Technical Support Group State-of-the-Practice Review of the Nondestructive Assay *in-situ* Holdup Program at the Y-12 Security Complex

June 22 – 25, 2009

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Executive Summary

The Y-12 facility has implemented several successful programs to monitor and control uranium holdup in process equipment with application to both Nuclear Criticality Safety (NCS) and Nuclear Material Control and Accountability (NMC&A). The total number of process equipment holdup monitoring points, the amount of uranium holdup in this equipment, and the measurement frequency of the holdup monitoring points are drivers of the Uranium Holdup Survey Program (UHSP). However, not all holdup measurement values are determined by the UHSP. Special campaign (e.g., to improve NMC&A inventory quantities) can generate substantially higher values than those of the UHSP.

The equipment holdup quantities measured for NCS are shared with NMC&A and vice-versa. This was not always true in the past. The assumptions and the interpretation of the data, especially the associated uncertainties, were often not applied in a uniform fashion by the two organizations. However, a new multidisciplinary Inadvertent Accumulation Prevention Program (IAPP) is now in place, which appears to be resolving these issues. The IAPP, in conjunction with UHSP and Technical Justification for Inventory Value (TJIV), appears to be working well in spite of some issues with outdated technology. The integration of MC&A measurement data under TJIV with criticality safety *in-situ* measurement data is a strength of the IAPP. The Technical Support Group (TSG) observed a high level of cooperation and communication between operations, engineering, criticality safety, and NDA measurement personnel, which allows all interested parties to remain cognizant of changes, needed revisions, and facility status. The TSG noted that the Criticality Safety, Waste Management, and NMC&A organizations are all competing for the same *in-situ* nondestructive assay (NDA) resources. There is also a fragmentation of NDA professionals across organizations (i.e., Waste, Analytical Chemistry, Engineering, and NMC&A).

The UHSP is a two-tiered program that first sends out teams of production personnel not trained in NDA to routinely survey process equipment with a simple, automated gamma rate meter system. This first-tier qualitative measurement covers a wide area and requires an easily reproducible survey at preselected locations. The readings taken are compared with previous or expected target values. Any potentially significant increases in holdup are flagged and investigated in the second tier of the program by the NDA holdup measurement group. A strength of the UHSP is the database used to maintain a record of all measurement point locations, action values, required measurement frequencies, and measurement results.

A combination of automated holdup software (HMS3 / HMS4) and spreadsheets developed on-site are used to perform gram quantity calculations. One noteworthy practice was the development of electronic mechanical drawings mapping the measurement points; these drawings are especially useful in areas of complicated piping.

The Y-12 Security Complex is presently designing a new processing facility that will replace aging existing facilities. The Uranium Processing Facility (UPF) design includes a system engineering review and interpretation of where NDA may interact with existing systems. Y-12 has retained a design team that includes a site NDA-knowledgeable individual who provides

continuous design review input that incorporates current and anticipated NDA measurement needs, adapts lessons learned from past operating experience, and adapts technology appropriate to the processing missions.

Y-12 holdup staff have performed several source checks to verify minimum-detectable-activity (MDA) calculations. While these checks have been performed primarily for waste container measurements, and these checks have not been formally documented, validating these calculations is a best practice for holdup measurements.

The peer and management review processes are effective methods for producing good results, improving technical capabilities, and increasing confidence that procedures are being followed.

The annual hands-on qualification of the measurement staff adds value in several significant ways. It allows the staff to exchange information related to recent events, and demonstrates to the measurement staff the MDA of the instrumentation, and verify the MDA calculations. Another part of the NDA group's training requirements is annual retraining. Within NDA Engineering, the lead engineer issues blind standards for assay to determine proper identification and quantification. Some measurement personnel who could benefit from advanced NDA training do not receive it. NDA training plans contain very few NDA-specific courses. The loss of trained measurement staff is an issue at Y-12, and the staff has personnel who are single-point failures if they leave.

The site performs cleanout of holdup deposits and compares measurements of the removed material with holdup measurements. This effort includes performing refinements to the models used for measurements.

The use of old NDA measurement equipment with limited automation leads to an increase in false measurements attributed to human error; also, the development of holdup technology at Y-12 is occurring less frequently than in the past.

ACRONYMS

CSE	Criticality Safety Engineering
CSO	Criticality Safety Officer
DNFSB	Defense Nuclear Facilities Safety Board
DOE	Department of Energy
EUP	Enriched Uranium Production
GGH	Generalized Geometry Holdup
HMS	Holdup Measurement System
HPGe	High-Purity Germanium
IAPP	Inadvertent Accumulation Prevention Program
IMS	Issues Management System
LANL	Los Alamos National Laboratory
LOIs	Lines of Inquiry
MC&A	Material Control and Accountability
MDA	Minimum Detectable Activity
NCS	Nuclear Criticality Safety
NDA	Nondestructive Assay
NMC&A	Nuclear Material Control and Accountability
ORNL	Oak Ridge National Laboratory
POC	Point of Contact
ROI	Region of Interest
TJIV	Technical Justification for Inventory Verification
TSG	Technical Support Group
UHSP	Uranium Holdup Survey Program
UPF	Uranium Processing Facility
Y-12	Y-12 National Security Complex
YSO	Y-12 Site Office

Introduction

The Department of Energy (DOE) issued the Implementation Plan for Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 2007-01, *Safety-Related* In Situ *Nondestructive Assay of Radioactive Materials* dated October 24, 2007. The Implementation Plan outlines a process to be implemented by a Technical Support Group (TSG) that addresses the issues raised in the Recommendation. A significant portion of that process involves the evaluation of the extent-of-condition of *in-situ* nondestructive assay (NDA) programs in DOE facilities managed by the Office of Environmental Management (EM) and the National Nuclear Security Administration (NNSA).

The primary goal of the TSG visit to the Y-12 National Security Complex (Y-12) was to identify the state-of-the-practice and good practices with respect to *in-situ* NDA assay. The intended purpose was to establish a baseline for future complex-wide development and program enhancement. The site review was not an assessment; any conclusions contained in this report are included for Y-12 to use at its own discretion. The final report submitted to DNFSB after the completion of all site reviews will not tie information to individual sites.

After all planned reviews have been completed, the state-of-the-practice review reports will be evaluated for suggested improvements to DOE *in-situ* NDA measurement programs. The evaluation results will be used to provide recommendations on standardizing the methodologies for *in-situ* NDA holdup measurements and reporting.

