PNL-10186
UC-606

UNITED STATES PROGRAM FOR TECHNICAL ASSISTANCE TO IAEA SAFEGUARDS

POTAS

DEPARTMENT OF STATE
DEPARTMENT OF ENERGY
ARMS CONTROL AND DISARMAMENT AGENCY
NUCLEAR REGULATORY COMMISSION

Final Report

Recommended Observational Skills Training for IAEA Safeguards Inspections

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September 1994

Prepared for
The International Atomic Energy Agency
Department of Safeguards

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EXECUTIVE SUMMARY

This report documents the activities, findings, conclusions, and recommendations from Phase 2 of a project designed to assist the International Atomic Energy Agency (IAEA) in enhancing the effectiveness of its international safeguards inspections through inspector training in Observational Skills. The objective of Phase 2 is to identify the current inspector job requirements, identify the types of observational skills that would help inspectors to enhance safeguards inspections, and then recommend a course curriculum or training modules that meet these objectives.

The previous work under Phase 1 of this project was essentially exploratory. The Phase 1 report, Concept *Paper: Knowledge Acquisition Skills Training for Enhanced Safeguards Inspections,* defined Observational Skills broadly to include all appropriate cognitive, communications, and interpersonal techniques that have the potential to help IAEA safeguards inspectors function more effectively. It identified 10 specific Observational Skills components, analyzed their relevance to IAEA safeguards inspections, and reviewed a variety of inspection programs in the public and private sectors that provide training in one or more of these components. The report concluded that while it should be possible to draw upon these other programs in developing Observational Skills training for IAEA inspectors, the approaches utilized in these programs will likely require significant adaption to support the specific job requirements, policies, and practices that define the IAEA inspector's job.

The primary objective of Phase 2 was to identify a set of Observational Skills required by IAEA inspectors to perform effectively and to provide the basis for the design and delivery of training to IAEA inspectors. Thus, one critical activity involved in this phase was to learn about the inspector job as it currently is performed, and how it is likely to be performed in the future under enhanced safeguards guidelines. To this end, the authors worked with IAEA Safeguards Training staff to interview a total of 24 IAEA inspectors, Section Heads, and Directors participated. During these interviews, participants were asked to describe the

specific details of conducting an inspection, and to describe the skills needed to conduct enhanced safeguards inspections.

Based on this interview information, input from IAEA Safeguards training staff, and a review of the current basic training course for IAEA inspectors (i.e., ICAS), the authors identified three sets of Basic Observational Skills that would complement inspectors current technical skills and result in conducting enhanced safeguards inspections. These three sets of Basic Observational Skills are:

- Visual Observational Skills
- Communications and Negotiations Skills
- Organizing Skills

The rationale for developing training modules in each of these areas is provided below.

During the interviews, inspectors and other Safeguards staff reported that inspectors can learn much about a facility by simply observing the physical environment. Thus, at the basic level, Visual Observation Skills address how to look for structural features and operating conditions that may be inconsistent with the State's declaration. This skill area includes recognition skills, visual attention and perception, memory skills, mental imaging, mental models, and judgment.

Communications and Negotiations skills were viewed as necessary skills in conducting inspections. Interview participants reported that it is important for the inspector to communicate clearly and accurately to team members and to facility personnel. In addition, inspectors should also be sufficiently skilled to recognize situations that require negotiations skills (diplomacy) or situations that require one to be more assertive. Thus, this training module was designed to provide inspectors with the skills needed to communicate clearly, recognize one's own communications strengths, and recognize when negotiations skills are warranted over more assertive behaviors. This module includes the following topics: general

communications, interviewing, detecting deception, negotiating, and operating in different cultures.

In the interviews with the Safeguards staff, participants very often described the need for planning inspections, working effectively as a team, analyzing the information collected during an inspection, and then summarizing and reporting this information in a clear and meaningful manner. In general, interview participants noted that the most successful inspections are those that are well planned in advance, take full advantage of team members skills and knowledge, and provide a clear and coherent analysis and summary of the information collected in the inspection. Therefore, Organizing Skills includes training for inspectors involving planning for inspections, working effectively as a team, analyzing information, and reporting information obtained during the inspection.

Finally, the Basic Observational Skills course includes a recommended practical skills exercise, a mock inspection of a facility. This exercise is designed to incorporate skills from the three Basic Observational Skills modules. That is, after inspectors complete the three modules they will participate with other inspectors in a mock inspection. This inspection will be constructed so as to require participants to use Organizing Skills to plan and conduct an inspection with a team of inspectors, Visual Observational Skills to discover potential anomalies, and Communications and Negotiations skills to overcome barriers presented by facility personnel, to ensure effective team interactions, and to obtain information from facility personnel as needed to explain potential discrepancies. The purpose of this mock inspection is to provide inspectors with hands-on experience in using Basic Observational Skills and to provide feedback on their performance.

After identifying the Observational Skills training course modules, the next step was to provide detailed modules descriptions that contain specific training topics, instructional methods, time required, and expected results for each topic area. Specific module training information was developed using the authors' previous experience in designing training programs, and information obtained from other government agencies who provide training to

inspectors and investigators, Contacts with these government agencies provided information about the general content of inspector or investigator training, specific courses offered in these training programs, and, in some instances, materials used to provide such training. The result is a recommended course curriculum for the three Observational Skills modules. This information can be used for the next phase of the project, design and delivery of Observational Skills training to IAEA inspectors.

ACKNOWLEDGMENTS

The conduct of Phase 2 of this project required coordination and cooperation among PNL, the IAEA, and other government agencies. For these coordination efforts, we express our appreciation to Richard Badalamente, the project manager, and to Robert Sorenson, the Senior Program Manager for International Safeguards at PNL. In addition, John Brown and Dick Libby of PNL provided useful input in planning and conducting this project and in reviewing the final product.

Several staff from the Department of Energy also provided critical input into this project. Ira Goldman and Erin Heaton O'Dell served as liaisons between PNL and other government agencies. Their efforts assisted us in gaining access to these agencies. In addition, Susan Pepper of POTAS also worked diligently to assist us in gaining access to government agencies.

Many IAEA staff contributed to the conduct of this project. In particular, Gene Bates and Jeanne Anderer of the IAEA Safeguards Training section coordinated all interviews with Safeguards staff. We express our appreciation to all Safeguards staff who shared their valuable time and expertise with us to make this project more firmly grounded in the specific needs of the Agency.

Finally, several Battelle staff assisted in analyzing and summarizing data for this report. These include Kim Johnson, Charleen Forslund, and Peggy Hunt. Anita Freeze provided the expertise needed to produce this report.

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1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

This is the second of two reports prepared to assist the International Atomic Energy Agency (IAEA or Agency) in enhancing the effectiveness of its international safeguards inspections through inspector training in "Observational Skills." The first (Phase 1) report was essentially exploratory (Morris & Toquam, 1993). It defined Observational Skills[1] broadly to include all appropriate cognitive, communications, and interpersonal techniques that have the potential to help IAEA safeguards inspectors function more effectively. It identified 10 specific Observational Skills components, analyzed their relevance to IAEA safeguards inspections, and reviewed a variety of inspection programs in the public and private sectors that provide training in one or more of these components. The report concluded that while it should be possible to draw upon these other programs in developing Observational Skills training for IAEA inspectors, the approaches utilized in these programs will likely require significant adaption to support the specific job requirements, policies, and practices that define the IAEA inspector's job.

The overall objective of this second (Phase 2) report is to provide a basis for the actual design and delivery of Observational Skills training to IAEA inspectors. The more specific purposes of this report are to convey a fuller understanding of the potential application of Observational Skills to the inspector's job, describe inspector perspectives on the relevance and importance of particular Observational Skills, identify the specific Observational Skill components that are most important and relevant to enhancing safeguards inspections, and make recommendations as to Observational Skills training for the IAEA's consideration in further developing its Safeguards training program.

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[1]The first report used the term "Knowledge Acquisition" skills rather than "Observational Skills." We have learned that Observational Skills is more meaningful to most readers and so use only that term in this report.

Readers should note that the scope of this report is limited in two important respects. First, it addresses "basic" Observational Skills that are generally applicable to inspections of all types of facilities and activities subject to safeguards. "Advanced" Observational Skills, which are applicable to specific facilities, activities, or proliferation indicators, are not addressed by the training recommended in this report, but are expected to be addressed subsequently. Second, for each training module or course recommended, this report includes instructional objectives, a course outline, and a discussion of training media and practical exercises. Preparation of actual training materials, however, is beyond the scope of this report.

1.2 RELATIONSHIP TO OTHER IAEA INITIATIVES

In light of recent experience with undeclared activities in States having a comprehensive safeguards agreement, the IAEA Director General has stressed the importance of strengthening the safeguards system by "enhancing the Agency's ability to detect and obtain access to any undeclared activities that should have been declared under safeguards agreements" (Report to the 36th Session of the general Conference, GC/XXXVI/1017).

At the Director General's request, the IAEA's Standing Advisory Group on Safeguards Implementation (SAGSI) re-examined "how Agency safeguards are implemented in order to advise on ways to reduce costs while meeting new requirements and maintaining effectiveness." Reporting in April 1993, SAGSI focused on the problem of undeclared activities revealed through the Iraq experience and urged that the IAEA safeguards system "be strengthened so as to provide confidence that no undeclared activities of proliferation relevance are being carried out in States with comprehensive safeguards agreements." In SAGSI's view, a basis for such a strengthened system is the greater degree of openness and transparency shown by the international community elsewhere in the arms control and disarmament field. SAGSI identified a number of specific measures that could be taken to address both undeclared activities and facilities. It noted that such an approach placed "less

emphasis on quantitative assessment and more emphasis on qualitative judgments about the declared operation of facilities."

In December 1993, the Deputy Director General for Safeguards described to the Board of Governors the IAEA Secretariat's Program for a Strengthened and More Cost-Effective Safeguards System. Referred to informally as "Program 93+2," this effort is currently evaluating the technical, legal, and financial implications of SAGSI's recommendations. With encouragement from the Board, these initiatives continue to move forward. Task 4 of Program 93+2 is aimed at reducing the costs of implementing safeguards while maintaining or improving their effectiveness and increasing the capabilities of the Agency to detect undeclared nuclear activities, especially through improved access to information and enhanced access to sites. Task 6 of Program 93+2 addresses enhanced safeguards training. While some training being planned in support of Program 93+2 must necessarily await developments elsewhere in the Program, the training recommended in this report is intended to be of sufficiently broad applicability to be generally supportive of the range of measures already taken, as well as under development in Task 4.

1.3 DATA SOURCES

A wide range of data was used in preparing this report. In addition to the individuals, organizations, and materials consulted for the Phase 1 report, which were also helpful in Phase 2, information sources included: IAEA publications and briefing notes for missions, IAEA training materials, interviews with IAEA Safeguards Department staff (described in Chapter 2), informal discussions with IAEA Safeguards Training Section staff, interviews with staff from various U.S. agencies that provide Observational Skills training or make use of Observational Skills in their inspections or investigations, and secondary sources in the various skill areas. In addition, the authors have participated in the U.S. Department of Energy's International Safeguards Inspector Training Task Force and have benefited from the insights of their Task Force colleagues.

1.4 REPORT ORGANIZATION

This report contains four chapters. Following this Introduction (Chapter 1), Chapter 2 presents results from a series of interviews conducted with IAEA inspectors and other members of the Safeguards Department. The purpose of these interviews was to gain a more complete understanding of the safeguards inspector's job and the potential applicability of Observational Skills to successful inspections, as well as to obtain the views of inspectors as to the relevance and relative importance of particular Observational Skills and any issues that could arise in providing training in Observational Skills.

Chapter 3 identifies the "core" Observational Skills judged by the authors to be most relevant and important to improving the effectiveness of safeguards inspections, especially in their capacity to detect undeclared facilities and activities. These include Visual Observation Skills, Communications and Negotiation Skills, and Organizing Skills. For each of these three skill areas, Chapter 3 contains a description of the skill and its components, results from analysis of the relevance and importance of the skill, and an assessment of the need for training in these skills.

Chapter 4 describes recommended IAEA inspector training modules and courses in Basic Observational Skills. For each training module or course recommended, Chapter 4 provides a set of instructional objectives, an outline of course contents (specific topics to be covered, and the approaches that will be used to teach them), and a description of training media and practical exercises that serve as aids to instruction.

Chapter 5 summarizes the report and its major conclusions.

2.0 SUMMARY OF INTERVIEW RESULTS

This chapter summarizes the approach used to collect information about the IAEA inspector job, characteristics of effective inspectors, and inspector perspectives on the application of Observational Skills to enhance the safeguards inspections. The purpose of this chapter is to investigate how inspection activities could be enhanced via Observational Skills training and to identify the specific Observational Skills recommended for inclusion in enhanced training modules based on input from inspectors and others at the IAEA who are knowledgeable about the job and job requirements.

2.1 BACKGROUND AND APPROACH

One of the purposes of this report is to summarize the duties and functions of the IAEA inspector job and from this to determine the types of General Observational Skills needed to perform the job effectively. Those most knowledgeable about the inspector job and the skills needed to perform inspections effectively are the IAEA inspectors and other Safeguards personnel who direct, arrange, and use information obtained from inspections. To obtain this information, the authors conducted structured interviews with Safeguards personnel in Vienna, Austria.

Interviews with IAEA Safeguards staff were conducted over a ten-day period in May 1994. The interviews were guided by a structured interview format that requested information about current job, education, experience at the IAEA, descriptions of inspection activities, and descriptions of characteristics of effective and less effective inspectors. A copy of the structured interview is provided in Appendix A. In addition, current inspectors were asked to complete a short survey questionnaire that asked about the specific training needs relevant to enhancing safeguards inspections. A copy of this questionnaire is provided in Appendix B.

A description of the Safeguards staff who participated in these interviews is provided Table 2.1. As is shown in this table, four directors from the Safeguards Department, six

Section Heads, 14 inspectors and staff from other sections participated in these interviews. All interviews lasted from 30 to 90 minutes. Although the structured interview format proved to be a useful tool for conducting these interviews, it served only as a guide. And, where appropriate, the nature of the interviews were allowed to take a different course. The survey questionnaire, as a rule, was completed only by inspectors. This is because these Safeguards personnel had direct, hands-on experience in conducting inspections. A total of ten Safeguards staff responded to this questionnaire.

TABLE 2.1. IAEA Safeguards Personnel Who Participated in Interviews
(Total N=24)

Directors (N=4)

Section Heads (N=6)

- Division A = N=2
- Division B = N=1
- Division C = N=2
- Section for Systems Studies = N=1

Inspectors (N=14)

- Division A = N=1
- Division B = N=2
- Division C = N=2
- Section for Programming and Resources = N=1
- Section for Effectiveness Evaluation = N=1
- Section for Statistical Analysis = N=1
- Section for Systems Studies = N=2
- DTR Section = N=1
- Other = N=3

In general, Safeguards staff responding to the interviews and survey questionnaire had extensive experience in working with the IAEA. On average, this group had 12.5 years of service. The majority of interview participants were nuclear engineers, nuclear physicists, or chemical engineers, with others experienced in software and computer engineering or data analysis. In addition, interview participants have inspections experience from a broad range

of States, such as countries participating in Euratom, and other countries in Europe (Finland and Sweden), Eastern Europe (Czechoslovakia and Poland), Eurasia (India and Pakistan), Asia (Japan, South Korea, and Taiwan), the Middle East (Libya, Israel, and Iraq), South America (Argentina and Brazil), Africa (Zaire, Egypt, and South Africa), and Australia.

