance procedures shall be site-specific and shall identify specific instructions to ensure that rejected items are addressed in accordance with approved procedures and DOE reporting requirements. | Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage | DOE-STD-3013-96 | 9-96 | 4.3.a.3 |
| 109 | Site Specific | Inspection and surveillance procedures shall be site-specific and shall identify frequency of inspection. | Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage | DOE-STD-3013-96 | 9-96 | 4.3.a.4 |
| 134 | Site Specific | All personnel participating in essential processes and procedures shall be trained and certified for their areas of involvement. | Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage | DOE-STD-3013-96 | 9-96 | 4.5.1 |
| 137 | Site Specific | Essential procedures and processes covered by QA and QC requirements shall include (but will not be limited to) surveillance procedure(s). | Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage | DOE-STD-3013-96 | 9-96 | 4.5.4.e |

## Table A.1: Preliminary IMSS Requirements

| ID | Function | Text | Source Name | Source # | Source Date | Paragraph # |
|---|---|---|---|---|---|---|
| 509 | Site Specific | Technical peer reviews shall be conducted as appropriate to validate conclusions | 94-1 PFA Baseline Research & Development Technical Requirements Document (BRD TRD) | PFA-TM-144A (incorporates PFA-TM-121A) | 03-25-96 | 3.7.3.2.7.4 |
| 153 | Site Specific | The ISS shall be based on standard requirements for the surveillance activities associated with the inventory. | 94-1 PFA Baseline Research & Development Technical Requirements Document (BRD TRD) | PFA-TM-144A (incorporates PFA-TM-121A) | 03-25-96 | IP 3.7.2.2.15 |
| 144 | Site Specific | A Systems Engineering approach shall be employed that includes: defining Requirements, defining system Functions, developing Approaches to meet requirements, performing Trade Studies to select the best approaches and Evaluating and Validating how well... | 94-1 PFA Baseline Research & Development Technical Requirements Document (BRD TRD) | PFA-TM-144A (incorporates PFA-TM-121A) | 03-25-96 | IP 3.6.1.7.1 |
| 175 | Site Specific | The ISS shall develop and employ an integrated approach for the surveillance of plutonium packages, using non-intrusive technologies that minimize personnel exposures. | 94-1 PFA Baseline Research & Development Technical Requirements Document (BRD TRD) | PFA-TM-144A (incorporates PFA-TM-121A) | 03-25-96 | RDP 1.3.6.2 |
| 182 | Site Specific | Surveillance measures shall be standardized for stored materials. | 94-1 PFA Baseline Research & Development Technical Requirements Document (BRD TRD) | PFA-TM-144A (incorporates PFA-TM-121A) | 03-25-96 | RDP 4.5.03 |

**Table A.1: Preliminary IMSS Requirements**

| ID | Function | Text | Source Name | Source # | Source Date | Paragraph # |
|---|---|---|---|---|---|---|
| 501 | Site Specific | The surveillance program shall provide assurance that the conditions of storage are consistent with the technical basis for acceptability of storage packages. Ex: A container qualified for handling and storage on racks up to 120 cm high shall be found unsatisfactory if stored on a rack higher than 120cm | Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials | PFA-TM-346 | 11-95 | 4.3.6 |
| 034 | Site Specific | Site specific plans and procedures shall incorporate inspection and surveillance procedures that identify prerequisites and assumptions. | Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials | PFA-TM-346 | 11-95 | 4.4.1 |
| 035 | Site Specific | Site specific plans and procedures shall incorporate inspection and surveillance procedures that identify acceptance criteria based on documented facility or site-specific storage package-evaluations and technical safety bases for interim storage. | Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials | PFA-TM-346 | 11-95 | 4.4.1 |
| 036 | Site Specific | Site specific plans and procedures shall incorporate inspection and surveillance procedures that identify specific instructions to ensure that rejected storage packages are repackaged and reinspected for acceptance after identification. | Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials | PFA-TM-346 | 11-95 | 4.4.1 |