The review criteria were provided to Y-12 before the site visit. Eight topical areas were reviewed, seven of which are explicitly required by the DOE Implementation Plan for DNFSB Recommendation 2007-1. These areas are 1) training and qualification; 2) design requirements for new facilities and equipment; 3) standards for conducting NDA holdup measurements; 4) implementation of standards; 5) research and development; 6) quality assurance; and 7) oversight. An eighth topical area was added during the development of the review criteria: roles and responsibilities.

Two notable programs implemented at Y-12 support safety-related *in-situ* NDA: the Uranium Holdup Survey Program (UHSP) and the Inadvertent Accumulation Prevention Program (IAPP). The extensive UHSP (procedure Y15-014), as its name implies, is an NDA surveillance program to monitor enriched uranium accumulations within process equipment and support systems that are not routinely accessed by visual observation or cleanout. The measurements support objectives for both material accountability and criticality safety, as referenced in the nuclear criticality safety program (procedure Y70-150). Both qualitative and quantitative analyses are reported. The qualitative NDA, performed by the Production organization by procedure (Y50-37-018) with a radiation survey gross gamma count ratemeter, is compared to action limits for each survey position. More than 80 percent of the UHSP survey locations are required by criticality safety documentation to be surveyed. Those survey readings that are above an action limit require disposition through UHSP procedure Y15-014. The UHSP response involves a review by NDA Technical Support that may include a qualitative review of the survey data, quantitative holdup measurements, trending analyses, and recommendation on whether to adjust

the survey parameters. The UHSP requires the coordination of NDA Technical Support, Criticality Safety Engineering (CSE), Criticality Safety Officer (CSO), Nuclear Material Control and Accountability (NMC&A), and the UHSP Lead for concurrence and approval. Quantitative holdup measurements are performed by procedure Y17-69-418 at locations requiring mass values for periodic inventory or due to "high-point" survey results. The results are issued in a UHSP high-alarm gram quantity report, a Technical Justification for Inventory Value (TJIV) report, or similar holdup report.

The IAPP was initiated in response to a detailed review of three events discovered as a result of the UHSP. The comprehensive program is noteworthy for its multidisciplinary approach to material holdup evaluations and necessary corrective actions. The IAPP procedure (Y70-162) employs a review team of personnel from CSO, CSE, NDA, process or system engineering, or design authority, who perform assessments of fissile material systems by tabletop evaluations and field walkdowns. In addition, an accumulation control group of personnel such as the UHSP manager, chief CSE, and production and operations managers review these IAPP assessments for concurrence and recommend corrective actions. To date, Phase I of the IAPP has focused on its baseline reviews of systems performing fissile material activities, and is nearly complete with the prioritized implementation of its recommendations. Recommendations have involved equipment changes and cleanout and UHSP improvements for revising monitoring points. Improvements also include performing additional quantitative measurements and efficiency changes to the UHSP database and survey location labels. The IAPP will focus on process revisions as the program matures.

TSG members toured the following facilities and observed the facilities and activities listed below:

- 9215 Facility;
- 9212 Facility;
- Holdup field measurements; and
- Calibration of holdup equipment.

Three presentations were made to the TSG:

- NDA Engineering Uranium Holdup Survey Program by the Non-Destructive Assay Engineering Supervisor;
- Nuclear Criticality Safety and NDA Interfaces by a Nuclear Criticality Safety Engineer; and
- Inadvertent Accumulation Prevention Program by an Enriched Uranium Production (EUP) Criticality Safety Officer.

The TSG interviewed the following individuals:

- NDA Professional;
- NDA Measurement Technician;
- NDA Manager;
- Training Coordinator;
- Criticality Safety Engineer;

- Criticality Safety Officer;
- Criticality Safety Manager;
- Systems/Program Engineer;
- System Engineer/Process Engineer (SE/PE) Manager;
- 9212/9215 Operations Manager;
- NDA Research and Development Professional;
- Research and Development Professional;
- Research and Development Post-Doctoral Student;
- Material Control and Accountability (MC&A) (Quality Assurance (QA)); and
- Y-12 Site Office (NNSA-OR).

The following eight sections contain the results from the state-of-the-practice review at Y-12. The majority of the information was obtained during interviews covering the lines of inquiry (LOIs). Other sources of information included document reviews, tours, work practice observations, follow-up questions, and presentations given by Y-12 personnel.

Training and Selection of *in-situ* NDA Holdup Measurement Personnel

Overview

The training and selection of NDA holdup personnel at the Y-12 National Security Complex is uniquely influenced by multidisciplinary requirements and the application of measurement technology at the site. The total amount of uranium holdup in equipment appears to be large from both an NCS and NMC&A standpoint. This large quantity, the total number of process equipment holdup monitoring points, and their measurement frequency to support NCS and NMC&A are all drivers of the UHSP. However, not all holdup measurement values are determined by the UHSP. Special campaigns (e.g., to improve NMC&A inventory quantities) can generate substantially more information about holdup than what is triggered by the UHSP.

The equipment holdup quantities measured for NCS are shared with NMC&A and vice-versa. This was not always true in the past. The assumptions and the interpretation of the data, especially the associated uncertainties, were often not applied in a uniform fashion by the two organizations. However, a new multidisciplinary approach is now in place, which appears to be resolving these issues. Because the quantities measured are typically not small, current holdup results are routinely being compared with the required criticality safety limits for the equipment. Furthermore, these large quantities often have an impact on the total inventory or inventory difference (ID) calculations. Routine monitoring and associated evaluations as part of the UHSP are relied on to address inadvertent accumulation concerns and to help identify measurement anomalies.

The UHSP is a two-tiered program that first sends out teams of production personnel not trained in NDA to routinely survey process equipment with a simple, automated gamma ratemeter system. This first-tier qualitative measurement covers a wide area and requires an easily reproducible survey at preselected locations. The readings taken are compared with previous or

expected target values. Any potentially significant holdup increases are flagged and investigated in the second tier of the program by the NDA holdup measurement group.

In-Situ *NDA Measurement Personnel*

There are four survey coordinators and about a dozen production personnel involved in the first tier of the UHSP. Personnel currently engaged as survey coordinators were either trained at the onset of the UHSP program in the 1990s or have been given on-the-job training by a predecessor. Although there is a module listed in the facility training system for this position, no evidence was found to indicate that it has ever been provided to anyone performing this function. Personnel currently involved as part of a measurement team collecting the survey data were, likewise, either trained at the onset of the UHSP program or have been given on-the-job training by a predecessor. There is also a training module for the measurement team operators, but it, too, exists only as a formality and has never been provided to anyone.