The remainder of this chapter describes the findings from the interviews. This includes a description of the primary job duties and functions performed by IAEA inspectors, characteristics of effective inspectors, and recommended training to enhance safeguards inspections. In addition, interview participants provided their perspective on some of the difficulties in conducting enhanced inspections; these are also summarized in this chapter.

2.2 DESCRIPTION OF THE INSPECTOR JOB

During the interviews, participants were asked to describe the details involved in initiating an inspection, and scheduling and planning an inspection; procedures for conducting the inspection and for concluding the inspection; and guidance for reporting and summarizing results from the inspection. It is important to note, that for the most part, participants based their responses on experiences gained from routine inspections. In some instances, however, participants' experiences were limited to those obtained during non-routine inspections. Because these types of inspections provided valuable insight on measures under consideration for strengthening safeguards, this information is also included in the interview summaries.

Table 2.2 provides a detailed list of the job functions and job duties performed by inspectors under four major functional headings: Preparing for the Inspection, Conducting the Inspection, Attending the Debrief and Summarizing Findings, and Follow-up Activities. Each of these functions is discussed in turn below.

TABLE 2.2. List of the Job Functions and Duties Performed by Inspectors

PREPARING FOR THE INSPECTION

1. **Schedule the inspection.** The facility officer ensures ongoing knowledge of the facility and handles various administrative matters (the inspector assigned to an inspection may be the facility officer).

   a. Identifies and develops the inspection procedures which results in a list of actions and activities to meet in the inspection goals.

   b. Using the Safeguards approach, identifies which procedures and which approach is required for a particular inspection.

   c. Reviews the most recent quarterly inspection schedule, the IAEA list of facilities, and the State's semi-annual operational forecast for the period to be covered.

   d. Prepares the RS1 which defines the actions and activities required for an inspection.

   e. Determines the date and ending book inventory of the previous examination, taking into account any updating of the book inventory; determines if inspection activities are to carried out by 100% checking or by a sampling plan; if relevant, prepares a preliminary sample plan.

2. **Reviews facility documents and other materials to prepare for the inspection.** The inspector assigned to an inspection may read or review the following prior to an inspection.

   a. Reviews inspection procedures and plans the inspection around those procedures.

   b. Reviews the facility attachment and design information, and prepares a file for the facility before the inspection begins.

   c. Reviews shipping and receiving records of the facility.

   d. Reviews reports sent by the State.

   e. Determines if there are physical inventory changes at the facility based on a review of documents.

   d. Identifies follow-up activities from the previous inspection. Reviews the facility status report to familiarize self with what is going on at the facility.

TABLE 2.2 (continued)

PREPARING FOR THE INSPECTION (continued)

3. **Works with others to determine inspection activities and identify team member(s).**

   a. Works with the Section Head and Facility Officer to determine which activities will be performed during an inspection.

   b. Talks to inspectors who have conducted inspections at the facility to get first-hand information about the facility.

   c. Works with the Facility Officer and Section Head to determine who the team member(s) will be (if more than one inspector is involved in the inspection.)

   d. Determines if individual team members are experienced or familiar with the facility and/or have used the equipment in the past (e.g., non-destructive assay (NDA), portable multi channel analyzer).

   e. Works with the Facility Officer and Section Head to determine the assignments for the team member(s).

4. **Prepares inspection plan and activities.** This includes working with team member(s) if other inspectors are participating.

   a. Determines which types of materials will be verified at the plant.

   b. Makes sure that the activities fit and accounts can be audited, and defines the period of inspection.

   c. Inspector and/or other team members may take a refresher course to enhance skills on certain equipment for use in taking measurements; identifies the refresher courses needed.

   d. Identifies potential diversion strategies relevant for a particular type of facility or process used.

   e. Meets with team members to plan activities and strategies for the inspection.

5. **Performs administrative duties to prepare for the inspection.**

   a. Makes sure that the equipment has been shipped and arrives on time.

   b. Makes sure that equipment has been calibrated.

   c. Plans travel and obtain documents to support travel to the State.

   d. Obtains other equipment that may be needed for the inspection (e.g., calculator).

TABLE 2.2 (continued)

CONDUCTING THE INSPECTION

1. **Briefs the State Authority and Facility Operator.**

   a. Discusses pending activities with the State Authority and Facility Operator.

   b. Explains the need for the information gathered, the reason for gathering information, and how the information will be used.

   c. Gathers relevant information from the State Authority and Facility Operator that may impact the inspection.

2. **Finalizes inspection plan.**

   a. Consults the checklist to conduct the inspection.

   b. Computes and identifies sampling techniques and requirements.

   c. Finalizes team member assignments, and breaks them into smaller teams, if appropriate.

3. **Examines accounting and operational records.**

   a. Obtains the most recent closing date for which the book inventory has been established and recorded in the general ledger.

   b. If relevant, adjusts the sample plan.

   c. Obtains relevant supporting documents on inventory changes.

   d. Identifies those accounting entries which either require confirmation from operating records or which require further review of operating records.

   e. Checks data from supporting documents for arithmetical accuracy and consistency.

   f. Checks data from the supporting documents to ensure they are correctly transcribed into the accounting records.

   g. Checks that the totals in the accounting records are arithmetically correct.

   h. Records separately for each element in the book inventory totals and, in the case of a PIT, the physical inventory totals.

   i. Compares results from the updating of the book inventory performed during a previous inspection with the examined book inventory values for the same date.

   j. Records all data and information necessary for the preparation of the Inspection Report.

TABLE 2.2 (continued)

CONDUCTING THE INSPECTION (continued)

4. **Examines materials records and sample materials.**

   a. Reviews transfer documents, determines which types of materials have been shipped, to where, and how much.

   b. Obtains access to the materials, either through the Facility Operator or through other facility employee.

   c. Examines transfer documents, reconciles the information the Agency has in its database versus what the facility reports in its database.

   d. Updates the Agency records if the facility has more current information.

   e. Takes inventory of materials. Obtains a listing of materials from the Facility Operator.

   f. Verifies that the materials are present.

   g. Determines the appropriate measurements needed, sampling, and NDA.

   h. Makes a sampling plan, and selects the samples based on this plan.

   i. Asks facility personnel to pull the samples.

   j. If material discrepancies are identified, asks State Authority/Facility Operator or other facility employee to explain the reason for the discrepancy.

5. **Coordinates Team Member Activities and Findings** (with two or more inspectors on a team)

   a. Monitors team members' activities to ensure that they match the inspection plan.

   b. Throughout the inspection, discusses team members' findings and issues.

   c. Based on team input, determines if additional information must be gathered and determines procedures for gathering this information.

   d. Works with team members to analyze findings to determine if problems exist.

TABLE 2.2 (continued)

CONDUCTING THE INSPECTION (continued)

6. **Examines, inspects, and services containment and surveillance equipment.**

   a. Physically inspects containment and surveillance devices. Any change in containment is a sign of tampering.

   b. Checks surveillance devices to ensure the seal is not broken or has been tampered with.

   c. Services the surveillance equipment, such as changing the film in the camera, and verifying that the camera has not been tampered with.

   d. Checks the seals on the materials to make sure that they have not been tampered with.

   e. Place new seals on materials and equipment.

   f. If surveillance devices indicate a break or a gap, discusses the reasons for the gap with the State Authority/Facility Operator.

   g. If a gap or break occurs in the surveillance device, reviews records to determine what activities occurred at the facility during the gap.

   h. Inspects the containment, matches current conditions with the facility design documents.

7. **Conduct continuous design verification.**

   a. Walks around the facility, comments and takes notes on things that might represent changes in the facility design, or might represent unnecessary materials for that particular facility (e.g., chemicals not required for operations).

   b. Observes facility characteristics and conditions.

   c. Observes equipment and other materials in the facility to ensure that these correspond to declared facility activities.

   d. Records changes by taking notes and making diagrams of the physical layout.

   e. Observes demeanor of facility personnel.

   f. Discusses possible facility changes and current and future facility activities with State Authority/facility staff.

TABLE 2.2 (continued)

CONDUCTING THE INSPECTION (continued)

8. **Responds to potential discrepancies and anomalies.**

   a. For any discrepancy/anomaly, tries to find its source. This may include reviewing additional records or conducting a visual search of the facility.

   b. If a discrepancy/anomaly is detected, asks for an explanation from the State Authority/Facility Operator and, if possible, takes the necessary steps to verify his explanation and to resolve the discrepancy.

   c. Informs the State Authority, as applicable, of the discrepancy/anomaly and asks for adequate corrective action to be taken.

   d. Determines the significance of the discrepancy/anomaly from a safeguards point of view and if necessary, reports the matter immediately to HQ using, if required, the emergency procedure.

9. **Conducts special measurements and analyses.**

   a. Performs tasks related to chemical analysis.

   b. Obtains measurements, including neutron intensity, gamma ray energies.

10. **Performs Administrative Activities**

   a. Records information, takes notes, and documents information obtained during the inspection.

   b. Completes the log sheets.

   c. Compares the list with the declared materials provided by the Agency.

11. **Debriefs the Facility Operator.**

   a. Wraps-up the inspection by discussing the findings with the State Authority/Facility Operator.

   b. Describes issues that require follow-up to the State Authority/Facility Operator. Informs them that if such issues are not resolved, these will appear in the summary report.

   c. Discusses gaps or problems with State Authority/Facility Operator. Obtains information about construction plans or changes in the facility.

TABLE 2.2 (continued)

DEBRIEF AND SUMMARIZE FINDINGS

1. **Debriefs the Agency following an inspection.**
   - a. Attends a debriefing session immediately upon return to the Agency. Participants include the Section Head, Facility Officer, and other team members. A representative from the Procedures Department attends if there is a potential anomaly.
   - b. Reports any facility changes. Identifies type of change, location, and reason for the change (as provided by the State Authority/Facility Operator).
   - c. Identifies issues or problems that occurred during the inspection.
   - d. Presents possible anomalies and discrepancies and other relevant information obtained from the inspection (e.g., future facility activities). Works with the Facility Officer and Section Head to determine the best course for dealing with an anomaly.
2. **Writes inspection report.**
   - a. Summarizes inspection findings in prescribed format.
   - b. Includes notes, log sheets, and results from the debriefing.
   - c. Identifies follow-up recommendations determined during or following the debriefing.
3. **Submits report for typing, reviews report when it is completed. Submits the report to the Facility Officer.**
4. **Retains a facility inspection folder of working papers and notes.**

FOLLOW-UP ACTIVITIES

1. Obtains results from statistical analyses; includes these in the report.
2. Provides a summary to the Section Head; discusses any potential anomalies.
3. Discusses results from inspection with the next inspector(s) assigned to the facility.

2.2.1 Preparing for the Inspection

Many of the scheduling and pre-inspection planning activities are performed by the Facility Officer within a particular Operations Section who may participate in the inspection. For that reason, these pre-inspection activities are described as potential inspector activities. Duties performed by the Facility Officer include identifying procedures for conducting the

inspection, preparing an RS1 (brief assignment description prepared by the Facility Officer before each inspection), and retrieving past inventory data for the facility.

Inspectors planning an inspection are responsible for reviewing several relevant documents. These include the inspection procedures, the facility attachment and design information, shipping and receiving records, previous inspection reports and findings, and reports submitted by the State. From these reviews, the inspector should identify past follow-up actions that should be part of the current inspection, information that may help in planning the inspection, as well as other information that may be useful for understanding current facility operations status.

The inspector or lead inspector (leads a team of inspectors) works with others to plan the inspection and to learn more about the facility. For example, the inspector works with the Section Head and Facility Officer to plan specific inspection activities, and if appropriate, to identify other team members and determine their assignments. The lead inspector also works with the Section Head to determine if team members require refresher training. He/she also talks to other inspectors who have conducted previous inspections at the facility.

After obtaining guidance from the Facility Officer and Section Head, the inspector (or lead inspector) begins developing the inspection plan, working with assigned team members when more than one inspector is assigned to the inspection. The lead inspector determines which types of materials are to be verified, and confirms that the inspection activities can be performed in the allotted inspection period. Also, the inspector may work alone or with team members to identify potential diversion strategies.

Finally, the lead inspector performs administrative duties related to the inspection. These include verifying that the necessary equipment has been shipped to the facility, obtaining the appropriate documentation for travel, and obtaining portable equipment that the inspectors will bring for the inspection (e.g., calculator, measurement devices, office supplies).

2.2.2 Conducting the Inspection

This job function contains 11 duties performed by the inspector while conducting the inspection including traditional nuclear material accountancy, sampling, and measurement activities. In particular, the traditional job duties include: (1) examining accounting and operational records; (2) examining materials records and samples materials; (3) examining, inspecting, and servicing containment and surveillance equipment; (4) conducting special measurements and analyses; and (5) performing administrative activities. The remaining job duties performed while conducting an inspection are discussed in detail below.

At the outset of the inspection, the lead inspector briefs the State Authority and Facility Operator. According to one inspector, this briefing is a very critical component that can set the pace for the entire inspection. For example, one inspector reported that if the inspector clearly defines the inspection activities, explains the rationale for collecting the information, and the estimated length of the inspection, the inspection will proceed more smoothly. This opening briefing can also be used to obtain information about facility operations that may influence the inspection plan and activities.

Following the State Authority/Facility Operator briefing, the lead inspector finalizes the inspection plan. This involves identifying and computing sampling techniques and requirements, and finalizing team assignments.

During inspections involving more than one inspector throughout the entire inspection, the lead inspector coordinates team member activities and findings. Included in these efforts are monitoring activities of team members to ensure that all inspection activities are performed as planned. The lead inspector also confers with team members throughout the inspection to identify any issues that have arisen. Team members report information that may help to clarify facility activities and operations. The team leader also works with team members to analyze the information collected from various sources (e.g., records reviews, discussions with facility personnel). Results from these ongoing and perhaps daily analyses

are used to determine if additional information is needed or if the inspection plan should be modified.

Inspectors participating in the interviews reported that all inspections include of continuous design verification. This includes walking around the facility to examine the current operations conditions and structural features and identifying equipment or materials that may be uncharacteristic of declared facilities or activities. Inspectors are expected to take notes to identify these potential changes and anomalies and, in the case of the structural features, to diagram the changes in the facility. Also, to clarify or understand the changes in the facility, the inspector asks the State Authority/Facility Operator and/or other facility staff to explain the changes. The inspector may also ask facility personnel to identify future changes in facility operations activities. Although some interview participants reported that this activity, in theory, should occur during each inspection, most participants reported that in practice it does not occur each time.

As the inspector(s) proceeds through the inspection plan, he/she may identify potential anomalies and discrepancies. As with potential design changes, the inspector attempts to determine the reason for such anomalies or discrepancies (e.g., materials measurements are significantly different from an expected value, or records show unexpected materials or equipment shipments). This may include discussing the matter with the State Authority/Facility Operator and other facility staff, reviewing facility records, conducting a visual observation of the physical structure and equipment and other materials in the facility. The objective for the inspector is to identify a reasonable explanation for the anomaly or discrepancy and to resolve the matter before the closing the inspection. If the matter cannot be resolved, the inspector may contact the Agency or submit this information as a follow-up item in the debriefing session at the Agency.