**Table A.1: Preliminary IMSS Requirements**

| ID | Function | Text | Source Name | Source # | Source Date | Paragraph # |
|---|---|---|---|---|---|---|
| 037 | Site Specific | Site specific plans and procedures shall incorporate inspection and surveillance procedures that identify frequency of inspection. | Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials | PFA-TM-346 | 11-95 | 4.4.1 |
| 039 | Site Specific | Safety and surveillance inspection of packages shall be integrated with other required inspections such as Materials Control and Accountability (MC&A). | Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials | PFA-TM-346 | 11-95 | 4.4.3 |
| 046 | Site Specific | Inspection and surveillance actions shall be in accordance with approved procedures and DOE reporting requirements. | Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials | PFA-TM-346 | 11-95 | 4.4.6 |
| 049 | Site Specific | Documentation of inspection and surveillance activities shall include a surveillance schedule for safety testing. | Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials | PFA-TM-346 | 11-95 | 4.4.8 |
| 050 | Site Specific | Documentation of inspection and surveillance activities shall include the consistency of labeling on the exterior of the container with MC&A \requirements. | Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials | PFA-TM-346 | 11-95 | 4.4.8 |
| 038 | Site Specific | Safety inspection and surveillance methods and responsibilities shall be documented and maintained for independent review and evaluation. | Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials; Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage | PFA-TM-346; DOE-STD-3013-96 | 11-95; 9-96 | 4.4.2; 4.3.2 |
| 122 | Store, Manipulate, and Analyze Data | The data base shall include LOI test results and conditions of tests. | Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage | DOE-STD-3013-96 | 9-96 | 4.4.2.a.4 |

## Table A.1: Preliminary IMSS Requirements

| ID | Function | Text | Source Name | Source # | Source Date | Paragraph # |
|---|---|---|---|---|---|---|
| 124 | Store, Manipulate, and Analyze Data | The data base shall include when plutonium was last separated - americium removed (if information is available). | Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage | DOE-STD-3013-96 | 9-96 | 4.4.2.a.6 |
| 125 | Store, Manipulate, and Analyze Data | The data base shall include specific processing condition(s). | Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage | DOE-STD-3013-96 | 9-96 | 4.4.2.a.7 |
| 128 | Store, Manipulate, and Analyze Data | The data base shall include package configuration - number of containers in package. | Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage | DOE-STD-3013-96 | 9-96 | 4.4.2.b.2 |
| 129 | Store, Manipulate, and Analyze Data | The data base shall include date and condition of packaging. | Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage | DOE-STD-3013-96 | 9-96 | 4.4.2.b.3 |
| 130 | Store, Manipulate, and Analyze Data | The data base shall include initial radiation field (gamma and neutron at contact and 30 cm. (12 in.)). | Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage | DOE-STD-3013-96 | 9-96 | 4.4.2.b.4 |
| 131 | Store, Manipulate, and Analyze Data | The data base shall include surveillance results. | Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage | DOE-STD-3013-96 | 9-96 | 4.4.2.b.5 |
| 132 | Store, Manipulate, and Analyze Data | The data base shall include records of the inspection tests performed, names of individuals performing inspections, and the dates of inspections, | Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage | DOE-STD-3013-96 | 9-96 | 4.4.2.c |

**Table A.1: Preliminary IMSS Requirements**

| ID | Function | Text | Source Name | Source # | Source Date | Paragraph # |
|---|---|---|---|---|---|---|
| 138 | Store, Manipulate, and Analyze Data | Essential procedures and processes covered by QA and QC requirements shall include (but will not be limited to) data base recording procedure and characterization parameters addressed in Section 4.4.2 | Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage | DOE-STD-3013-96 | 9-96 | 4.5.4.f |
| 119 | Store, Manipulate, and Analyze Data | A data base shall be maintained to serve as a source of relevant information about stored materials and containers. For completeness, MC&A documentation should be coordinated with the data base. | Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage; Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials | DOE-STD-3013-96; PFA-TM-346 | 9-96; 11-95 | 4.4.1; 4.4.8 |
| 506 | Store, Manipulate, and Analyze data | The data base shall include identification of chemical form, element, isotopic content or code (e.g. plutonium, americium, uranium), and isotopic distribution (e.g.% 238 Pu,% 239 Pu,% 240 Pu,% 241 Pu,% 242 Pu) | Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage; Criteria for Interim Safe Storage of Plutonium-Bearing Materials | DOE-STD-3013-96; PFA-TM-346 | 9-96; 11-95 | 4.4.2.a.1; 4.4.a.2; 4.4.8 |
| 123 | Store, Manipulate, and Analyze Data | The data base shall include source of stored material (facility that generated the material). | Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage; Criteria for Interim Safe Storage of Plutonium-Bearing Materials | DOE-STD-3013-96; PFA-TM-346 | 9-96; 11-95 | 4.4.2.a.5; 4.4.8 |
| 127 | Store, Manipulate, and Analyze Data | The data base shall include fill gas composition on sealing. | Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage; Criteria for Interim Safe Storage of Plutonium-Bearing Materials | DOE-STD-3013-96; PFA-TM-346 | 9-96; 11-95 | 4.4.2.b.1; 4.4.8 |