The NDA holdup measurement group currently has 10 personnel engaged in performing uranium holdup measurements as the second tier of the UHSP. A majority of the personnel performing these holdup measurements acquired their NDA knowledge with on-the-job training (OJT) and classroom training at a DOE facility rather than at an educational institution. The group has been staffed by selecting personnel with a technical degree or a technical background (if possible) and an aptitude for fieldwork. The selected individuals were then trained in NDA and in performing holdup measurements.

The NDA holdup measurement group is subdivided into two categories of personnel. The highest category is the NDA Leads (professionals or specialists). They are responsible for calculating and reporting quantitative measurements and for interpreting the first-tier qualitative survey measurements. The second category is the NDA Technicians (operators). They are responsible for managing the holdup instruments, performing calibrations and repairs, and maintaining the qualitative measurement program. All of the personnel in the NDA holdup measurement group are responsible for conducting field measurements, which is typically performed in pairs. Because of the differences in roles and responsibilities, each group has some unique training requirements, as well.

The table below lists the NDA holdup measurement group personnel identified per the guidance in the ASTM International Standard C1490 – 04, *Standard Guide for the Selection, Training and Qualification of Nondestructive Assay (NDA) Personnel*..

Senior NDA Professional	NDA Professional	NDA Technical Specialist	NDA Qualified Instrument Operator
0	1	5	4

In addition to the 10 personnel assigned to the NDA holdup measurement group, there are two more individuals in the field NDA organization who are available for measurement consultations. These two individuals have NDA knowledge and experience commensurate with the Senior NDA Professional category.

In-Situ *NDA Measurement Personnel Training*

All NDA holdup personnel are required to attend a formal holdup training course. This requirement can be met by taking DOE course MCA-243, offered at the Los Alamos National Laboratory (LANL), or by taking one of the week-long holdup courses taught in Oak Ridge. Several members of the Y-12 NDA group have taken multiple courses to improve their understanding and to update their hardware and software skills. Both of the formal courses offered by LANL and Oak Ridge National Laboratory (ORNL) cover the physics of gamma interaction and transmission, detection of gamma rays, gamma spectroscopy, holdup modeling and calibration, holdup calculations and correction factors, and measurement uncertainty. In addition, all personnel conducting holdup measurements have also attended a class on automated holdup measurements using Holdup Measurement System (HMS)3 and HMS4 software and hardware. Although these two courses are necessary for staff who conduct quantitative measurements, they do not constitute sufficient training. Any new member of the NDA group is also required to undergo approximately one year of on-the-job training and mentoring with experienced personnel before being allowed to work independently.

Another part of the NDA group's training requirements is the annual retraining that is used to reinforce skills needed to perform the requirements of each NDA position. Because the NDA technicians are responsible for supporting and performing qualitative measurements for the UHSP, the technicians are trained annually on the use of the qualitative survey procedure and the HMS software program. The NDA Leads have an annual requalification requirement of performing a quantitative measurement on a standard, masked as an unknown. The Leads also attend an annual classroom retraining module. The current form of the annual training module gives a review of holdup theory, includes new topics for improving measurements, and provides a refresher on sources of bias in measurements and how to minimize and correct for them. It is noted that there is a desire for these professionals to have an opportunity to practice these lessons, but a venue needs to be established.

A summary of the current training and qualification program for *in-situ* NDA holdup measurement personnel at Y-12 is provided in the following table.

Table 1: Summary of Holdup Training and Qualification Status at Y-12

Formal holdup training course required	Yes
Formal holdup training provided to members performing calculations	Yes
Formal OJT holdup training or mentoring required	No*
OJT holdup training provided	Yes
Formal transition mechanism in place for personnel turnover	No
Sufficient holdup training evident to perform simple holdup measurements	Yes
Sufficient holdup training evident to perform complex holdup measurements	Yes
Retraining mechanism in place to update measurement knowledge	Yes
Sufficient funding identified to properly train NDA individuals	Limited
Tests in place to demonstrate knowledge adequacy	Yes
Qualification program in place for each NDA measurement level in NDA group	Yes
Appropriate manpower in place at each expertise level maintain a balanced program	No
Formal oversight of less experienced or qualified individuals performing measurements	Yes
NDA program manager is knowledgeable about NDA	Limited
NDA professionals are knowledgeable about NDA	Yes
Understanding of holdup measurement uncertainty and limitations evident in customers using the data: NCS, MC&A	Yes

*Not formalized, but OJT is provided.

Y-12 recognizes the need to continue building its ongoing annual training program. Further suggestions and training needs were provided and are listed below.

- Further understanding of measurement uncertainty is needed– what are the contributors and the magnitudes associated with each? Can traditional statistical methods be adapted to holdup measurement uncertainty calculations?
- Further understanding is needed in how transmission measurements in the field are best performed, and in how these are used to correct for self-attenuation and/or equipment attenuation.
- Further understanding is needed in performing volume measurements and making self-attenuation corrections when matrix materials are present.
- Further understanding of the uranium production processes and equipment design would enhance the understanding of holdup accumulation in the production areas.
- It is suggested that some of the NDA professionals retake the fundamental holdup course after some period of field experience for a deeper understanding of holdup theory.
- It would be useful to be able to recognize deficiencies and weaknesses in understanding through a standardized testing program.
- It would be useful to have a DOE NDA certification program that recognizes graduated measurement skill mastery.
- It would be informative to participate in a round-robin exercise with other facilities engaged in measuring holdup.
- It is important to have a hands-on opportunity to use the latest available instruments and software.

- Some NDA holdup cross-training with NCS and NMC&A personnel would help strengthen the mutual understanding of each of these disciplines.

There does not appear to be a critical lack of available funding for sending individuals for formal training. However, the increasing costs associated with travel, added to that of higher class tuitions, is a growing concern because of the size of the NDA group. It has been noted previously that another DOE site used onsite training sessions where the trainers are brought in rather than sending individuals out of town to attend a course. The next alternative would be to provide regional training, if possible.

Design Requirements for New Facilities and Equipment

Design Process

The Y-12 Site is presently designing a new processing facility that will replace aging existing facilities. The Uranium Processing Facility (UPF) is an advanced facility design process that has included system engineering review and interpretation of where NDA may interact with these systems. This effort has included a review of existing NDA-related features and incorporation of these features when possible. For example, the UPF design plans include engineering features to reduce unplanned accumulation. Y-12 has retained a design team that includes a site NDA-knowledgeable individual who provides ongoing design review input to incorporate current and anticipated NDA measurement needs for both MC&A and criticality safety and to consider lessons learned from past operating experience.