Before closing the inspection, the lead inspector conducts a debriefing with the State Authority/Facility Operator. This final activity is designed to ensure that the State Authority/Facility Operator are fully informed of any important findings or conclusions. For

example, if follow-up activities are warranted, the inspector explains the information that prompted the follow-up action and procedures for resolving the issue before the next inspection is conducted. This also provides the inspector with the opportunity to obtain additional information about ongoing or future facility activities that may be relevant to the inspection.

2.2.3 Debrief and Summarize Findings

Upon return to the Agency, the inspector or inspection team debriefs the Facility Officer and the Section Head on the findings from the inspection. At the debriefing, the inspector describes the inspection activities and identifies any potential anomalies or discrepancies that were identified during the inspection. Also at this time, the inspector describes actions taken to resolve anomalies or discrepancies and results of those actions. Any additional information about current or future facility operations activities are also reported during the debriefing. If follow-up actions are warranted, the inspector works with the Facility Officer and Section Head to identify what those actions are. The inspector generally is <u>not</u> directly involved in addressing an anomaly or discrepancy that requires more serious actions. Instead, this is the responsibility of the Section Head and the Operations Division. Therefore, the inspector simply reports the findings and potential discrepancies or anomalies.

After attending the debriefing, the inspector prepares the written report documenting the inspection. This report includes a computerized report that summarizes findings from records and materials analyses. Also included in the report is information about the facility and facility activities that does not fit into the computerized report, such as the need for follow-up actions and the specific modifications or changes that should be evaluated at the next inspection. This completed report is then submitted to the Section Head for review and comment. The inspector will make any recommended changes or modifications before the report is sent up for review. Finally, the inspector is expected to retain all notes and working

papers obtained during the inspection. This information should remain on file for future inspections.

2.2.4 Follow-Up Activities

Inspectors wrap up the inspection by obtaining results from statistical analyses of data collected during the inspection. Inspectors reported that on some occasions the data analyses were completed well after the debriefing session and after the inspector completed the written report. Therefore, the inspector may be required to add the data analyses results a month or two after completing the inspection. This may require the inspector to discuss additional findings from these analyses with the Section Head. Also, the inspector should expect to discuss results from the inspection with the next inspector assigned to inspect that facility.

2.2.5 Conclusions from Inspector Job Description

Interview participants reported that a large portion of the inspector's time is spent planning and conducting analysis of facility records and facility materials. In addition to these duties, however, inspectors participating in the interviews reported that other job duties and tasks also play a role in the success of inspectors. For example, interview participants emphasized the importance of preparing for the inspection, including reviewing relevant documents and talking to others familiar with the facility and the State. Some participants concluded that effective pre-inspection planning is a critical factor in the overall success of the inspection. Also, interview participants noted the importance of explaining the purpose and activities involved in the inspection in a clear and concise manner to the State Authority/Facility Operator. Participants concluded that the relationship an inspector establishes with the State representation and the Facility Operator, whether a long-term relationship or relatively new, can be very important in conducting a successful inspection. It is also important for the inspector to establish contact and discuss facility activities with other facility personnel. Facility staff can be particularly helpful in resolving potential discrepancies

or anomalies. It is the effective inspector that promptly resolves any discrepancies discovered during the inspection.

Interview participants also stressed the importance of making visual observations of the facility during each inspection. These participants cautioned that often the inspector has too little time to complete all record reviews and materials sampling, while at the same time conducting a "walk-through" of the facility. Even more, participants reported that the State Authority/Facility Operator may be less than cooperative if the inspector requests access to facility areas included in the State's declaration, but which are not normally part of the facility inspection. Hence, participants noted again that it is useful for inspectors to develop a working relationship with the State Authority/Facility Operator to avoid confrontations.

2.3 CHARACTERISTICS OF EFFECTIVE INSPECTORS

After defining the inspectors' job and the tasks and activities that an inspector must perform to complete a successful inspection, interview participants were asked to define the abilities, characteristics, and skills that effective inspectors should possess. This information was collected in two ways. First, interview participants were asked, in open-ended questions, to describe the effective inspector based on their own personal experiences. Second, the survey questionnaire asked inspectors to identify the important skills and abilities required of effective inspectors. Results obtained from both the interviews and questionnaires are presented below.

2.3.1 Results from Open-Ended Interview

In the interviews, Safeguards personnel reported a variety of characteristics that define the effective inspector. The general themes gleaned from all interviews are summarized below. These are in no particular order, and represent the recommendations summarized across all interview participants (N=24).

Technical Competence. Interview participants emphasized the need for the inspector to be technically knowledgeable about the facility and processes that he/she is inspecting. With this expertise, the inspector should be able to scan the physical layout and the equipment and components in a facility and immediately know their purpose and the way in which each is used. Further, technical competence is also defined as a thorough understanding of the Safeguards Criteria and therefore, knowing the reasons for record reviews, auditing, and materials sampling. Technical competence feeds into other skills. As one interview participant described it, "the inspector should always be right."

Interpersonal Effectiveness. Interpersonal skills are applicable in two ways. First, the inspector should develop effective working relationships with the State Authority and Facility Operator and other facility personnel. Such relationships are necessary when attempting to clarify unexpected findings (e.g., records, materials, or physical facility conditions). Interpersonal skills are also useful in guiding and directing team inspections. Interview participants provided numerous examples of effective team inspections. These teams were often successful because the team leader effectively communicated job assignments, and created an open environment for discussing issues that arose during the inspection. Thus, the inspector and team leader must be effective communicators who can express requests clearly and in a positive manner both within the Agency and with facility personnel.

Inquisitive and Analytical Approach. Many interview participants reported that the effective inspector is inquisitive. That is, the effective inspector is one who recognizes when "the pieces do not fit" and identifies questions about records, operations, and processes and continues to explore reasons for unusual findings until he/she is satisfied with the explanations. In addition to being inquisitive, the effective inspector is also analytical. This means that the inspector identifies an unusual event or information and seeks to find an explanation for it. With each explanation for the unusual event, the inspector critically analyzes it to determine if it is a reasonable or plausible explanation. If not, the inspector continues to explore other alternatives and to obtain more information.

Diplomacy. Effective inspectors were also described as being experienced negotiators and diplomatic in handling difficult situations. These skills are similar to Interpersonal and Communications Skills, but are targeted more toward interactions with State representatives and facility operators. Many interviewees described situations in which a potential conflict arose between the State Authority/Facility Operator and the inspector. The effective inspector was able to resolve such difficulties by recognizing how to approach the Facility Operator. For example, in some instances a firm, unyielding request was effective; in other situations, the inspector spent a considerable amount of time explaining the situation, the Safeguards Criteria, and inspection activities required to resolve the difficulty and then negotiated mutually-agreed upon resolution with the State Authority/Facility Operator. Thus, the effective inspector recognizes that different situations require different approaches. The astute inspector recognizes and discerns the best approach for dealing with a potentially difficult situation.

Manages Time Effectively. Interview participants suggested that inspectors must plan and organize an inspection and attend to the plan throughout the inspection to ensure that all planned activities are performed as required. Pre-inspection planning often allows the inspector to perform additional activities during the inspection, such as investigating facility changes or unusual events. One interview participant reported that the most effective inspector returns from the inspection with much more information about the facility than the average inspector. This is due, in part, to a well-planned and well-organized inspection.

Perceptual and Spatial Abilities. Effective inspectors appear to have what some interview participants referred to as "built-in" abilities to observe the physical layout of the facility and compare it with the design verification information. This is especially difficult because inspectors, as a rule, do not take facility design diagrams to the inspection. Thus, this comparison task (current physical layout versus design documents) requires ability to perceive all components of the facility, spatially represent these in one's mind and then remember this information. This also includes the ability to recognize when other elements in the situation are "out of sync" (e.g., declared production levels do not match the level of activity at the

facility, the number and experience level of facility personnel does not correspond with the declared activities).

Computer Skills. Some interview participants defined technical skills as competency in operating computers and other tools and equipment during the conduct of an inspection. This includes operating computer software, such as word processing, spreadsheets, and electronic mail.

Ability to Lead. Several interview participants identified the ability to lead as important for success in conducting inspections. This ability can be defined in different ways. First, obvious leadership abilities relate to organizing and conducting a team inspection. In this arena, leadership abilities include making inspection task assignments, following up on team members' activities and findings, and working with team members to analyze and clarify findings. Interview participants also described leadership abilities in dealing with facility personnel. Defined in this manner, leadership may be viewed as willingness to take initiative, to forge ahead in an inspection, and push beyond the traditional inspection boundaries, yet remain within the Safeguards Criteria limits.

2.3.2 Results from Survey Questionnaire

In the survey questionnaire, current inspectors participating in the interviews were asked to identify the abilities and skills that define the effective inspector (N=10). Thus, unlike the open-ended interview questions, questionnaire respondents were asked to respond to a list of abilities and skills generated by the report authors based on previous input from safeguards staff. In addition, inspectors were also asked to identify factors that contribute to effective inspections. Summary data for the two questionnaire items are discussed below.

In the first survey questionnaire item, inspectors were asked to identify inspector skills and abilities that contribute to effective performance. The survey questionnaire item contained a list of 11 abilities and skills. Respondents were asked to identify the five most

important abilities and skills and rank order these from most important (1) to less important (5). Results from this item are presented in Table 2.3.

TABLE 2.3. Inspector Skills and Abilities Important to Perform Effectively

Mean Rank Order of Importance	Inspector Skill or Ability
1.8	Perceptual
2.2	Analytical (e.g., statistics)
2.7	Concentration
2.8	Perseverance: Following up on discrepancies
3.3	Computational
3.3	Doing several things at once
3.4	Mechanical (operating instruments)
3.5	Electronic (computer hardware and software)
3.6	Note-taking
3.7	Memory
4.0	Perseverance: List finishing

Inspectors were asked to rank order the items on the basis of which of the skills and abilities they perceived as important for an inspector to employ. Inspectors were asked to identify the five most important skills or abilities and rank order these from (1) most important to (5) moderately important.

According to the information in this table, inspectors identified Perceptual abilities (ability to perceive the physical structure and compare with the facility design) as the most important inspector ability. Other important abilities are Analytical, Concentration, Perseverance (following up on discrepancies), Computational, and doing several things at one time. Abilities and skills of moderate importance include Mechanical, Electronic, Note-taking, Memory, and Perseverance (completing lists).

Inspectors were also asked to identify the factors that contribute most to successful inspections. The survey questionnaire contained an item that included 11 factors.

Respondents were asked to rank order these factors from 1 (most important) to 11 (least important) in terms of contributing to successful inspections. Data for this item are provided in Table 2.4. In general terms, current inspectors indicated that successful inspections are primarily a function of an inspector's skills and experience (i.e., inspector's experience and technical skills, familiarity with the facility or facility type, ability to get additional information from facility personnel, and general relations with the site or facility). Inspectors also indicated that successful inspections are influenced by facility personnel (i.e., time allowed at the facility and flexibility accorded the inspector to move freely from place to place). Management at the IAEA can also contribute to successful inspections by providing backup and assistance during the inspection.

TABLE 2.4. Factors that Contribute to Effective Inspections

Mean Rank Order of Importance	Factor
1.0	Inspector's experience and technical skills
2.3	Inspector's familiarity with the facility or type of facility
4.7	Ability to get additional information from facility personnel
4.8	Agency's or inspector's general relations with the site or facility
4.8	Time allowed at the facility
6.4	Flexibility accorded the inspector to move freely from place to place within the facility
7.2	Ability/need to obtain direction/assistance/backup from IAEA management during the course of inspections
8.0	Ability to do things a second time, return to areas already visited
8.1	Discretion to "follow one's nose"
8.3	Access to a quiet space for reflection or analysis
9.1	Absence of Fatigue

Questionnaire respondents were asked to rank order the items from most important (1) most important to (11) least important. Information in the table represents rank order data average across all respondents (N=10).

The final group of factors that contribute to the success of inspections to a much smaller degree involve the time allotted to perform the inspection (i.e., ability to return to areas already visited to do things a second time, discretion to "follow one's nose," and access to quiet space for reflection or analysis). The low importance ratings of these factors indicate that inspectors generally deal with tight schedules and limited opportunities to repeat activities (e.g., measurements or observations). Thus, all inspection activities must be performed efficiently and correctly the first time.

2.3.3 Characteristics of Effective Inspectors: Conclusions

In general, Safeguards personnel were consistent in both the interviews and survey questionnaire in identifying the characteristics that define the effective inspector. From both sources, it is clear that technical competence is critical for success in any inspection. Also, critical, however, are interpersonal effectiveness, perceptual and visual observation abilities, probing and analytical skills, ability to concentrate, time management skills and ability to do several things at once, willingness to stick with a task until completed (perseverance), computational skills, leadership abilities, mechanical abilities in operating computers and other inspection equipment, memory, and taking clear and concise notes.

In addition, responses to the survey questionnaire demonstrated that even the most effective inspector may be limited by factors outside of his/her control. For example, successful inspections may be limited by (1) the relations that the Agency or the inspector has with the facility or State, (2) the time that the facility allows to perform the inspection, and (3) the flexibility accorded the inspector to move freely about the facility. These factors play an important role in the success of any particular inspection. To some degree, many of these factors can be defined for a particular inspection, so that the inspector can anticipate when issues or problems in these areas might arise and can plan for these in advance. Thus, these factors and the ability to plan inspectors based on these factors may also play a role in the success of a given inspection.

2.4 TRAINING ISSUES

Interview participants were asked to identify what type of training would be useful for enhancing safeguards inspections to develop the required skills and enhance required abilities. Below is a brief summary of verbatim recommendations for inspector training to meet enhanced safeguards inspections:

- Inspectors must be trained to ask questions about equipment and facilities.
- Enhanced training should include methods for analyzing information. The inspector must know what is normal in a State and facility to determine what is an indication of an abnormal event.
- Inspectors should be trained to identify and look for indicators of diversion. For example, if the facility operator reports that there is no nuclear material in a tank, the inspector should be able to devise a plan to verify that statement, especially if he/she cannot look inside of the tank.
- The Agency needs to develop experts in areas such as tank calibration and in each of the specific facility types.
- More training is needed to guide inspectors in possible diversion strategies. More diversion scenario training is needed.
- Inspectors need training on what to look for in facilities and how to look for it.
- If training in visual observation is provided, this should include training to enhance short-term memory.
- Language and cultural inhibitions may be a problem for some inspectors. Training should be designed to cover differences between people.
- Time management training may be useful for inspectors. Also, it may be useful to train all Safeguards staff on the process debriefing.

These and other training recommendations provided by interview participants were content-analyzed and summarized. Results from this analysis are presented in Table 2.5.