**Table A.1: Preliminary IMSS Requirements**

| ID | Function | Text | Source Name | Source # | Source Date | Paragraph # |
|---|---|---|---|---|---|---|
| 507 | Store, Manipulate, and Analyze data | The data base shall include baseline package weight and dimensions | Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage; Criteria for Interim Safe Storage of Plutonium-Bearing Materials | DOE-STD-3013-96; PFA-TM-346 | 9-96; 11-95 | 4.4.2.b.6; 4.4.8 |
| 133 | Store, Manipulate, and Analyze Data | The data base shall include locations of stored materials. | Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage; Criteria for Interim safe Storage of Plutonium-Bearing Materials | DOE-STD-3013-96; PFA-TM-346 | 9-96; 11-95 | 4.4.2.d; 4.4.8 |
| 121 | Store, Manipulate, and Analyze Data | The data base shall include identification of quantity (mass) of plutonium. | Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage; Criteria for Safe Storage of Plutonium-Bearing Materials; Criteria for Interim Safe Storage of Plutonium-Bearing Materials | DOE-STD-3013-96; PFA-TM-346; PFA-TM-346 | 9-96; 11-95; 11-95 | 4.4.2.a.3; 4.4.8; 4.4.8 |
| 126 | Store, Manipulate, and Analyze Data | The data base shall include other information relative to the contents. | Criteria for Packaging of Plutonium Metals and Oxides for Long-Term Storage; Criteria for Interim safe Storage of Plutonium-Bearing Materials | DOE-STD-3013-96; PTA-TM-346 | 9-96; 11-95 | 4.4.2.a.8; 4.4.8 |
| 048 | Store, Manipulate, and Analyze Data | The surveillance testing program shall be adjusted to account for the results of previous surveillance testing. | Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials | PFA-TM-346 | 11-95 | 4.4.7 |
| 051.3 | Store, Manipulate, and Analyze Data | The database shall include material description. | Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials | PFA-TM-346 | 11-95 | 4.4.8 |

**Table A.1: Preliminary IMSS Requirements**

| ID | Function | Text | Source Name | Source # | Source Date | Paragraph # |
|---|---|---|---|---|---|---|
| 051.5 | Store, Manipulate, and Analyze Data | The database shall include characterization testing results. | Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials | PFA-TM-346 | 11-95 | 4.4.8 |
| 051.6 | Store, Manipulate, and Analyze Data | The database shall include characterization testing dates. | Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials | PFA-TM-346 | 11-95 | 4.4.8 |
| 051.7 | Store, Manipulate, and Analyze Data | The database shall include characterization testing conditions. | Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials | PFA-TM-346 | 11-95 | 4.4.8 |
| 051.9 | Store, Manipulate, and Analyze Data | The database shall include storage package configuration. | Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials | PFA-TM-346 | 11-95 | 4.4.8 |
| 051.12 | Store, Manipulate, and Analyze Data | The database shall include backfill gas pressure on sealing (if applicable). | Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials | PFA-TM-346 | 11-95 | 4.4.8 |
| 051.13 | Store, Manipulate, and Analyze Data | The database shall include surveillance result history. | Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials | PFA-TM-346 | 11-95 | 4.4.8 |
| 051.14 | Store, Manipulate, and Analyze Data | The database shall include unique material identification codes (e.g., item description code) | Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials | PFA-TM-346 | 11-95 | 4.4.8 |
| 051.15 | Store, Manipulate, and Analyze Data | The database shall include source of stored material (facility and process that generated the material). | Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials | PFA-TM-346 | 11-95 | 4.4.8 |
| 051.2 | Store, Manipulate, and Analyze Data | The database shall include unique package identification number. | Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials | PFA-TM-346 | 11-95 | 4.4.8 |

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