The system engineering team, including the engineer familiar with present challenges in NDA holdup measurements, conducts design reviews and evaluates the process features and their interaction with NDA measurement needs. There is significant reliance on engineered features; specifically, filters that protect geometrically unfavorable containers and systems from accumulations. Filters lend themselves well to maintenance and can reduce the number and frequency of measurements required further upstream. Thus, they are a preferred engineered design feature. Also, they have been proven effective in current operations, and design elements from existing processes are incorporated into the new designs. An example of an evolution in design is the plan to redesign vacuum systems from a centralized vacuum system to individual glovebox systems internal to specific locations. The vacuum systems are geometrically favorable by design.

The Y-12 site contractor does not have a procedure that requires a design review to identify needed *in-situ* NDA measurement capabilities in the design process. The Y-12 process is mostly an expert-based system that relies upon several disciplines: NDA, MC&A, criticality safety, and engineering.

Requirements Implementation in Existing Facilities

Equipment and process modifications require reviews by NDA-knowledgeable staff prior to their implementation. This is accomplished through the facility change control process, a well-defined, mature process managed by the Engineering Division. An Operational Safety Board can also recommend reviews by NDA-knowledgeable staff during process design safety reviews. Any change to the Criticality Safety Evaluation invokes the IAPP, which invokes an NDA review at the discretion of NCS staff. Additionally, when the new or modified operation is implemented, the IAPP intends to provide assurance that engineering features will prevent inadvertent accumulation of material when possible and develop *in-situ* NDA requirements for locations where NDA experts have determined that such measurements can be successful.

New and modified designs receive a Design Verification Review, which includes walkdowns by the criticality safety staff. One of the important aspects of the Design Verification Review process is the incorporation of NDA *in-situ* measurement capability expertise and engineered process safety features. Engineered controls relied upon for safety are surveilled on a periodicity determined through examination of the historical operating data for the system. Conservative surveillance requirements are imposed initially and sometimes relaxed as appropriate.

Design Details that Aid in-situ Holdup Measurement and/or Control

Although numerous traps, low points, and geometrically unfavorable locations may exist in process equipment, those areas are surveyed routinely utilizing the UHSP process. This process requires that *in-situ* measurements are made on a regular basis with a specific focus on historically problematic locations. Accessibility is considered in new designs and process modifications. Fixed instruments are not used for continuous monitoring. Y-12 believes that significant human interaction is necessary to ensure that suitable safety assessments and measurements are made and that they are accurate. Engineered controls are provided to limit material from entering process off-gas systems through the use of mist eliminators, mist-eliminating filters, and metal filters. These design features have a proven track-record at Y-12.

Cleanout ports and access points have been provided at accumulation points in the existing facility design. For the new facility, the use of cleanout ports for ducts is under consideration, but the design is still evolving. Process-knowledgeable staff members are intimately involved in the design and design review processes. New glovebox designs incorporate surface finishes and radius of curvature that will enhance the ability to decontaminate. Glovebox surfaces will be polished stainless steel. The standards developed by the American Glovebox Design Standards committee are being used.

Containers

Containers are, in general, designed to permit nondestructive analysis of the contents and minimize shielding where possible. Most containers used in the existing facility processes are amenable to NDA fixed counter measurement. Newer containers present challenges, as they are

designed to be more robust to accommodate other safety concerns, but to date, this has not been shown to present a significant NCS concern.

Facility Issues

In many locations, background radiation is unavoidable due to the proximity of the measurement locations to other equipment and materials. Because background radiation levels are unavoidable, they are evaluated; however, the lack of uniformity requires that the measurement team continuously evaluate and investigate this significant and variable source of measurement uncertainty. Key measurement points are not, in general, ergonomically located. However, the facility has designed appropriate tools to assist operations personnel in making the measurements accurately and quickly. "As-built" drawings exist and are used routinely by the NDA group in their measurement surveillance (i.e., UHSP) program implementation. The long measurement history and excellent involvement of the NDA team with operations and engineering have assisted in the characterization of attenuation correction factors. The facility makes use of alternative methods for controlling and preventing inadvertent accumulations; e.g.; cleanouts when NDA experts determine that measurements would not be successful, filters, mist eliminators, and other design features.

Standards for Conducting NDA Holdup Measurements

Measurement Program

Most *in-situ* NDA surveillances in support of criticality safety are qualitative. Other measurements that are made include qualitative scanning, quantitative verification, and confirmation. Management, operations, and NDA personnel are all involved in the procedure-writing process. The TSG found evidence of good processes in place for developing and reviewing procedures. The procedures are well-written, clear, and concise; unnecessary information is kept to a minimum. The documentation meets the needs of the intended audience (i.e., instrument operators) as well as facilities, engineering, and NDA supervisors and managers. Instrument operators wrote most of the documents, resulting in a very user-directed focus.

All measurements are performed according to approved procedures. Measurement procedures contain the appropriate level of specificity and are higher-level in nature, describing the process to make a measurement not how each individual measurement is made. Procedures also contain some guidance on how some measurement specifics might be decided. Skill-of-the-craft (operator experience) is used to determine how to best implement the measurement in the field.

The peer and management review processes are effective in producing good results, improving technical capabilities, and increasing confidence that procedures are being followed. The technical approach to *in-situ* holdup measurements is based on the methods described in the book *Passive Nondestructive Assay of Nuclear Materials*[1], the report *Gamma-Ray Measurements of*

[1] Doug Reilly, Norbert Ensslin, and Hastings Smith, Jr., Eds. *Passive Nondestructive Assay of Nuclear Materials*, U.S. Nuclear Regulatory Commission report NUREG/CR-5550 (March 1991).

Holdup Plant-Wide: Application Guide for Portable, Generalized Approach (LA-14206)[2], and LANL training manuals.

Y-12 has NDA instrumentation to meet nearly all of its measurement needs. NDA instrumentation, controlled and operated by NDA Analytical Chemistry, includes segmented gamma scanner, neutron multiplicity counter, calorimeter, solution assay system, active well coincidence counter. The *in-situ* holdup equipment and measurements are the responsibility of the Nondestructive Analysis Engineering organization. Nearly all of the *in-situ* measurements are made using sodium iodide (NaI) detectors, which provide adequate resolution, considering that nearly all of the measurements are performed on uranium isotopes. Some germanium systems are also in use at the site.

The UHSP is a major, necessary resource for the IAPP, which is the backbone upon which criticality safety is maintained across the site. The UHSP is intended to periodically monitor enriched uranium process equipment and ventilation systems to detect changes in accumulations in areas that are not readily or routinely accessed for visual observation or cleanout. The qualitative measurements under the UHSP are performed by plant operations personnel using a simple ratemeter to measure the gross gamma count rate. The qualitative measurements are used as a screening process to detect change against predetermined action values. A strength of the UHSP is the UHSP database that is used to maintain a record of all measurement point locations, action values, required measurement frequencies, and measurement results.