TABLE 2.5. Recommended Training Areas by Interview Participants (N=22)[a]

Total Number of Responses	Training Category
Visual Observation Skills (N=9)	
1	Attention to detail
2	Spotting anomalies
6	General observational skills training
Communication Skills (N=9)	
1	Interpersonal skills
1	General communication skills
1	Conflict management in the interview skills
1	Objectivity skills
5	Interviewing techniques
Management and Organizational Skills (N=9)	
1	Skills in diplomacy (political aspects of inspection deemed important for managers to understand)
1	Coordination of information sharing among inspectors
1	Planning
2	Management training in general
2	Concept of the "big picture"
2	Teamwork training
Specialized Training (N=6)	
1	Specific facilities training
2	Specific experience that can be learned from more experienced inspectors
3	Specialized training (e.g., tank calibration, design verification)

[a]Recommendations from an interview participant may appear in more than one category. Thus, the total number adds up to more than 22.

As indicated in the table, interview participants' recommendations for training fall into one of four areas. The numbers in parentheses indicate the frequency with which each area was mentioned in the interviews. For example, of the 22 interview participants who responded to this item, nine recommended training to enhance Visual Observation Skills. Within the Visual Observation Skills area, participants mentioned attention to detail, spotting anomalies, and general observational skills training.

Interview participants also recommended Communications Skills training. Based on participant input this includes developing interpersonal skills, general communications skills, enhancing interviewing and conflict management skills, and objectivity training.

A third recommended training area includes development of Managerial and Organizational Skills. Specific skills areas include general management training, skills in diplomacy, coordinating and sharing information, teamwork training, and planning skills.

A final training area focuses on specialized training for inspectors. Included here is training on specific facilities, learning about specific inspections experience from seasoned inspectors, and learning specific techniques, such as tank calibration and design verification.

In the survey questionnaire, inspectors were asked to review the list of General Observational Skills components and select those that would be good candidates for training (these include the ten Observational Skills components identified in the first report; see Morris and Toquam, 1993). Inspectors were asked to check all skill areas that they would recommend for inclusion in the training program. Results are presented in Table 2.6. Based on this information, the General Observational Skills components most frequently recommended for inclusion in training is Visual Observation of Physical surroundings. Next, training that emphasizes Report Writing and Gathering and Corroborating Evidence was recommended. Also, Inspection Planning, Analytical Techniques, Working Together as a Team, and Briefing and Debriefing were frequently mentioned as areas requiring training components. Fewer respondents recommended training in such areas as Leadership and Team-building, Interview Techniques, Computer Software Skills, Conducting Interviews, Brainstorming, and Interpreting Non-verbal Behaviors.

TABLE 2.6. Recommended General Observational Skills Training by Category (N=10)

Number of Inspectors Recommending This Category	General Observational Skills Training Category
10	Visual observation of physical surroundings
8	Report writing
8	Gathering and corroborating evidence
7	Inspection planning
7	Analytic techniques
7	Working together as a team
7	Briefing and debriefing
6	Leadership and team-building
6	Interview techniques (verbal and non-verbal)
6	Computer and software skills
6	Conducting interviews
5	Brainstorming
4	Interpreting non-verbal behaviors

Inspectors were asked to check all items that would be beneficial for IAEA inspectors in the current safeguards environment.

Using the interview and questionnaire data to identify the types of training needed to conduct enhanced safeguards inspections, it is clear that there was some consistency in Safeguards staff recommendations. Most agreed that General Observational Skills focusing on visual observation of the environment is an important component for training. Interview participants provided a number of examples related to visual inspection, such as inspecting the physical layout of the facility to determine if unreported changes have been made, reviewing operational records to determine if operations changes have occurred, or determining if personnel changes have occurred that may not correspond with the declared activities in a facility.

Most participants also agreed that communications skills were important for success in conducting inspections. Some participants pointed out, however, that it is inappropriate to view inspectors as "interviewing" facility personnel. Formal interviews are generally not conducted, although inspectors do have the opportunity to interact with facility personnel and are generally free to ask questions. Thus, the notion of interviewing may not apply directly, however, engaging in conversation and asking direct questions of facility personnel are important activities for inspectors to learn as much as possible about the facility and to explore reasons for discrepancies.

Participants' recommendations for training in team skills were mixed. This may be due, in part, to the frequency with which team inspections occur. Some participants had participated only in single-inspector inspections, and therefore, did not view team training as necessary. Other participants experienced in team inspections recommended including this type of training.

Several participants recommended offering specialized training involving facilities and inspection techniques. This type of technical training is beyond the scope of this effort. Instead, these recommendations for enhanced technical training will be covered in other follow-up research efforts.

Results from the interviews and survey questionnaires provided useful information for making recommendations for inspector observational skills training. This information is used in conjunction with data from other U.S. agencies providing similar types of training and from training specialists working on the project to recommend a comprehensive approach to General Observational Skills training that correspond to enhanced safeguards inspections. The types of training courses and modules and their content are discussed and described in detail in the next two chapters.

3.0 CORE OBSERVATIONAL SKILLS

3.1 INTRODUCTION

For verification planning purposes, the IAEA has routinely made use of two key concepts: the diversion hypothesis and the diversion strategy (IAEA, 1987). The former is a working hypothesis "in which it is assumed that non-compliance cannot be excluded a priori and that consequently there is a low but non-zero probability that a diversion could be attempted in all safeguards situations." A diversion strategy is a "general scheme which could be adopted by a State to divert nuclear material or misuse other items subject to IAEA safeguards." Among other things, diversion strategies postulated for safeguards planning purposes might include the unreported removal of nuclear material from a safeguarded facility, the unreported production or reprocessing of plutonium or enrichment of uranium, the use of diverted material in declared facilities, and the concealment of such activities.

Under Program 93+2, the IAEA is developing two complementary concepts: the expanded declaration and the diversion critical path (IAEA, 1994). The objective of the expanded declaration is to make a State's nuclear fuel cycle and associated activities as "transparent" as possible. Currently, a State's declaration is only required to include nuclear material subject to safeguards, associated processes (to the extent process information is needed to safeguard the nuclear material), and nuclear facilities and design information for facilities containing declared nuclear material. An expanded declaration might include all nuclear material and descriptions and locations of all nuclear-related processes, production, research and development, and training activities. The objective of the diversion critical path, which is being developed with expert assistance from Member States, is to define "all known pathways for the production of weapons usable material and subsequent weaponization." The critical path postulates a sequence of nodes that could result in weapons usable material. Each node consists of a process (e.g., uranium enrichment) that could be a step in the production of such material, a description of the process, and indicators of the process (e.g.,

special equipment, infrastructure and non-nuclear material requirements, and potential environmental signatures).

The diversion critical path and the expanded declaration would mutually support strengthened safeguards, particularly the detection of undeclared activities. For example, the diversion critical path provides both a template to ensure that all potentially weapons-relevant processes would be included in the expanded declaration and a structure for analyzing results from verification activities, including safeguards inspections. In particular, indications of weapons-relevant activities outside the expanded declaration would be a definite cause for concern.

As discussed in more detail below, broadening of inspector Observational Skills directly supports safeguards inspections predicated on application of the diversion hypothesis, the diversion strategy, the expanded declaration, and the diversion critical path by enabling inspectors to more effectively obtain and use information that may be indicative of nuclear materials diversion, undeclared activities or facilities, or attempts to conceal them.

One important consideration in recommending General Observational Skills training components concerns the training that is currently offered to entry-level inspectors or inspectors with some experience. That is, before recommending any new course modules, it was important to demonstrate that such training or similar training was not already being offered. For this reason, the current entry-level training for IAEA inspectors was reviewed to determine if there was any overlap between General Observational Skills training components. For the interested reader, the learning objectives for three entry-level or basic inspector courses are summarized in Appendix C. It is clear that some elements of the General Observational Skills training are touched upon in these courses, but not presented in depth.

Based on information from the interviews described in Chapter 2, reviews of current training and secondary literature, and detailed descriptions of the inspectors job duties and activities, we have regrouped and reordered these skills into three core areas: (1) Visual

Observation Skills, (2) Communications and Negotiation Skills, and (3) Organizing Skills. In brief, Visual Observation Skills address the inspector's ability to look for, recognize, remember, and draw inferences from information about physical structures, operating conditions, and human behaviors that could be indicative of anomalies, especially undeclared facilities or activities. Communications and Negotiation Skills address the inspector's ability to communicate constructively, both with other inspectors and with facility operators and State representatives. An important aspect of such skills is the ability of inspectors to operate effectively in different cultures. Organizing Skills address the inspector's ability to plan and manage successful inspections.

The sections below describe each of the three core areas in more detail, analyze the relevance and importance of each to safeguards inspections, and assess the need for training in each skill area.

3.2 VISUAL OBSERVATION SKILLS

3.2.1 Description

Visual Observation Skills are techniques that assist an individual in looking for, recognizing, remembering, and reaching judgments about physical surroundings and human behaviors. These skills include Recognition, Visual Attention, Mental Imaging, Memory, Mental Modeling, and Judgment.

Recognition/Perception. Most human beings have an impressive capacity to recognize objects and scenes at a moment's glance (Biederman, 1990). The theory of object recognition known as recognition-by-components (RBC) suggests that individuals achieve this capacity by representing an object as an arrangement of simple primitive 3-dimensional shapes known as "geons." From a repertoire of 24 possible geons, only two or three are required to uniquely specify an object. When individuals are able to "recover" such an arrangement from a visual image, they can quickly recognize an object, even when partially obscured, rotated, novel,

extensively degraded, or lacking in usual detail, color, or texture. Interestingly, observers can accurately recognize an integrated real-world scene almost as rapidly as individual objects. Possibly, this rapid recognition of scenes is achieved through the perception of "geon clusters," an arrangement of geons from different objects that produces a recognizable combination.

Visual Attention/Attention to Detail. Despite human capacities for rapid recognition of single objects and scenes, observers often have difficulty in identifying a given object among many entities at different spatial locations in the visual field (Biederman, 1990). Instead, individuals often tend to select one object at a time for attention. This selectivity occurs in part because only the central 2 degrees of the retina is capable of resolving fine detail. Therefore, to recognize multiple objects, the eyes must be moved in a series of jumps from one part of the visual field to another (saccadic movements). In addition, experimental evidence suggests that attention must be shifted from one position to another when recognition depends on attending to a combination of several attributes that are "mapped" separately in the brain, such as color and shape. Such limitations can impose a significant "bottleneck" on rapid recognition of multiple objects distributed across the visual field.

Memory. Memory consists of three main phases: encoding information, retrieving it from memory, and forgetting it (Potter, 1990). The first step in memory is encoding, putting the information to be remembered into an appropriate form for later use. Ordinarily, encoding reduces and transforms the information, so that the important material is retained and the trivial is eliminated. How information is encoded depends on context, the perceptions, sensations, or thoughts that are active at the time. One important aspect of context is point of view. In one experiment, for example, two groups of college students read a story about the activities of two boys at home. One group of readers were asked to assume the point of view of a burglar "casing" the house, the other the point of view of an interested home buyer. The perspective affected what the readers could later recall: the "burglars" were more likely to remember the coin collection and color TV, while the "home buyers" were more likely to remember that the basement had a musty smell. Another important principle

of encoding is temporal contiguity: perceptions, thoughts, and other information that is encoded at the same time are likely to become linked, so that when one of the items is later recalled, so are the others. The second step in memory is retrieving previously encoded information. Retrieval apparently occurs through a process of content addressing, which matches the current contents of experience to an "address" in memory where similar information is stored, and then retrieves associated information stored at that address. The final step in memory is forgetting. While forgetting information that is needed often constitutes a system failure, forgetting also serves the useful function of merging information about related matters to yield a more general and potentially more useful representation of experience. Forgetting appears to occur through a combination of disuse (use it or lose it) and interference (activation of related information that mixes with or substitutes for the forgotten information). Strategies for improving memory include "embedding the information in a meaningful context, thinking while encoding the situations in which the information will later be needed, and retrieving the information at frequent intervals." Memory skills can be learned, but many memory techniques appear to be more useful in memorizing verbatim information than in developing and retaining understanding.

Mental Imaging. Mental imaging is "seeing in the mind's eye" — perceiving objects or scenes based on remembered information rather than immediate sensory input (Kosslyn, 1990). One purpose of mental imaging is to enable the "observer" to recognize the properties of objects in the image, thereby facilitating the retrieval of information from memory. For example, in responding to a question, such as "How many toes does a cat have?" or "Which is larger, a ping pong ball or a plum?," most people report that they attempt to visualize the objects and then examine them in order to answer the question. This technique is most often used when the information to be retrieved is a subtle visual property, the property has not been previously determined and "labeled," and the property cannot be readily deduced from other remembered information. A second important purpose of mental imaging is to explore spatial "what if" questions by anticipating what will happen if objects are moved in particular ways, such as whether there is room on the office wall for a book case and a filing cabinet. In practice, there are a variety of types of mental imaging tasks, including image generation,

image retention, and image transformation. Experimental evidence suggests that mental imaging ability is not an all-or-nothing skill: people who are poor at one type of mental imaging task may be good at another.

Mental Modeling. People form mental models of technological and other systems with which they interact to predict and explain the interaction. While these models need not be completely accurate, and usually are inaccurate in some respects, they do need to be functional. Typically, individuals will update a mental model over time as they interact with the system to get an increasingly workable result — that is, one with predictive and explanatory power (Norman, 1983). Four concepts have been identified as basic to the mental modeling of "mechanistic devices," such as machines, electronic and hydraulic devices, and reactors:

> The most basic, device topology, is a representation of the structure of the device (i.e., its physical organization). For example, the steam plant consists of a steam generator, turbine, condenser, their connecting pipes, etc. The second, envisioning, is an inference process which, given the device's structure, determines its function. The third, causal model, describes the functioning of the device (i.e., a description of how the device's behavior results from its constituent components which is stated in terms of how the components causally interact). The last is the running of the causal model to produce a specific behavior for the device, by giving a chain of events each causally related to the previous one (de Kleer and Brown, 1983).

One can use mental models of known systems to assist in the identification of unknown systems by comparing the observed structures or behaviors of the unknown system to those of known systems and asking which systems are most consistent with the observed structures or behaviors.

Judgment. While judgment potentially encompasses a wide variety of cognitive, interpersonal, and ethical matters, one particularly important aspect concerns the ability to estimate the probability of uncertain events consistent with elementary probability theory (Osherson, 1990). Of particular importance is recognition of the "Bayesian intuition" that in

estimating the current probability of an uncertain event one should take into account the prior odds and not just the most recently acquired item of information. Experimental evidence suggests that individuals, including professionals as well as college students, tend to ignore prior odds and commit other fallacies, such as concluding that the probability of two independent events both occurring exceeds the probability of only one occurring. Training in statistics and probability theory has been shown experimentally to lead most people to adopt a more Bayesian conception of chance and thus to improve their judgments of probabilities.

3.2.2 Relevance to Safeguards Inspections

Visual Observation Skills are directly relevant to the inspector's job in that they assist the inspector in observing structural features and operating conditions of the facility to draw inferences about the possibility of the diversion of nuclear material, the existence of undeclared activities or facilities, or attempts to conceal such instances of non-compliance with safeguards agreements. Under current practice, these skills support the inspector's verification of design information. In applying the concepts being developed under Tasks 4 and 5 of Program 93+2, these skills would support the inspector's verification of the expanded declaration by assisting in the observation of indications of the possibility of weapons-relevant activities outside the expanded declaration.

At the basic level, Visual Observational Skills address how to look for structural features and operating conditions that may be inconsistent with the State's declaration. Guidance on what to look for (the indicators themselves) are expected to be addressed in advanced Observational Skills training, which is beyond the scope of this report. Providing basic training first is desirable because inspectors can begin to use what they learn immediately (based on their own technical knowledge and experience). In addition, basic training will lay the groundwork for subsequent advanced training; once inspectors know the "how" of observing they will be better able to focus on the "what" to observe. To make this distinction more concrete and to assist in the creation of examples for basic training, some

illustrative proliferation indicators are included in Appendix D. The relevance of each of the various General Observations to Safeguards inspections is as follows.

Recognition skills enable the inspector to better identify potentially important structural features or operating conditions, particularly those that may be novel or partially obscured.

Skills in Visual Attention and Perception assist the inspector in observing the full range of potentially important objects in the inspector's field of view, including peripheral or subtle objects and not just the most central or the most obvious. For example, the inspector may remember to look up at the ceiling and not just at what is visible at eye level, or the inspector may be better able to pick potentially important structural features and operating conditions out of the clutter of objects and scenes visible at any one time during the course of the inspection.

Memory skills are important in helping the inspector both remember information that may be useful in the course of an inspection, such as the expected or normal appearance of particular facility features and retain accurate recollections of observations made during the course of an inspection for later analysis. For example, the inspector may observe structural features or operating conditions that may not have seemed notable at the time of the inspection, but which may have relevance in light of other information made available at the debriefing or obtained at subsequent inspections.

Mental Imaging techniques can facilitate observation in a variety of ways. For example, they can assist the inspector in recovering from memory subtle visual properties of an object, such as whether a particular item of equipment should have the observed arrangement of valves. These skills also enable the inspector to consider such spatial "what if" questions as whether a given arrangement of walls could conceal a hidden room.

The ability to construct and use Mental Models can assist the inspector in determining what to look for in a facility that might be indicative of undeclared activities and in reasoning

from observations of structural features or operating conditions to the types of facilities or activities that are consistent with these observations. While a checklist of "proliferation indicators" may assist in this regard, and is planned for subsequent phases of this project, the ability to construct functional mental models of licit and illicit facilities and processes is likely to greatly enhance the inspector's ability to observe and interpret subtle or ambiguous information for indications of undeclared activities or facilities.

Judgment skills assist the inspector in reasoning from observed features, conditions, and behaviors to conclusions about the likelihood of weapons-relevant activities. Educated probabilistic intuitions help inspectors put the value of new information into perspective by relating it to prior information in a systematic way. These skills foster an appreciation that finding a "smoking gun" is less important than developing a defensible picture over time based on the pattern that emerges from repeated observations and other information sources.

3.2.3 Training Needs Assessment

The IAEA does not currently provide explicit training in these Visual Observation Skills. From the interviews described in Chapter 2, it is apparent that with few exceptions (notably in preparing for UNSCOM inspections in Iraq), such skills do not appear to be consciously cultivated on the job, although, for many inspectors, at least some of these types of skills appear to emerge through inspection experience. Because these skills are so fundamental to design information verification under current practice and verification of expanded declarations under the concepts being developed through Program 93+2, the need for such training is high, for both new and experienced inspectors.

3.3 COMMUNICATIONS AND NEGOTIATION SKILLS

3.3.1 Description

Communications and Negotiation Skills are techniques that assist an individual in communicating with others to convey or obtain information. These include General Communications, Interviewing, Detecting Deceptions, Negotiating Skills and skills needed to Operate in Different Cultures.

General Communications. Effective communication, which informs or persuades, takes the form of a dialogue in which both parties are actively involved (Hamlin, 1988). Achieving such involvement is assisted by advance planning that considers the substantive goals, interpersonal needs, and expectations of the listener, as well as oneself. A critical first step in most meetings or discussions is putting the other party at ease so that they want to communicate; it helps to be friendly and open, knowledgeable and confident, as well as organized. Rapport is also established by attempting to reach agreement at the outset on such basic matters as the agenda for the discussion, both parties' goals, and the time available. Once the discussion begins, it is important to listen actively to the other party and acknowledge what they say, speak to be understood (not to win debating points or brow beat the other party), and speak to a purpose (not to convey extraneous information or fill the time) (Fisher & Ury, 1981).

Interviewing. Success in obtaining information through questioning requires skills acquired through a combination of personal experience in interviewing and observation and emulation of more experienced interviewers (Wellman, 1936). As in communications, generally interviewers are more likely to elicit the desired information if they are able to put the subject at ease through a courteous and cordial demeanor. Intimidation rarely succeeds (although a degree of assertiveness may be necessary). The appropriate line of questioning to pursue depends on the context and, in particular, whether the subject appears to be wholly cooperative, biased or mistaken, evasive, or deceptive. While there are no absolute rules,

interviews involving the first three categories of subjects are generally best conducted by a step-by-step approach in which the subject is led gradually from more comfortable to more difficult topics and, if the subject is biased or mistaken, from implausible or internally inconsistent answers to the truth. If the subject appears to be concealing information (as indicated, for example, by the nonverbal cues noted by the discussion of Detecting Deception below), the interviewer may be able to obtain accurate answers by pointing to inconsistent information supplied by the subject or known to the interviewer from other sources.

Detecting Deception. Deception (lying) has been associated experimentally with nonverbal behaviors unintentionally "leaked" by would-be deceivers (National Research Council, 1991). Nonverbal behavioral "cues" that may reveal deception include various body movements, such as decreased use of "hand illustrators" (movements used for emphasis), increased use of "self-adapters" (movements directed toward one part of the body), and increased postural shifts, as well as tone of voice. (The critical cues are thought to depend at least in part on situation and culture, but there has been very little research on the impact of cultural similarities and differences on deception and its detection.) Interestingly, highly motivated deceivers are easier to detect than non-motivated deceivers. Untrained observers, whether amateurs or experts, are generally poor at detecting deception, although they also tend to have a high level of confidence in their (faulty) judgments. This low accuracy and high confidence may be attributable to the prevalence of incorrect folk wisdom about how deceivers are supposed to behave. However, training in the detection of deception can improve accuracy. While it is unclear which particular heuristics are most valuable, one approach that appears to improve accuracy considerably is "inference training," which provides an organized method for processing and evaluating information about several important cues of deception.

Negotiating. The possibility, and the need, for negotiation arises when the ability of one party to achieve his or her ends depends largely on the choices that another party makes (Schelling, 1960). A common approach to negotiation is positional bargaining in which each side stakes out a position, argues strenuously for it, and then makes concessions to reach a

compromise; an alternative approach that is gaining increasing acceptance with a wide range of negotiators is the strategy of principled negotiation (Fisher & Ury, 1981). This approach has four elements. The first is "separating the people from the problem" — working to build and preserve a constructive working relationship with the other party that does not allow substantive differences to escalate into personal differences. The second element is focusing on interests rather than positions. The third element is to invent options for mutual gain — solutions that accommodate both parties' interests. The final element is to insist on judging solutions based on objective criteria.

Operating In Different Cultures. National cultures differ in their dominant work-related values (Hofstede, 1984; Phillips, 1994). These differences tend to vary along four dimensions. The first is power distance, which concerns how accepting individuals are of unequal distributions of power. Where power distance is high, managers are afforded great deference; where power distance is low, employees have a voice in management decisions. The second dimension is uncertainty avoidance, the extent to which people will tolerate uncertainty and ambiguity. Where uncertainty avoidance is high, societies tend to create and follow rigid rules and are averse to taking risks. Where uncertainty avoidance is low, there is less tolerance for rules and greater willingness to take risks. The third dimension is individualism, which concerns the relative importance individuals place on their own well-being and that of their immediate families versus a wider group. Individualistic societies emphasize competition and individual self-fulfillment; more collective societies place greater value on consultation and collaboration. The fourth dimension is masculinity, which addresses the relative importance of work-related values such as power and success versus values such as nurturing and sharing. Appreciating such cultural differences facilitates operation in unfamiliar cultures.

3.3.2 Relevance to Safeguards Inspections

Successfully communicating with facility operator personnel to convey and obtain information is a crucial part of the inspector's job, both under current practice and in implementing measures being considered to strengthen safeguards. General Communications, Interviewing, and Negotiating Skills are thus directly relevant to safeguards inspections.

General Communications skills assist the inspector in establishing clear expectations and a constructive working relationship with facility operating personnel so that the inspection may be conducted efficiently and with a minimum of conflict. Both the content and the manner of the communications are important. In terms of content, the inspector needs to clearly convey to facility operators such information as the activities and procedures involved in the inspection, the need for access to facility records, areas, and personnel, follow-up questions from previous inspections or record reviews, and anticipated changes from previous inspection routines. The inspector also needs to listen carefully to the questions and concerns of facility personnel so that they can be addresses at the outset. In terms of manner, the inspector needs to establish rapport with facility personnel that creates the basis for a correct but cordial relationship.

Interviewing Skills. Under current practice, inspectors routinely engage in conversation with facility personnel in order to learn of any special circumstances that could affect the inspection, obtain explanations of potential anomalies and discrepancies that are identified during the course of the inspection as a result of examining records, sampling materials, or checking containment and surveillance measures, and clarify observed changes in facility design. The need for such conversations is likely to increase as inspectors seek to verify expanded declarations as the potential for observing changes expands commensurately. Inspectors who are skilled in interviewing are likely to be more successful in obtaining useful information from such discussions.

Skills in Detecting Deception are most useful in alerting the inspector to the possibility that facility personnel may be attempting to conceal something and, thereby suggesting that the facility warrants further attention that it might not otherwise receive, either during the course of the inspection or in future inspections. Indications of deception might also tend to corroborate indications of anomalies or undeclared facilities or activities obtained by more direct means.

Negotiating Skills come into play when the inspector seeks something that facility personnel have the power to delay or deny, such as granting access to a particular location or item of equipment within the facility or taking a sample. Such situations arise fairly often under current practice and may be expected to occur more frequently as measures to strengthen safeguards are implemented — in particular, as broader access is sought. Overcoming evasiveness or obstruction on the part of facility personnel in these instances calls for the inspector to exercise interpersonal skills that strike a balance between tact and diplomacy on the one hand and persistence and perseverance on the other; inspectors need to be assertive, but not combative. Inspectors may also find it useful to apply the strategy of "principled negotiation" described above.

Operating in Different Cultures. IAEA inspectors have operated successfully in different cultures since the inception of IAEA safeguards. However, dealing with cultural differences in the inspection context has always been challenging and could become more so as the number of States (including previous nuclear-weapon states) subject to safeguards inspections increases and inspections become more intrusive.

3.3.3 Training Needs Assessment

The IAEA does not currently provide explicit training in Communications and Negotiation Skills. The interviews described in Chapter 2 suggest that inspectors do recognize the importance of these skills. The attributes of an effective inspector are generally viewed as including ability as a diplomat, negotiator, and interviewer. As a result, Communications and

Negotiation skills are cultivated on the job and most inspectors appear to acquire some competence in this area as their careers proceed or else they leave the Agency. It is likely, however, that inspectors could be more effective at the outset and move more swiftly in enhancing their learning on the job if training in these skills is required.

3.4 ORGANIZING SKILLS

3.4.1 Description

Organizing Skills are techniques that enable managers to successfully plan, perform, and evaluate projects and the project team's ability to function effectively both individually and as a group. Organizing Skills include Planning, Working Effectively As a Team, and Analysis and Reporting.

Planning. Planning is a critical management function; it enables the manager or team leader to establish concrete objectives, organize, direct, and evaluate the project team's performance, and anticipate and address problems that could otherwise threaten the successful completion of the project (Badawy, 1982). One useful model for planning includes eight steps: (1) setting objectives, (2) defining the tasks to be performed, (3) assembling the project team, (4) identifying and obtaining other necessary resources (e.g., documents, instruments, equipment, materials, transportation), (5) specifying implementation procedures, (6) estimating costs and establishing a budget, (7) setting a schedule, and (8) developing mechanisms for evaluation and follow-up. In a team setting, involvement of the entire team in planning helps build team commitment to successfully executing the plan.

Working Effectively As a Team. A defining characteristic of an effective team is that the highest priority of its members is the accomplishment of team goals (Quick, 1992). When a team works effectively, the group functions as a unit, even though each member may perform a different and often highly specialized role. Effective teams generally do not just "happen." It is not enough to simply bring together people, even personally compatible

people, assign them responsibilities, and let them work together. Rather, team building requires a conscious effort on the part of the team leader and team members to define collective objectives, assign individual roles, and develop approaches for communicating internally, motivating individual team members, acknowledging and addressing conflict, and reaching collective decisions. In teams that include members of different nationalities, a particular motivational and communication challenge can be accommodating culturally-based differences in team members' goals and values (Phillips, 1994).

Analysis and Reporting. Analysis involves the application of logic, causal models, and the analyst's experience and judgment to the available evidence in order to reach conclusions that best explain the underlying facts (Lerner, 1959). While there is no "cookbook" for this process, careful analysts generally follow several precepts. They consider a range of alternative explanations for the evidence and where there is uncertainty about the true explanation for the observed data, they express the result in probabilistic terms. They look for patterns to emerge over time and in considering new evidence, consider the prior odds as well as the latest information. Finally, they are sensitive to the needs of the end-users of their analysis in reporting the results (Wohlstetter, 1962). Good reporting is organized, clear, and concise; it separately identifies observations, judgment, and opinion or speculation, but does not shrink from the latter if it may be helpful to end-users (Irving, 1988).

3.4.2 Relevance to Safeguards Inspections

Successful safeguards inspections depend to a large degree on good organization. Scheduling, staffing, and other resource constraints typically result in a situation of "so much to do, so little time." As a result, there is a premium on making the best use of the time, personnel, and other resources that are available, as Organizing Skills are intended to do. Adoption of measures to strengthen safeguards will tend to place even more demands on the inspection team, further the underscoring the need for Organizing Skills.

Planning. Under current practice, Facility Officers and inspection team leaders must assemble and review documents, such as facility design information and summaries of previous inspections to update their understanding of the status of the facility to be inspected and tailor the inspection plan accordingly. Measures to strengthen safeguards, such as use of broader sources of information on facilities and the State's nuclear program, as well as verification of expanded declarations, are likely to make inspections and inspection planning more complex. Hence, planning skills, already important, are only likely to become more so.

Working Effectively As a Team. While some inspections are conducted by individual inspectors, team inspections are increasingly the norm. A number of developments seem likely to increase the importance of effectively functioning inspection teams. These include the increasing size and complexity of facilities, the addition of new and specialized inspection tasks (such as environmental monitoring and the verification of expanded declarations), the increasing frequency of non-routine inspections, and perhaps the reduction in size of some inspection teams due to resource constraints and technological developments (such as remote monitoring). As in the case of planning, the ability of inspection teams to function effectively is important now and is likely to become more important in the future.

Analysis and Reporting. Under current practice, inspectors and inspection teams must synthesize and report on the various types of information obtained in the inspection. As inspections become more complex and include even more diverse and qualitative sources of information, the premium on analysis and independent judgment to obtain a coherent picture will increase. In turn, the need to convey the results of such analysis in a clear, concise, and persuasive manner will increase as well.