Under the UHSP, numerous routine qualitative holdup measurements are made to determine areas of possible uranium accumulation. Action levels are determined by measured count rates above historically defined count rates at all of the thousands of predefined measurement sites. All high count-rate measurements must be resolved either by a qualitative remeasurement at the predefined measurement location or a quantitative measurement in the area of the high reading. High qualitative measurements could be caused by increased holdup in the area of the measurement, not necessarily at the measurement point itself.

Any follow-up quantitative analysis measurements are performed by NDA Engineering personnel with NaI gamma-ray systems using two photopeak regions of interest (ROIs) at 60 keV and 186 keV and three background ROIs bracketing both photopeak ROIs. The results of any quantitative measurements are reported in grams and are evaluated by subject matter experts to determine the potential impact on criticality safety and/or MC&A.

The TJIV is a program that uses all existing measurement results to establish reasonable actions for inventory measurements including equipment cleanout, if indicated. These measurements for MC&A are also used for criticality safety purposes. If facility personnel know how the quantity and distribution of the material, they can identify unsafe situations. The integration of MC&A measurement data under TJIV with criticality safety *in-situ* measurement data from the UHSP is a strength of the Y-12 measurement program.

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[2] Phyllis A. Russo. *Gamma-Ray Measurements of Holdup Plant-Wide: Application Guide for Portable, Generalized Approach*, Los Alamos National Laboratory report LA-14206 (June 2005).

The IAPP limits material accumulations to low levels such that NCS concerns are minimal. Accumulation is limited by a combination of factors such as design features, process design, UHSP measurements, and/or routine maintenance activities.

Changes to Procedures

Procedures are required to be reviewed every five years or less. Training on procedures occurs every year. Unlike the Analytical Chemistry organization, the NDA engineering program does not have any identified procedure writing personnel. Procedure changes can be implemented by anyone, but they must undergo a thorough review and approval process. Version control is effectively implemented via a web-based system.

Lessons learned are communicated well across the site. At Y-12, everyone is working with uranium; therefore, all lessons learned are relevant. Changes in the state of the facility are communicated to the measurement personnel by the operations supervisor and shift manager. The measurement leads are required to know facility conditions before commencing measurements. All modifications to equipment or processes should be noted when completing the Performance Documentation Checklist prior to making a measurement. Measurement leads check with the operation supervisor or shift manager at the beginning of each day and when they notice a change in the facility during the day.

The TSG observed a high level of cooperation and communication between operations, engineering, criticality safety, and NDA measurement personnel that allows all interested parties to remain cognizant of changes, needed revisions, and facility status.

Results and Calculations

Calculations are typically performed using commercially available holdup software, either HMS3 or HMS4. Spreadsheets developed onsite may also be used to perform gram-quantity calculations; however, these spreadsheets are not controlled. One noteworthy practice was the development of electronic mechanical drawings mapping the measurement points. These mechanical drawings are especially useful in areas of complicated piping.

Implementation of Standards

The TSG's review of standards implementation consisted of observations, briefings, and interviews to determine the state-of-practice of the implementation of standards and requirements for performing holdup measurements at Y-12 to support compliance with NCS limits.

The NDA Manager gave an overview of holdup measurements. The holdup measurement personnel reside within the Engineering organization. While holdup measurement staff have been moved between several organizations, the Engineering Manager, who is a corporate vice-president, met with the TSG and demonstrated his substantial awareness of holdup measurements and staff. The TSG toured two major processing facilities and the NDA

calibration facility, which is used to calibrate both qualitative and quantitative instruments, and observed holdup measurements being performed during the tours. Reviews of documents occurred before and throughout the site visit.

Interviews provided consistent details concerning the implementation of holdup measurements at Y-12. LOIs were primarily used to examine the holdup measurement program, although TSG members also interviewed NDA personnel who perform measurements not directly related to holdup measurements. The holdup measurement staff consists of a wide range of expertise and experience levels. All quantitative measurements are performed by the NDA staff, while qualitative scans are initially performed by operations personnel. When significant changes in scan results are identified, the NDA staff investigates, repeats, or performs quantitative measurements as indicated. The UHSP requires these scans for NCS monitoring against accumulation over long time periods. The quantitative measurements that result from high point investigations are used to support NCS and MC&A. Holdup measurements are performed to support MC&A, NCS, waste management, and decontamination and decommissioning activities. A work request system is being developed to allow site organizations to electronically notify the holdup measurement staff of upcoming work requests as well as issues related to the work requests.

Several efforts in recent years have strengthened communication between NCS, NDA, and operations personnel. One of these has been the creation of a point-of-contact (POC) within NCS who ensures that holdup results are made available to the appropriate NCS area lead, assists NCS engineers in the use of holdup data, and serves as the central communication point between the NCS and NDA organizations. Y-12 also has an active CSO program in which operations personnel work with NCS engineers to implement NCS requirements. CSO personnel were interviewed and conducted one of the building tours. They were very knowledgeable of holdup measurement results and associated issues. A third effort that has strengthened communication was the development and implementation of the IAPP. This program, which has been well-supported, has implemented multidisciplinary walkdowns of all systems with active NCS requirements. Walkdowns of inactive systems are currently in progress. These walkdowns have prompted further efforts when determined appropriate, such as requiring process cleanouts or engineering modifications.

Holdup measurements are performed using the Generalized Geometry Holdup (GGH) method, based on a LANL recommendation, primarily to support NCS and MC&A with additional measurements required to meet waste removal. The holdup measurement personnel are confident that most holdup at Y-12 has been measured. Accelerated decontamination and decommissioning efforts are reducing unidentified holdup locations. The majority of measurements are performed based on process knowledge and engineering drawings. Isotopic characterization is based on destructive analysis of process materials. In cases where material impurity could cause isotopic variation, either high-purity germanium (HPGe) or destructive analysis measurements are used to investigate these deposits.

Y-12 holdup personnel currently use HMS3 and are transitioning to HMS4, with a goal of completing this transition during calendar year 2009. HMS systems automatically record data at each measurement location and support the storage of logged data and calculated results. One

significant benefit is the near-elimination of data entry errors. The HMS4 version includes algorithms to correct for finite-source and self-attenuation errors and to check counting statistics. ORNL personnel who helped develop the system are supporting the Y-12 transition.