3.4.3 Training Needs Assessment

The IAEA does not currently provide explicit training on planning for inspections, working effectively as an inspection team, or analyzing and reporting inspection results. To some extent these are addressed incidentally in current training courses. These skills also appear to be developed on the job by most inspectors. Nonetheless, in light of the new challenges facing safeguards inspectors, consideration should be given to providing explicit training in these areas.

4.0 RECOMMENDED BASIC OBSERVATIONAL SKILLS TRAINING

4.1 INTRODUCTION

This chapter contains detailed descriptions of the recommended Basic Observational Skills modules for IAEA inspectors. The content of these courses is based upon the discussion of important elements for conveying knowledge and skills described in the previous chapter. Also, the courses are designed to provide trainees with the opportunity to practice using the skills and to obtain feedback on their performance.

For each module, recommended course content is based on well-established principles from research in psychology, sociology, and human factors. In addition, information obtained from discussions with other U.S. agencies that provide training to inspectors and investigators was used to assist in the development of course content and practical exercises. Table 4.1 provides a list of the U.S. agencies contacted during this development phase. Contacts with representatives from these agencies resulted in: (1) general information about the types of training provided to inspectors or investigators, (2) course outlines for specific courses or modules, or (3) actual training materials used by the students training for inspection or investigator jobs.

TABLE 4.1. U.S. Agencies Contacted During Phase II

- National Enforcement Training Institute, Lakewood, Colorado
- Foreign Diplomat Training Program, Arlington, Virginia
- On-Site Inspection Agency, Washington, D.C.
- Federal Bureau of Investigation, Washington, D.C.
- U.S. Customs Service, Washington, D.C.
- Arms Control Intelligence Staff, Washington, D.C.

Below are detailed descriptions of the three modules comprising Basic Observational Skills training. These are Visual Observation Skills, Communications and Negotiations Skills, and Organizing Skills. Each description includes a general one-page course description and a detailed curriculum containing specific topics and instructional methods, time required, and expected results for each module. It is expected that these three modules can easily be coordinated with the current ICAS course. In fact, it is essential to provide Basic Observational Skills training in close coordination with technical skills training so that inspectors can utilize and apply knowledge and skills acquired in one arena with knowledge and skills acquired in the other arena. Similar training in Observational Skills could also provide experienced inspectors with the same type of training provided in the modules recommended for the ICAS course. Because it is expected that Advanced Observational Skills training will concentrate on facility-specific technical knowledge and proliferation indicator technical knowledge, the specific content of these Advanced courses cannot be specified at this time. It is expected, however, that the Advanced courses will contain some of the same observational skills elements and these elements will be tied directly to facility specific or proliferation indicator knowledge.

4.2 VISUAL OBSERVATION SKILLS MODULE

Table 4.2 provides a general description of the Visual Observation Skills module. As indicated in the table, the course is designed for newly hired IAEA safeguards inspectors who have completed the ICAS course. In general terms, this course relies on lectures, group discussions, role playing, small group exercises, experiential learning, and anecdotal examples to convey knowledge and skills to inspectors.

Table 4.3 describes the module in greater detail. This description includes the specific topics presented, methods for presenting topics (lecture, discussion, group exercise), amount of time spent on a particular activity, and the expected results from the trainee's perspective. The Visual Observation Skills module includes the following topics:

TABLE 4.2. Description of Visual Observation Skills Module

Location/Sponsor:
Classroom

Duration:
16 hours

Intended Audience:
Primarily new inspectors who have had some on-the-job experience.

Major Course Objective:
To understand and apply skills in memory, visual attention, recognition/perception, mental imaging/mental models, visual observations of physical surroundings to IAEA inspections

General Description:
Use of lecture/discussions, role play, small group exercises, experiential learning, and anecdotal examples of experienced inspectors to convey the principles of memory, visual attention, recognition/perception, mental imaging/mental models, and visual observations of physical surroundings as these apply to IAEA inspections.

Specific Prerequisites:
Administrative: Completed ICAS training

Technical: Completed ICAS training

Criteria for Successful Completion:
1. Successful completion of all modules of this course.

2. Completion of all practical exercises given during the modules of this course.

TABLE 4.3. Visual Observation Skills Module

Topic Area	Instructional Method	Time	Expected Results
Perception/Recognition	**Lecture/Discussion** • Definition of perception and recognition Use of overheads as examples: • figure and ground • simplicity • similarity • proximity • continuity • closure	**60 minutes**	A clear understanding of how perception can enhance or detract from observational tasks
	Lecture/Discussion • Influence of past experience (including memory, beliefs or culture and motivational factors) on accurate perception • Beware: the tendency towards closure	**30 minutes**	
	Small Group Exercise • Recall test of similar items present or absent • Facilitators present scenarios in which objects and behaviors are ambiguous. The group interprets the objects and behaviors	**60 minutes**	
	Small Group Discussion with Facilitators • Implications of perception for IAEA inspections	**30 minutes**	

TABLE 4.3 (continued)

Topic/Subtopic Area	Instructional Method	Time	Expected Results
Visual Attention/ Attention to Detail	**Experiential Learning** • Participants are shown a video of various scenes. Accompanying sound is in discord with the scenes. Participants are tested on their ability to attend to and comprehend each stimuli **Lecture/Discussion** • People notice only gross physical characteristics of signals to which they are not attending and they fail to notice things that require interpretation **Experiential Learning** • Recalling objects in a room after short exposure **Lecture/Discussion** • The importance of attention to detail in IAEA inspections and circumstances that compromise attention to detail **Experiential Learning** • Participants are provided with guidelines for observing and attending to different stimuli (e.g., audio) during an inspection	**60 minutes** **30 minutes** **30 minutes** **30 minutes** **30 minutes**	Clear understanding of how people miss information when many demands are made on attention Understanding of what types of information are most important to attend to Practical experience in using guidelines for making observations

TABLE 4.3 (continued)

Topic Area	Instructional Method	Time	Expected Results
Memory	**Lecture/Discussion** • Types of memory and situations in which each predominates • The use of memory in IAEA inspections	**20 minutes**	A clear understanding of the limitations of memory and factors that decrease memory Techniques for enhancing memory, especially encoding and retrieval
	Experiential Learning • Video scenario and recall test	**2 minute video/8 minute test**	Practical experience in exercising memory enhancing techniques
	Lecture/Discussion • Memory enhancers: association, mnemonic devices, chunking, method of loci, pegword system, interactive images	**40 minutes**	
	Experiential Learning (test of memory enhancers) • Video scenario and recall test	**2 minute video/8 minute test**	
	Debriefing: Effectiveness of memory enhancers	**20 minutes**	

TABLE 4.3 (continued)

Topic Area	Instructional Method	Time	Expected Results
Mental Imaging/Mental Models	**Lecture/Discussion (with overhead examples)** • The importance of spatial perception in inspecting equipment and facilities • Object-centered cues: linear perspective, interposition, height in the plane, light and shadow, relative size, textural gradients, proximity-luminance covariance, aerial perspective, and relative motion gradient or parallax • Observer-centered cues: binocular disparity, convergence, accommodation • Anecdotal examples from experienced inspectors regarding instances in which spatial perception principles and abilities have helped during an inspection	**90 minutes**	Ability to use knowledge of spatial perception principles to examine a facility room and equipment to discern inconsistencies and false information Practical experience used to assess one's ability to perceive three-dimensional spatial relations in two-dimensional space Practical experience in evaluating facilities and equipment from photographs or video footage
	Experiential Learning • Space perception test using 20 pictorial items--measures ability to determine what a one-dimensional object would look like in three dimensions	**20 minutes**	
	Experiential Learning • Shepard-Metzler Mental Rotations (computerized test)--measures ability to mentally rotate three-dimensional objects	**20 minutes**	
	Experiential Learning • Flanagan Industrial Assembly test--measures ability to visualize the appearance of an object assembled from a number of separate parts	**20 minutes**	

TABLE 4.3 (continued)

Topic Area	Instructional Method	Time	Expected Results
Mental Imaging/Mental Models (continued)	**Lecture/Demonstration (with photographs or video footage)** • The importance of creating and updating workable mental models of facilities, equipment, and processes • Model elements: device topology. envisioning, causal modeling, running the model • Anecdotal examples from inspectors regarding instances in which having an accurate mental model has been important to an inspection **Experiential Learning** • Structural representation test--measures accuracy of understanding of a device's physical layout • Causal model test--measures understanding of how components causally interact	**60 minutes** **60 minutes**	Appreciation for importance of functional mental models Practical experience in creating and updating mental models of facilities, equipment, and processes
Visual Observation of Physical Surroundings	**Slide Presentation** • Demonstration of detecting minor changes in a physical setting **Small Group Discussion** • Examples from actual inspections based on experiences reported by experienced IAEA inspectors **Lecture/Discussion** • Review of memory, perception, and attention to detail	**20 minutes** **30 minutes** **30 minutes**	This section will integrate information presented in the previous three sections and provide inspectors with basic tools for observation Practical experience in integrating memory, perception, and attention to detail, mental modules, and mental imaging

TABLE 4.3 (continued)

Topic Area	Instructional Method	Time	Expected Results
	Pictorial Room/Facility Walk-through • Discussion of procedures for observing physical surroundings in terms of equipment and systems that may not appear necessary for declared activities • Discussion of procedures for observing physical surroundings in terms of equipment and systems required to perform declared activities **Debriefing/Questions**	**2 hours** **30 minutes**	

- Perception/Recognition: This includes a discussion of phenomenon related to perception and recognition that can influence or bias what is actually perceived.

- Memory: This topic concentrates on mechanisms for enhancing memory and providing a clear understanding of the limitations of memory.

- Visual Attention/Attention to Detail: Lectures focus on ways in which important information can be overlooked by excessive demands on attention created by a variety of stimuli (e.g., visual, auditory, olfactory). Exercises focus on procedures for filtering out unwanted information and focusing on the most important information.

- Mental Imaging/Mental Modeling: Lectures and group discussions focus on the ability to spatially represent three-dimensional objects in two-dimensional space and to create and retain mental models of facilities, equipment, and processes. Practical exercises give students an opportunity to assess their own mental imaging skills and to create mental models of equipment and facilities they will observe during actual inspections.

- Visual Observation of Physical Surroundings: Lectures and exercises provide students with the opportunity to integrate memory, perception, attention to detail, and mental imaging techniques.

4.3 COMMUNICATIONS AND NEGOTIATION SKILLS MODULE

The second recommended module for inclusion in the Basic Observational Skills course is Communications and Negotiation Skills. Table 4.4 provides a general overview of this course. In general terms, the purpose of this course is to help inspectors to develop skills related to communicating with others, including other Agency staff and facility staff, negotiating with facility staff to conduct inspections as planned and as required, and obtaining information from facility staff. The specific topics and exercises are described in Table 4.5 and include the following:

- General Communications: Lectures and exercises provide basic principles for establishing effective communications.

TABLE 4.4. Description of Communication and Negotiation Skills Module

Location/Sponsor:
Classroom

Duration:
22 hours

Intended Audience:
Primarily new inspectors who have had some on-the-job experience.

Major Course Objective:
To understand and apply skills in communicating with facility operators and other personnel throughout the inspection, skills in gathering information from facility personnel, and skills in working with team members.

General Description:
Use of lecture/discussions, role play, small group exercises, experiential learning, and anecdotal examples of experienced inspectors to convey communication and negotiation skills, as well as skills in gathering pertinent information from facility personnel as these apply to IAEA inspections.

Specific Prerequisites:
Administrative: Completed ICAS training

Technical: Completed ICAS training

Criteria for Successful Completion:
1. Successful completion of all modules of this course.

2. Completion of all practical tests and exercises given during the modules of this course.

TABLE 4.5. Communication and Negotiation Skills Module

Topic Area	Instructional Method	Time	Expected Results
General Communication Skills	**Lecture/Discussion** • Communication principles including methods for communicating clearly and making sure the message is conveyed accurately • Methods for communicating effectively	**45 minutes**	Understand principles and methods for communicating effectively
	Experiential Learning • Participants are provided with examples of effective and ineffective communication, working in small groups, participants plan and generate communications on prescribed topics	**45 minutes**	
	Lecture/Discussion: The importance of clarifying expectations • Provide clear, detailed explanations of the activities and procedures involved in the inspection • Describe any activities intended to follow-up findings from previous inspections • Describe any changes to the previous routine in conducting inspections	**45 minutes**	
	Experiential Learning • In groups of two, one participant provides an introductory inspection briefing; the second participant evaluates the communication	**30 minutes**	

TABLE 4.5 (continued)

Topic Area	Instructional Method	Time	Expected Results
Negotiation	**Lecture/Discussion**	**45 minutes**	Understand methods and practice skills in establishing a constructive environment for negotiations
	• Principles of negotiation. Includes methods for establishing a constructive negotiating environment		
	Lecture/Discussion	**30 minutes**	
	• Negotiating with uncooperative facility operators (anecdotal examples from experienced inspectors)		
	• Negotiation rules and techniques		
	Group Activity: Negotiation Role Play	**90 minutes**	
	• Setting the facility operator at ease		
	• Winning over the uncooperative facility operator		
	• Appropriate responses to facility operator claims that the inspection cannot occur for a variety of reasons		
	Debriefing/Questions	**30 minutes**	
	• Participants share experiences from actual inspections		

TABLE 4.5 (continued)

Topic Area	Instructional Method	Time	Expected Results
Communication Skills/Assertiveness	**Lecture/Discussion** • The importance of expressing any concerns and explaining follow-up action to be taken	**30 minutes**	Understanding how to wrap up an inspection in a positive manner and pave the way for any subsequent follow-up activities
	Group Activity: Assertiveness Exercise • Appropriate responses to facility operator objections to inspection concerns or proposed follow-up action	**60 minutes**	
	Small Group Discussion • Examples from actual inspections based on experiences reported by experienced IAEA inspectors	**45 minutes**	
	Debriefing/Questions	**30 minutes**	

TABLE 4.5 (continued)

Topic Area	Instructional Method	Time	Expected Results
Interviewing	**Lecture/Discussion** • Principles for conducting interviews and establishing relationships • Routine questions that can and should be asked during every inspection (based on anecdotal information from experienced inspectors)	**30 minutes**	Understanding of how to conduct an effective interview
Detecting Deception	**Lecture/Discussions** • Behavioral cues that suggest potential deceptions • Facilitators demonstrate non-verbal cues: change in expression on the face, change in body movement, change in inflection in voice, swallowing or deep or shallow breathing, long pauses between words, slip of the tongue, microfacial expression or a gestural slip **Lecture/Discussion** • Recognizing non-verbal cues that may conflict or contradict information personnel are providing. Are non-verbal cues an indicator of personal expression or of deception? • The danger of overconfidence in detecting deception **Experiential Learning** • Video tapes showing examples of behavioral cues that indicate deception **Role Play with Facilitators** • Participants role play with facilitators in detecting deceptions and then planning follow-up questions	**30 minutes** **30 minutes** **30 minutes** **45 minutes**	Understanding of non-verbal cues that may indicate deception Appreciation of the caution that must be used in applying these techniques

TABLE 4.5 (continued)