The Y-12 holdup staff have performed several source checks to verify minimum-level-of-detection calculations. Although these checks have been performed primarily for waste container measurements, they have not been formally documented. Validating the calculations is a best practice for holdup measurements. Through these efforts, the holdup measurement systems can routinely identify less than one gram of U-235.

Personnel are taught to identify and document high background and other interferences through training. Observed field measurements indicated that holdup measurement personnel were well-trained in detector positioning to minimize interferences and in positioning lead plates to reduce background as needed. The Compton background is subtracted by the use of ROIs established during calibration. During data analysis and reporting, high attenuation locations are reviewed. Locations where transmission is less than 5 percent are investigated. Correction factors for shielding are calculated based on engineering drawings and ultrasonic testing.

Equipment in use at the site is well-maintained. Repairs to the qualitative and quantitative systems are performed onsite by two technicians who directly support this effort. The NDA group uses NaI detectors for most holdup measurements. The group owns, but does not routinely use, a cadmium-zinc-telluride detector. Holdup measurement systems are routinely stored in locked rooms within the Material Access Area. Sources are stored in the same area in approved source storage containers. Reports are stored in accordance with records management requirements. Measurement ROIs are stored by the NDA professional performing the analysis.

Although uncertainty calculations are incorporated into HMS3, they are further reviewed when quantification results are reported. Modeling calculations and errors have been refined based on cleanout results. MC&A statisticians support analysis of error propagation, including an evaluation of cleanout comparisons. Uncertainties from count time, sampling, and modeling have been considered. Modeling and sampling uncertainties have been determined to be the dominant sources of holdup measurement uncertainty. The measurement team tracks trends in holdup results and reports the previous result at each location, as well as the current result.

The TSG observed several strengths during this review. Clearly, the level of communications between NDA, NCS, engineering, and MC&A staff is important to ensuring that holdup personnel provide the results needed by end users and get the support they require to perform measurements useful to the end users. Maintaining these channels of communication should be a continuing, mutually beneficial effort. The site has started cleaning out holdup deposits and comparing measurements of the removed material with holdup measurements. As a result, the models used for measurements have been refined. Upgrading the holdup measurement systems and instrumentation is important to obtaining state-of-the-art measurements. The HMS4 upgrade requires significant site support, including information technology support, and delays will impact this implementation. The annual hands-on qualification of the measurement staff adds value in several significant ways. It allows the exchange of information related to recent events, demonstrates the MDA of the instrumentation to the measurement staff, and verifies these

calculations. The loss of trained measurement staff is an issue at Y-12 and some of the staff are single-point failures if they leave. This is not unique to Y-12; it appears to be typical across the DOE complex.

Research and Development

The LOIs for this section evaluated research and development (R&D) activities associated with NDA and NDA holdup measurements, including, but not limited to instrumentation, data analysis, procedures, automation, uncertainty, process, techniques, nuclear material standards, and calculations.

The TSG interviewed two pairs of individuals. The first interview pair was from the Analysis and Characterization Group of Applied Technologies. This pair had very limited *in-situ* holdup knowledge and limited NDA expertise in general. Nearly all of the R&D funding comes from the Plant Directed Research and Development program. The R&D projects touted as in support of holdup measurements through the Applied Technologies organization did not appear to be related at all to holdup or NDA.

The second pair interviewed was from the NDA Engineering organization. These individuals have been very prolific in conducting NDA-related research. Any practical R&D efforts in NDA measurements at the site appear to originate from the two NDA Engineering personnel. Research results and conclusions are disseminated via daily interactions, conferences such as those sponsored by the Institute of Nuclear Materials Management, and the DOE Information Bridge.

All of the equipment used onsite is commercially available and commercially supplied. The most pressing equipment improvement needs at Y-12 is improved ruggedization, miniaturization, and integration (fewer components). The identification of technology needs at Y-12 was recognized by the TSG as ineffective. When needs that would benefit the measurement program are identified, Y-12 NDA personnel are not clear as to how that need should be conveyed or which organization is to act upon the need. The technical staff views all of the onsite NDA holdup equipment as obsolete. The use of old equipment with limited automation increases the potential for false measurements due to human error, which, in turn, increases the measurement burden from remeasuring points that are not really above action limits. More importantly, mistakes could occur where a point that is above an action limit is measured low and no action would be taken, but the next bimonthly survey would more than likely remedy the mistake.

The only calibration sources available onsite are point sources. Recently, funding was secured to prepare much-needed line and area sources. All of the standards are working reference standards.

Lessons learned are conveyed via word of mouth, the peer review process, and some onsite presentations. It appears that any funding for training or conference attendance must come from organizations other than the holdup or NDA personnel's organizations. Research collaboration within, or external to, the site has been nearly nonexistent in recent years.

The separation of NDA personnel into different organizations is detrimental to the development of site knowledge. This is especially disadvantageous given the small number of individuals practicing NDA. There are two waste facility personnel, two NDA laboratory personnel, 14 NDA field measurement personnel, and a measurements group within NMC&A.

Quality Assurance (QA)

Program Management

The responsibility for the QA program resides within the NDA Engineering Group. Field NDA engineers initiate response actions to out-of-control conditions. The NDA Field QA Lead within the NDA organization compiles and interprets measurement control data. The QA plan is described in the Y-12 document Y/DK-2145, *Measurement Control for Y-12 Uranium Holdup Measurements*. Further detail is described in multiple procedures.

Measurement control is an inherent function of the HMS-series software used to collect and analyze data. The automation capabilities of the HMS(*x*) system allow for a rigorous measurement control scheme. A uranium cup standard is measured once every 20 measurements. In addition, an americium (Am)-241 source is attached to the front of the detector. This signal is analyzed with every measurement. Quality measurement performance is ensured through these features, in conjunction with yearly training and regular procedure reviews.

Annotated control charts are attached to each measurement report and are available to all data users. The MC&A organization reviews the data to ensure that it meets the stringent requirements of the DOE Orders. Detection levels are typically less than one gram in low-background areas, and this is generally adequate for criticality safety as well as MC&A.

When practical, holdup measurements are compared to cleanout values. As needed, these feedback data are used to adjust models and measurement approaches.

Documentation and Calibration

Measurement data and analysis results are maintained in a centralized file cabinet. Hard-copy files can be associated with locations and process equipment within the facility. In the near future, it is planned to upgrade the measurement system to HMS4, which includes a central electronic database.

Calibration records are kept both electronically and in a paper file. Instrument manuals and logbooks are kept for each instrument. Investigations of out-of-control situations are tracked by physically writing on the control charts. Reports are tracked by control number.

Instrument calibrations are performed in a low-background area in a separate building that does not contain holdup. High-quality standards are used to perform calibrations, although only in the last month have line and area sources been available to verify calibrations.

Operationally, the limits of the instrument calibration are in terms of areal density (g/cm^2), and not the overall gram quantity of the item. The practical calibration limit is where the item has a sufficient areal density so that it appears infinitely thick. Infinite thickness checks are incorporated into the measurement program. Measurements are validated by comparisons to cleanout data and by comparisons to other measurement techniques (high-resolution spectroscopy). These comparisons are used to help ensure that the measurement range is valid.

For the qualitative measurements, each radiological survey meter is calibrated to read the same count-rate on similar sources. The survey meters are calibrated each day in which a survey is conducted. Action limits for the survey are set by evaluating the variability of each data point. Those points that exceed the action limit are investigated and normally remeasured.

Calibrations for the quantitative instruments are valid for one year. This timeframe was initially set by observing spectral degradation over time. Detectors that cannot meet quality assurance checks within one year are removed from service. Calibrations are validated with a uranium standard every 20 measurements and validated against an americium source attached to the detector with every measurement. The calibration status of equipment is controlled through procedure and by software. A full recalibration is required after any maintenance, except for cable replacement.

Nuclear Material Calibration Standards

Nuclear material standards were prepared at Y-12. They were prepared to the same exacting standards as would be used in uranium parts. They are high-integrity standards that are well-characterized. The standards used for quality control were made with New Brunswick Laboratory-certified reference material and fabricated at Y-12. The standard used for calibration is a working reference standard. The material used for the calibration standard was characterized by the Y-12 plant laboratory and the standard was fabricated at Y-12. The documentation for this standard was captured in report Y/DK-2145, *Measurement Control for Y-12 Uranium Holdup Measurements*.

Check Sources and Control Charts

The control standard is a uranium cup standard that fits over the collimator. A second standard is an Am-241 seed attached to the detector endcap. Control parameters are contained within each instrument to alert the operator of an out-of-control situation. If the uranium control standard fails, the system does not let the operator continue with data collection without rectifying the situation. If the instrument is out of control, the operator has an opportunity to move to a lower background area or to clean the detector. If the instrument is out of control after multiple attempts, the operator is trained to stop all data collection until a more thorough review has been performed.

The NMC&A organization routinely reviews the measurement control program and reviews the measurement control data that are issued as part of the quantitative reports produced per system measured. This program has also been reviewed during routine external reviews, including the 2008 Office of Independent Assessment inspection.

Validating Measurement Results

Validation of NDA measurement results against cleanout data is performed when practical, although opportunities are rare. In some situations, parallel measurements are made by peers using alternate measurement techniques. Additionally, a comparison of NDA measurements of a system over time is tracked through the IAPP and TJIV programs. These opportunities are used to help better define measurement uncertainties and changes in holdup deposits. HMS, HMS3, and HMS4 software has been maintained, verified, and tested in accordance with Y-12 Software QA programs. Input values are double-checked through peer review.

Oversight

In general, oversight activities involve both internally- and externally-initiated reviews to determine the extent to which programs and personnel are performing work activities in compliance with specific requirements. The application of particular review criteria for the purpose of assessment is effective for readiness reviews, performance analyses, and demonstration of adherence to policies and programmatic or operational procedures. This method is also effective for identification of deficiencies and opportunities for improvement, and for enhancement through self-assessment and independent oversight.

NDA may be implemented to support various requirements for compliance involving several site-level programs or functional areas. These areas typically include material control and accountability, criticality safety, safeguards and security, and waste characterization programs. Therefore, oversight performed on these programs may demand demonstration of compliance of NDA performance and identify deficient or noteworthy conditions as well as lessons learned. Often, oversight reviews will concentrate on performance objectives and criteria, broken down into specific LOIs, that are directed according to a high or low level of focus within a program or organization.

The LOIs established for the Oversight section of this review were directed toward determining what, when, and how oversight is performed and how the results are applied to NDA assessments and improvements, with a focus on criticality safety. Oversight reviews at Y-12 involve both internal (onsite) reviews and external reviews, typically directed by DOE. Internal oversight of NDA practices are routinely performed by the CSE, CSO, NMC&A, and site nuclear criticality safety committee organizations. The Y-12 NDA Manager noted that the NDA support required for recent external oversight has impacted the resources available for internal reviews; in particular, self-assessments. Typically, assessments involve reviewing the two NDA programs implemented for the uranium processing systems within Buildings 9212 and 9215: the UHSP and the IAPP.

The UHSP requires the coordination of NDA Technical Support, CSE, CSO, NMC&A, and the UHSP Lead for concurrence and approval. Quantitative holdup measurements are performed by procedure Y17-69-418 at locations requiring mass values for the periodic inventory or due to high point survey results. The results are issued in a UHSP high-alarm gram quantity report, a TJIV report, or similar holdup report as appropriate. Each report undergoes a technical review. UHSP results are distributed to several NDA customer organizations that provide a review of results, including facility managers, CSE/CSO, and NMC&A. These reports are excellent documentation of NDA measurements within the UHSP for any oversight reviews. NDA holdup measurements and analyses are not reviewed by individuals outside of NDA Engineering. Such an external review, if implemented, could provide a more comprehensive understanding of the advantages and difficulties of NDA capabilities.

Several criticality safety evaluations credit the UHSP for equipment holdup monitoring in the Administratively Controlled Limits and Requirements sections. The controls may also include requirements for engineered features or periodic cleanouts of system equipment. The bases for the survey action values are recorded in a UHSP survey basis report. However, there does not seem to be documentation that provides a calculation link between an individual survey action limit for a defined assay configuration and the corresponding criticality safety limit. The survey frequency is set to detect and track the assumed slow accumulation of uranium deposits and allow for CSE guidance. A Technical Deviation or Clarification (TDC) report is issued by CSE to document the guidance, or as requested for support.

The CSE may request an IAPP review for a particular need as deemed necessary during development of a criticality safety evaluation. Several program assessments are required by the IAPP procedure (Y70-162). These oversight assessments are performed according to the Y-12 nuclear criticality safety committee, the nuclear criticality safety review program procedure (Y70-66-002), the management assessment procedure (Y15-902), or independent assessment procedure (Y15-903).

Oversight assessments are routinely performed by several internal organizations with respect to the UHSP and IAPP, involving the implementation of criticality safety practices and NDA measurements. External oversight includes expert individuals recruited for particular reviews as well as larger site evaluations that include NDA program elements. The IAPP, by definition of its scope, provides an oversight function of NDA implementation for criticality safety because systems are analyzed, issues are identified, and corrective actions are recommended. While all of the individuals interviewed for this portion of the TSG review were knowledgeable of the UHSP and IAPP, several were not familiar with the documented safety analysis or authorization basis documents applicable to the processing facilities, Buildings 9212 and 9215.