Topic Area	Instructional Method	Time	Expected Results
Gathering Information	**Lecture/Discussion** • Verifying that facility use and activities are unchanged from declaration documents • Using statements of individuals as evidence • Documenting statements of individuals as evidence	**10 minutes**	Ability to verify that the facility use and activities are unchanged from declaration documents. Ability to engage in casual conversation with personnel to gain information, recognize when conflicting information should be followed-up, and understand procedures for obtaining corroborating information.
	Role Play with Facilitators • Participants role play engaging facility personnel in casual conversation and recognizing/noting information that is pertinent to the inspection	**45 minutes**	Ability to recognize non-verbal cues that may conflict or contradict information personnel are providing
	Lecture/Discussion • Procedures for obtaining corroborating non-oral information	**20 minutes**	Ability to identify routine questions that can and should be asked during every inspection
	Small Group activity • Given a description of a case study inspection (based on anecdotal information from experienced inspectors) and a list of questions asked during the inspection, participants indicate whether questions are appropriate or not and identify any additional questions that should be asked	**45 minutes**	Practical experience in obtaining information
	Debriefing/Questions	**30 minutes**	

TABLE 4.5 (continued)

Topic Area	Instructional Method	Time	Expected Results
Accommodating Inspector Style Differences	**Lecture/Discussion** • How interpersonal interaction styles can affect teamwork and inspection dynamics **Individual Activity** • Each participant completes the Meyers-Briggs Type Indicator survey **Lecture/Discussion/Role Play** • Definition of each Meyers-Briggs style • Recognizing one's own interpersonal interaction style • Techniques for working effectively with different interaction styles	**30 minutes** **90 minutes** **2 hours**	Ability to recognize one's own style for interpersonal interaction Ability to understand how differences in interpersonal interaction styles can affect teamwork and inspection dynamics

TABLE 4.5 (continued)

Topic/Subtopic Area	Instructional Method	Time	Expected Results
Operating in Different Cultures	**Lecture/Discussion** • General cultural differences that may influence an inspection outcome (e.g., power distance, uncertainty avoidance, individualism, and masculinity) • Techniques for avoiding culture-based misunderstandings • Techniques for mending culture-based misunderstandings **Role Play** • Based on anecdotal examples from experienced inspectors, scenarios in which culture-based misunderstandings might occur during inspections are portrayed Participants evaluate the inspection situations and identify alternative means to overcome cultural differences before they lead to misunderstandings **Debriefing/Questions**	**90 minutes** **2 hours** **30 minutes**	Ability to recognize how cultural differences may influence the outcome of inspections Ability to understand how cultural differences may lead to misunderstandings and barriers to communication Ability to identify and use strategies that avoid culture-based misunderstandings Practical experience in using knowledge about cultural differences

- Negotiations: Lectures and exercises cover the communications skills needed to begin conducting an inspection and to initiate contact with the facility operator.

- Assertiveness: Lectures and practical role-playing exercises address situations in which the inspector must be assertive (e.g., recommending follow-up actions to the facility operator; gaining access to all areas in a declared facility). In general, lectures and exercises are designed to train students to identify the "best" approach for a given situation.

- Interviewing: Lectures and exercises provide knowledge about basic interview methods.

- Detecting Deception: Lectures and exercises provide participants with skill in detecting deceptions and using interview techniques to learn more about the potential deception.

- Gathering Information: Lectures and practical role-playing exercises demonstrate the skills for obtaining information from facility staff and recognizing conflicting information and methods for corroborating it.

- Inspector Style Differences: This topic focuses on each inspector's unique style in communicating with others (e.g., willingness to negotiate, comfort level in requesting additional information when needed). During this period, students will complete a personal style questionnaire and discuss their scores. These scores will be interpreted in the context of one's personal style of interacting with others and the different approaches that one may take in an interaction to achieve the same goals are described.

- Operating in Different Cultures: This section provides a discussion of the general ways in which persons from different culture can differ. This is based on numerous studies designed to assess cultural differences and their implications in the workplace.

4.4 ORGANIZING SKILLS MODULE

The Organizing Skills module focuses on planning and organizing materials and information for an inspection, coordinating and working together as a team, analyzing information, and summarizing subjective information for the inspection report. This course is designed as a 21-hour program for inspectors who are completing or who have completed the ICAS course. Table 4.6 presents the general description for this module. Table 4.7 presents

TABLE 4.6. Description of Organizing Skills Module

Location/Sponsor:
Classroom

Duration:
21 hours

Intended Audience:
Primarily new inspectors who have had some on-the-job experience.

Major Course Objective:
To understand and apply skills in planning and organizing materials, working as a team, analyzing information, and reporting the findings.

General Description:
Use of lecture/discussions, role play, small group exercises, experiential learning, and anecdotal examples of experienced inspectors to understand how to plan and organize materials, work as a team, analyze information, and report findings from the inspection.

Specific Prerequisites:
Administrative: Completed ICAS training

Technical: Completed ICAS training

Criteria for Successful Completion:
1. Successful completion of all modules of this course.

2. Completion of all practical tests and exercises given during the modules of this course.

TABLE 4.7. Organizing Skills Module

Topic Area	Instructional Method	Time	Expected Results
Planning Techniques	**Lecture/Discussion** • General principles and methods in planning, such as designing an implementation plan, considering all alternative or optional activities, what questions must be answered • Techniques for plan design and implementation	**40 minutes**	Ability to design a plan and to evaluate the plan

TABLE 4.7 (continued)

Topic Area	Instructional Method	Time	Expected Results
Planning for Inspections	**Lecture/Discussion** • Pre-planning for an inspection: Establish a clear objective of what accomplishments are expected from the inspection Know the applicable regulations, compliance history, and physical site layout to define the scope of the inspection Know the Standard Operating Procedures for the type of inspection activities to be conducted Determine the equipment and material needed to conduct the inspection and collect evidence Know the safety plan for protecting all members of the inspection team from potential hazards at the site • Types of information to be reviewed before an inspection **Small Group Exercise** • Reviewing facility design information: What to look for • Reviewing summaries of previous inspections: What to look for (Note: Participants will break in to small groups, be given design facility information and summaries of previous inspections, and will be asked to explain what information they would gleen from these documents and why. Facilitators will be available to answer questions.)	**40 minutes** **90 minutes**	Ability to plan and review materials in preparation for an inspection Practical experience in preparing an inspection plan based on available information

TABLE 4.7 (continued)

Topic Area	Instructional Method	Time	Expected Results
Planning for Inspections (continued)	**Experiential Learning** • Constructing an inspection plan (Note: Each participant will be given descriptions of documents available before a hypothetical inspection. These documents will be based on anecdotal information from experienced inspectors. Each participant will be asked to review the document descriptions, indicate any additional information that should be obtained, and write an inspection plan based on those documents. The inspection plan will contain, at a minimum, objectives/background history of the inspection, scope and assessment topics, inspection activities and field techniques, a sampling plan, a safety plan, and administrative requirements.) **Debriefing/Questions**	**90 minutes** **30 minutes**	

TABLE 4.7 (continued)

Topic Area	Instructional Method	Time	Expected Results
Working Effectively as a Team	**Lecture/Discussion** • Introduction: Working as a team • Choosing a team leader and team members • How personal styles affect team dynamics (based on Myers-Briggs data) • Leadership qualities • Defining team members' roles and responsibilities	**90 minutes**	Ability to assume either team leader or team member roles and work effectively with others to conduct an inspection Practical experience in identifying team activities and making team assignments
	Small Group Exercise • Building trust among team members	**30 minutes**	
	Role Play • Team leader interactions with team members (scenarios will be taken from anecdotal examples from experienced inspectors) • Team interactions in challenging inspection situations (scenarios will be taken from anecdotal examples from experienced inspectors)	**60 minutes**	
	Lecture/Discussion • Effective team meetings • Effective time management	**40 minutes**	

TABLE 4.7 (continued)

Topic Area	Instructional Method	Time	Expected Results
Working Effectively as a Team (continued)	**Small Group Exercise** • Team work in planning an inspection (Note: Participants work together in groups of 2 or 3 to review hypothetical inspection scenarios, plan an ensuing inspection, and determine the tasks to be assigned to each inspector on the team. Information for the inspection scenarios will be provided by experienced inspectors.) **Debriefing/Questions**	**60 minutes** **20 minutes**	

TABLE 4.7 (continued)

Topic Area	Instructional Method	Time	Expected Results
Analysis: Drawing Inferences	**Experiential Learning** • Series of problems in which course participants are given a fact situation and asked to assign probabilities or make predictions	**60 minutes**	Appreciation for the importance of probabilistic reasoning, particularly the value of new information and the use of prior odds in reaching conclusions
	Lecture/Discussion • Common biases and fallacies in use or non-use of prior odds and new data in assigning probabilities and reaching conclusions based on limited information • How probabilistic reasoning can improve decision making under uncertainty • Overview of elementary probability theory	**2 hours**	Practical experience in probabilistic reasoning in the inspection context — i.e., using the expected value of new information to allocate attention during an inspection, using prior odds to draw inferences from inspection results
	Experiential Learning • Group problem-solving exercise in which participants are given hypothetical inspection scenarios and are asked to make decisions about where to focus inspection activity and what conclusions to draw from inspection results	**2 hours**	

TABLE 4.7 (continued)

Topic Area	Instructional Method	Time	Expected Results
Analysis and Reporting	**Lecture/Discussion** • The need to track all collected information (important or trivial) • Pre-planing for analysis: Categorizing information and ensuring all information is complete and intact • When to analyze information during the inspection • When to analyze information after the inspection	**60 minutes**	Ability to recognize the need to track all information collected during an inspection Ability to analyze all collected information both during and after an inspection Ability to determine if information warrants follow-up or further information gathering
	Small Group Exercise • Participants analyze written descriptions of a facility and information collected from the facility to determine if any information is missing or questionable. Examples for the facility description and collected information descriptions will be taken from anecdotes of experienced inspectors	**60 minutes**	Practical experience working alone and as a team to analyze information and draw meaningful conclusions Ability to choose and summarize information obtained from the inspection that does not fit into the technical portion of the report
	Lecture/Discussion • Judgment skills in analyzing the need for inspection of follow-up actions	**30 minutes**	Practical experience in summarizing subjective data in meaningful manner
	Small Group Exercise • Participants work as a team of 2 or 3 to analyze and discuss information obtained from a hypothetical inspection (based on examples taken from anecdotes of experienced inspectors) • Participants use judgment skills to determine if information warrants follow-up or further information gathering	**60 minutes**	

TABLE 4.7 (continued)

Topic Area	Instructional Method	Time	Expected Results
Analysis and Reporting (continued)	**Lecture/Discussion** • Elements of the subjective comment and summary section of IAEA reports • Recognizing what information should be included in the subjective section	**30 minutes**	Ability to choose and summarize information obtained from the inspection that does not fit into the technical portion of the report Practical experience in summarizing subjective data in meaningful manner
	Debriefing/Questions	**20 minutes**	
	Experiential Learning • Participants are given written examples of subjective comments obtained during a hypothetical inspection (based on examples from anecdotes of experienced inspectors). Participants must choose and justify reporting subjective comments for the inspection	**40 minutes**	
	Lecture/Discussion • Summarizing subjective comments and effective reporting techniques	**30 minutes**	
	Experiential Learning • Participants practice summarizing written narratives of hypothetical subjective comments (based on anecdotes from experienced inspectors)	**40 minutes**	

the details of the content and activities included in this module. This module includes the following topic areas:

- Planning and Organizing Materials: Lectures and discussion sessions are designed to provide students with a clear picture of the inspection activities and requirements, variety of sources available to learn about the facility to be inspected, and an overview of the procedures to follow to ensure the safety of all team members. Experiential learning exercises are designed to provide students with the opportunity to plan inspections based on the available information.

- Working Together as a Team: This topic area covers issues related to conducting inspections as a member of a team or as the team leader. The objectives are to learn the procedures involved in identifying team members and team members' assignments, demonstrating leadership qualities as the team leader, and ensuring effective team interactions before, during, and following the inspection. Practical exercises are designed to give students the opportunity to plan and work together as a team and to handle difficult situations.

- Analyzing Information: This topic focuses on the need for attention to detail in tracking and maintaining notes or files on information collected during the inspection. Also, included are guidelines for drawing inferences and analyzing subjective information and working with a team to analyze information collected during the inspection. In addition, lectures and practical exercises are used to provide skills in determining what information is meaningful and what is less important.

- Reporting: Lectures and practical exercises are used to give students the skills to report findings from an inspection to ensure that the report contains all relevant, non-quantitative information obtained during the inspection. The emphasis is on presenting information in such a manner so that the reader or listener can discern which information is conjecture and which is associated with firm evidence.

4.5 ENHANCED COMPREHENSIVE INSPECTION EXERCISE

This final Basic Observational Skills module represents a means to integrate skills acquired from both the technical (ICAS program) and Basic Observational Skills training course. Table 4.8 presents a summary of the course objectives for this exercise. In general, this exercise is designed for inspectors who have completed both the technical components of the ICAS course and the newly developed Basic Observational Skills modules. The

TABLE 4.8. Description of Enhanced Comprehensive Inspection Exercise

Location/Sponsor:
Volunteer Facility--preferably a nuclear research reactor

Duration/Date:
Two-day in-field training: 2 hours for overview of observational and technical skills and technical skills and exercise activities; 2 hours for inspection planning; 1 1/2 days for inventory check on inspection of the facility. Evening may be used to modify inspection plan and integrate early findings.

Intended Audience:
Primarily new inspectors who have had some on-the-job experience.

Major Course Objective:
To apply observational with technical skills in a mock inspection

General Description:
--Inventory of records

--Exercise in working with inspection team and facility personnel

Specific Prerequisites:
Administrative: Completed ICAS training and Basic Observational Skills training

Technical: Completed ICAS training

Criteria for Successful Completion:
Inspector/team must complete and pass two to four critical observation exercises, including recognizing potential anomalies embedded with the facility structure or based on information available from facility staff. Failure results in repeating the exercise(s).

objective is to provide students with a realistic mock inspection exercise. This is similar to the mock inspections designed by the On-Site Inspection Agency for international inspectors (Boyette, personal communication, August 1994). During the enhanced inspection exercise, students will work together as a team to plan the inspection, determine team member assignments, interact with the Facility Operator and other facility staff, and inspect the facility to determine if any potential anomalies exist. During this exercise trainers will serve as the Facility Operator and staff and pose various difficulties for the student inspection team, such as refuse access to rooms or to records. If possible, structural characteristics of the facility will be modified and serve as potential indicators of anomalies or discrepancies. The task for the students is to form an inspection plan, overcome obstacles presented by the Facility Operator, learn as much as possible from facility staff and recognize potential structural anomalies. To make sure that students fully integrate the Observational and technical skills, trainers will observe the inspection and provide feedback to students at key points during the inspection.

4.6 ISSUES FOR CONSIDERATION IN COURSE DELIVERY

Each training module depends upon several practical exercises to impart knowledge and skills to the students. In particular, each module contains one or more practical exercises or discussion sections in which information from actual inspections is used to make a point. In this way, students will obtain first-hand knowledge about what to expect when conducting inspections and can develop a repertoire of knowledge and skills for dealing with unexpected events that may arise during inspections. As an example of inspection experiences that should be included in these courses, Appendix D contains a list of proliferation indicators that inspectors can be trained to look for, as well as other events or behaviors that may trigger awareness of these indicators. Therefore, it is important to note that in the development of these modules and the practical exercises, it will be essential to obtain practical information from experienced inspectors. Actual examples or lessons learned will serve to enhance skill development in all course modules.