A significant annual review of selected elements of the Y-12 criticality safety program is conducted by a broad team of site experts, including selected *ad-hoc* members external to Y-12. The Y-12 nuclear criticality safety committee conducts its annual review according to an assessment plan developed according to input from various sources. These sources include defined review criteria as LOIs, previous oversight issues, assessment databases, and potential customer concerns. Typically, the review will focus on a specific interest area or concern. As an example, an annual review report contained criteria specific to assessing the corrective actions in

response to a filter investigation. Committee recommendations of findings, observations, or opportunities for improvement are considered by a review board for selection of prioritized corrective actions and tracking in the site issues management system (IMS) database. The committee performs a review of the IAPP on a three-year schedule.

The Y-12 Site Office (YSO) approves the corrective actions in IMS that are given higher priority than others. Site Office personnel perform quarterly assessments according to selected criteria or concerns or to follow up on previous oversight concerns and record the results in a dedicated, DOE-owned database, Pegasus. Both the IMS and Pegasus databases interface with read-only capability, allowing for excellent communication between the contractor and DOE as well as YSO oversight of identified issues.

Annual process reviews of fissile systems are performed by CSE personnel according to established LOIs. Similarly, CSE performs program reviews per industry administrative requirements (i.e., the American National Standards Institute (ANSI)/ANS-8.19 Standard). The LOI sections include UHSP, IAPP, inventory control, and large-geometry exclusion areas. Monthly meetings are used to discuss lessons learned, deficiencies or noncompliance items, and corresponding performance metrics. The CSE point of contact serves as the interface with the NDA organization to review monthly holdup reports and facilitate resolution of high survey results for Buildings 9212 and 9215. This CSE position is instrumental to the efficient communication between the criticality safety and NDA organizations and to the integration of both programs. CSE personnel are frequently in view of fissile material operations. However, holdup surveys and quantitative NDA measurements are seldom observed by CSE personnel, but would provide a valuable input for the CSE self-assessments. Self-assessments, which include NDA holdup criteria, are also periodically performed by NMC&A personnel.

Criticality safety self-assessments are also performed by the CSO for each fissile material process. A surveillance database requires the CSO to perform periodic reviews of the validation, implementation, and annual surveillance of criticality safety requirements. The surveillances are conducted according to a checklist of general criteria that includes a review of NDA controls from criticality safety documents. An “unsatisfactory” result requires that a supervisor be notified to determine further disposition, including the recording and tracking of corrective actions in the surveillance database. In general, the CSO functions as a vital, expert asset for coordinating NDA requirements for criticality safety with process operations via the UHSP and IAPP. Inclusion of the CSO and CSE findings and corrective actions in the Y-12 IMS database could better drive continuous improvement. The IMS is a more formal database that ensures an adequate, consistent review of issues for proper identification of corrective actions and their tracking to completion. In addition, the IMS provides a central point for calculation of various performance metrics and a source of review data for various oversight needs.

General self-assessments are not performed by NDA personnel because of limited staffing resources. Within NDA Engineering, blind standards are issued by the lead engineer for assay to determine proper identification and quantification. The NDA Engineering Manager stated that recently NDA personnel were expected to support a number of external oversight queries, which limits NDA support beyond the UHSP duties. Occasionally, the NDA Engineering organization relies on the technical review and support of an NDA expert from ORNL. This type of external

technical review should be used on a regular basis to provide a fresh view of NDA methods, potential improvements, or overlooked problems.

Roles and Responsibilities

The contractor roles and responsibilities for the UHSP program are adequately defined in procedures Y15-014 and Y70-162. Federal roles and responsibilities for overseeing elements of the UHSP related to nuclear criticality safety are described in YSO-5.9. The UHSP program resides within both the NDA group, which is part of the Engineering Organization, and within Production. The NDA group is composed of staff having technical expertise ranging from senior technical specialists to technicians. The UHSP Manager, who is concurrently the NDA Group Manager, is responsible for identifying funding needs. Funding is project-based, and is negotiated with the Operations organization. Included in this funding is contingency planning to account for unexpected resource expenditures such as unplanned quantitative measurements and emergent work. Additional funding needs are quantified by the NDA Group Manager and submitted to the Vice-President for Engineering for further disposition. These roles and responsibilities are clearly defined in procedures Y15-014 and Y70-162.

Procedure Y15-014 assigns overall responsibility for the conduct of uranium holdup surveys and coordination of activities of applicable support organizations such as criticality safety and NMC&A. Procedure Y70-162 implements the multiorganizational IAPP to address geometrically unsafe areas within fissile material activity systems. This procedure defines roles and responsibilities for the Engineering, Quality and Manufacturing organization, Operations organization, and Deputy Manager. Together, these procedures provide for clear and effective communications between interfacing organizations.

Procedures Y15-014 and Y70-162 also define the functions, assignments, responsibilities, and reporting relationships necessary to support line management control of safety. Discussions and presentations by the CSO regarding the IAPP demonstrated effective interfaces between the Operations organization, which is responsible for the UHSP; and NCS, which is responsible for promulgating the guidance necessary for ensuring continued safe operation of processes and equipment having the potential for enriched uranium holdup. The IAPP, which serves to validate the potential for holdup, has been designed to document the potential for holdup, and identify best methods or technologies for minimizing such potential. This program includes a mechanism with technical recommendations that require funding for implementation, which may be brought to line management attention for further resolution and disposition. Several corrective actions stemming from completion of IAPP activities were assigned as capital items requiring Plant Manager approval for the release of funding.

The UHSP is implemented by NDA technical support staff and by Production staff. Procedure Y15-014 defines the roles and responsibilities for the following NDA and holdup measurement personnel: Survey Coordinator (Production); Qualitative Measurement Survey Team (Production); and NDA Technical Support (Engineering). Per Procedure Y15-014, the Survey Coordinator oversees the routine qualitative surveys in an assigned area. The Survey Coordinator is alerted to surveillance due dates, ensures that the surveys are completed within

the required time period, and is responsible for transferring the data results to the central UHSP database. The Survey Coordinator is also responsible for preparing holdup survey equipment to be used by the Qualitative Measurement Survey Team. Technical support for operation of the holdup survey equipment, including calibration, modifications, repair, maintenance, equipment specifications, and for the purchase of survey equipment, is provided by the NDA Technical Support group. This group also performs routine follow-up qualitative and quantitative measurements in response to qualitative results exceeding defined action thresholds.