A second consideration involves the methods or media to impart knowledge and develop skills. The three Basic Observational Skills modules described above primarily rely on traditional formal classroom methods for imparting knowledge and skills. For the Visual Observation Skills module, traditional classroom techniques are expected to be less effective than using computer-based training applications. In this module, students will be asked to visualize current equipment and facilities that they will eventually inspect. Further, the training topics are designed to enhance students' skills in detecting anomalies or discrepancies based on their knowledge of equipment and facilities. Computer-based training would provide students with more realistic practical exercises in inspecting facilities. Therefore, for this module, we recommend designing computer-based practical exercises. The other two modules involve interaction with others and practical exercises include working with others to resolve problems, plan inspections, analyze information, and so on. To develop and enhance these skills it is important for students to practice interacting with others. It does not appear that computer-based training, at this point in its development could be used to develop or enhance these skills. In fact, a representative from the Federal Bureau of Investigation (FBI) reported that the agency did not even consider developing computer-based training for developing skills related to interviewing and communicating with others (Geidi, personal communication, August 1994).

5.0 SUMMARY AND RECOMMENDATIONS

This report documents the activities, findings, conclusions, and recommendations from Phase 2 of the project designed to assist the IAEA in enhancing the effectiveness of its international safeguards inspections through inspector training in Observational Skills. The objective of Phase 2 was to identify current inspector job requirements, identify the types of observational skills that would help inspectors to enhance safeguards inspections, and then recommend training modules that meet these objectives.

This report builds on Phase 1 of the project, in which research was conducted to identify the skills that may be classified as observational skills. To this end, we surveyed training materials from both government and private agencies designed to provide participants with the skills and knowledge needed to perform as investigators or inspectors. Results from this survey revealed that observational skills may be broadly defined as encompassing cognitive, communications, and interpersonal skills; in all 12 specific observational skills were identified. This information was used to guide the activities performed in Phase 2.

The primary objective of Phase 2 was to identify a set of Observational Skills required by IAEA inspectors to perform effectively and to provide the basis for the design and delivery of training to IAEA inspectors. Thus, one critical activity involved in this phase was to learn about the inspector job as it currently is performed, and how it is likely to be performed in the future under enhanced safeguards guidelines. To this end, the authors worked with IAEA Safeguards Training staff to schedule and conduct interviews with staff from the Safeguards Department. A total of 24 inspectors, Section Heads, and Directors participated in these interviews. During these interviews, participants were asked to describe the specific details of conducting an inspection, and to describe the skills needed to conduct enhanced safeguards inspections.

Interview information served as the basis for recommending the modules to be included in a Basic Observational training course. In addition, we relied upon input from

IAEA Safeguards training staff and our knowledge of research findings in psychology, sociology, and human factors. This information was used to identify the skills needed to conducted enhanced safeguards inspections. A review of the current basic training course for IAEA inspectors (i.e., ICAS), was reviewed to determine if any basic observational skills were represented in that program. Using this information, we identified three Basic Observational Skills that would complement inspectors current technical skills and result in conducting enhanced safeguards inspections. The three Basic Observational Skills include:

- Visual Observational Skills
- Communications and Negotiations Skills
- Organizing Skills

The rationale for developing training modules in each of these areas is provided below.

During the interviews, inspectors and other Safeguards staff reported that inspectors can learn much about a facility by simply observing the physical environment. Thus, at the basic level, Visual Observation Skills address how to look for structural features and operating conditions that may be inconsistent with the State's declaration. This skills area includes recognition skills, visual attention and perception, memory skills, mental imaging, mental models, and judgment.

Communications and Negotiations skills were viewed as necessary skills in conducting inspections. Interview participants reported that it is important for the inspector to communicate clearly and accurately to team members and to facility personnel. In addition, inspectors should also be sufficiently skilled to recognize situations that require negotiations skills (diplomacy) or situations that require one to be more assertive. Thus, this training module was designed to provide inspectors with the skills needed to communicate clearly, recognize one's own communications strengths, and recognize when negotiations skills are warranted over more assertive behaviors. This module includes the following topics: general

communications, interviewing, detecting deception, negotiating, and operating in different cultures.

In the interviews with the Safeguards staff, participants very often described the need for planning inspections, working effectively as a team, analyzing the information collected during an inspection, and then summarizing and reporting this information in a clear and meaningful manner. In general, interview participants noted that the most successful inspections are those that are well planned in advance, take full advantage of team members' skills and knowledge, and provide a clear and coherent analysis and summary of the information collected in the inspection. Therefore, Organizing Skills includes training for inspectors involving planning for inspections, working effectively as a team, analyzing information, and reporting information obtained during the inspection.

Finally, the Basic Observational Skills course includes a recommended practical skills exercise, a mock inspection of a facility. This exercise is designed to incorporate skills from the three Basic Observational Skills modules. That is, after inspectors complete the three modules they will participate with other inspectors in a mock inspection. This inspection will be constructed so as to require participants to use Organizing Skills to plan and conduct an inspection with a team of inspectors, Visual Observational Skills to discover potential anomalies, and Communications and Negotiations skills to overcome barriers presented by facility personnel, to ensure effective team interactions, and to obtain information from facility personnel as needed to explain potential discrepancies. The purpose of this mock inspection is to provide inspectors with hands-on experience in using Basic Observational Skills and to provide feedback on their performance.

After identifying the Observational Skills training course modules, the next step was to provide detailed modules descriptions that contain specific training topics, instructional methods, time required, and expected results for each topic area. Specific module training information was developed using our previous experience in designing training programs, and information obtained from other government agencies who provide training to inspectors and

investigators, Contacts with these government agencies provided information about the general content of inspector or investigator training, specific courses offered in these training programs, and, in some instances, materials used to provide such training.

This report includes recommended course curriculum for the three Observational Skills modules. This information can be used for the next phase of the project — design and deliver Observational Skills training to IAEA inspectors.

It is recommended that IAEA inspectors complete these Basic Observational Skills training modules shortly after completing the basic inspector technical training course (ICAS). It is also recommended that more experienced inspectors attend this course to ensure that all inspectors operate in the enhanced safeguards inspection environment with the skills required to perform effectively.

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APPENDIX A

STRUCTURED INTERVIEW PROTOCOL

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STRUCTURED INTERVIEW PROTOCOL

Observational Skills Training
Interview Questions

Background

1. What is your area of expertise (e.g., nuclear engineering, statistics)?

2. How long have you been an Agency inspector?

3. In which States have you served as an inspector?

4. Have you performed both routine and non-routine inspections?

Preparing for an Inspection

5. How are inspectors assigned to a particular inspection?

6. How do you prepare for an inspection? (e.g., what documents and materials do you review)

7. Do you contact the host State directly before an inspection? If so, what is the purpose of the contact?

Conducting an Inspection

8. Describe the activities associated with a typical inspection and the specific steps involved in performing them -- e.g.,

   - Reviewing records
   - Taking inventories
   - Physically inspecting containment and surveillance devices
   - Taking samples
   - Measuring
   - Asking questions of personnel

9. What equipment or tools do you use during the course of an inspection?

10. What kinds of evidence do you believe is most likely to be indicative of a diversion if their were a diversion?

11. What actions do you take if you identify an anomaly during an inspection?

12. What actions do you take if you identify a discrepancy after completing an inspection?

13. Do you ever obtain information that is useful, but is outside the scope of the inspection? If so, how do you obtain that information (e.g, interviews with staff, comparing the declared activities with evidence at the site)?

Follow-up to inspections

14. How is inspection information reported? And, to whom do you report information or submit reports?

15. What other follow-up activities to inspections occur? (e.g., debriefs, small group meetings).

16. How is the total performance of an inspection evaluated (e.g. findings, outcomes, etc.)?

    - What factors cause an inspection to be judged as effective according to the IAEA's current evaluation system?

    - What factors cause an inspection to be judged as ineffective according to the IAEA's current evaluation system?

Effective inspectors and inspections

17. Based on your experience, describe the effective inspector.

18. Now, please describe the ineffective inspector.

19. What kinds of formal education is necessary to be an effective inspector?

20. What kinds of training do inspectors require after being hired for the job?

21. What are typical mistakes that IAEA inspectors make?

    - How can those mistakes be prevented?

Aspects of Working in Another State

22. What level of familiarity does the inspector need to have with the State he or she is visiting? How do you propose the inspector become familiar with the country?

23. What level of "authority/responsibility" do IAEA inspectors have or need to have in order to conduct effective inspections?

24. Can host State constraints prevent an effective inspection?

    - How do IAEA inspectors currently deal with constraints imposed by another State?
    - What does IAEA need to provide in order to counteract/prevent constraints?

Aspects of Working with Other IAEA Inspectors

25. What factors determine the overall composition of an inspection team?

26. Does a group of inspectors tend to work regularly together as a team, or does the team for each inspection involve a new combination of individuals?

27. Do inspection team members have distinct, well-defined roles (i.e., what is the division of labor)?

28. What level of familiarity does the inspector need to have with the other inspectors that he or she is working with?

29. Describe an effective inspection team (e.g. what mix of skills, experience, personality traits, etc. is useful for the team members to have in order to function well as a team)?

Current IAEA Inspector Training

30. Describe the training you received to become an inspector (Initial training/orientation, on-the-job training, ongoing training)?

31. Do all inspectors receive the same training? If not how does training differ among inspectors?

Improving IAEA Inspector Training

32. Would you recommend changes to the current training program for inspectors? If so, what are those changes?

APPENDIX B

SURVEY QUESTIONNAIRE

APPENDIX B

SURVEY QUESTIONNAIRE

IAEA Inspectors Checklist: Qualifications and Training Needs

1. What documents, materials, and other information do you obtain and review to prepare for an inspection? (Check all that apply).

___ Facility or State documents, plans, or records.

___ Direction provided by IAEA management.

___ Information about the State's nuclear program (IAEA or non-IAEA).

___ Discussion with other inspectors or IAEA staff.

___ Inspection reports summarizing results/findings from previous inspections.

___ Inspection plans or checklists developed for the current inspection.

2. What factors affect an inspector's ability to operate effectively during the inspection? (Rank order these factors from most to least with 1 as the most important factor and 11 as the least important factor.)

___ Inspector's experience and technical skills

___ Inspector's familiarity with the facility or type of facility

___ Agency's or Inspector's general relations with the State or the facility

___ Flexibility accorded the inspector to move freely from place to place within the facility

___ Time allowed at the facility

___ Ability to do things a second time, return to areas already visited

___ Access to quiet space for reflection or analysis

___ Ability to get additional information from facility personnel

___ Ability/need to obtain direction/assistance/backup from IAEA management during course of inspection

___ Discretion to "follow one's nose"

___ Fatigue

3. What kinds of evidence do you believe are most likely to be indicative of a diversion if their were a diversion? (Rank order from most to least likely with 1 most likely to 4 least likely.)

___ Material accounting discrepancies

___ Compromise of containment or surveillance devices

___ Measurements

___ Other (please identify) _____

4. What step(s) are taken to attempt to resolve anomalies or discrepancies? (Rank order from most likely step 1 to least likely step 5)

___ Re-do measurements or calculations

___ Seek explanation from facility personnel

___ Attempt to expand scope of inspection

___ Seek guidance from Agency management

___ Seldom have the opportunity to resolve anomalies or discrepancies.

5. How do you deal with information that might be useful, but is outside the formal scope of an inspection? (Rank order these from 1 as the most likely approach you would use to 4 as the least likely approach you would use.)

___ Openly seek such information

___ Surreptitiously seek such information

___ Limit to volunteered or "plain view" information

___ Do not use such information

6. How do you record your observations and other information? (Rank order these from 1 - most likely recording procedure to 6 least likely recording procedure.)

___ Contemporaneous notes

___ Photographs

___ Samples

___ Copies of documents

___ Rely on memory

___ Other (please identify) _____

7. What specific techniques must inspectors be able to employ in order to function? (Please identify the five most important techniques that you use, rank importance from 1 as most important to 5.)

___ Computational

___ Analytical (e.g., statistics)

___ Mechanical (e.g., operating instruments)

___ Electronic (computer hardware and software)

___ Perceptual

___ Memory

___ Concentration

___ Perseverance: list finishing

___ Perseverance: following up on discrepancies

___ Doing several things at once

___ Note-taking

8. Do you believe that training in any of the following skill areas would be beneficial for IAEA inspectors in the current safeguards environment? (Check all that apply.)

___ Inspection planning

___ Leadership and team-building

___ Visual observation of physical surroundings

___ Gathering and corroborating evidence

___ Interview techniques (verbal and non-verbal)

___ Analytic techniques

___ Brainstorming

___ Working together as a team

___ Computer and software skills

___ Conducting interviews

___ Interpreting non-verbal behaviors

___ Briefing and debriefing

___ Report writing

APPENDIX C

SKILLS AND KNOWLEDGES COVERED BY ENTRY-LEVEL/BASIC TRAINING COURSES AT IAEA

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SKILLS AND KNOWLEDGES COVERED BY ENTRY-LEVEL/BASIC TRAINING COURSES AT IAEA

List of Skills and Knowledges for IAEA Inspectors Covered by ICAS and Other Entry-Level Courses[a]

ICAS Course Knowledges and Skills

1. Safeguard Approaches, Goals, and Technical Criteria

   - Learn and understand safeguards criteria and goals.

2. Inspection Procedures at Item Facilities

   - Learn about the Criteria requirements for frequency and timing of (physical inventory verifications [PIVs]).
   - Learn about the types of records kept in Light Water Reactor (LWR) facility and the role of auditing activities in the safeguards approach.
   - Learn how items counting and serial number identification should be done in a LWR facility.
   - Learn methods for confirming the absence of unrecorded production.
   - Learn to identify and evaluate non-zero materials unaccounted for (MUF) or shippper/receiver difference (SRD) values.
   - Learn the process for material balance evaluation for this type facility.

3. Inspection of Research Reactors

   - Learn how the safeguards approach and inspection activities for this type of facility differ from that for a LWR.

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[a]Information about specific knowledges and skills covered on these courses was obtained from *Safeguards Training Database* (based on Safeguards Criteria 1991-1995) POTAS Task B.57.

- Understand similarities and differences (from LWRs) in types of records, reports and auditing activities and differences in how item counting or item identification are carried out.

- Learn about methods for analyzing Pu or U-233 production capability; methods for evaluating burn-up in comparison with design information; material balance activities; verification and re-examination of design information.

4. Inspection of On-Load Refueled (OLR) Power Plants

   - Learn how the safeguards approach and inspection activities for this type of facility differ from that for a LWR.

   - Understand similarities and differences (from LWRs) in types of records, reports and auditing activities and differences in how item counting or item identification are carried out.

   - Learn how containment/surveillance (C/S) systems fit into the safeguards approach and how these systems are evaluated and used; material balance activities; verification and re-examination of design information.

   - Learn how to evaluate non-zero MUF or SRD values.

   - Learn about the verification and re-examination of design information as well as verification of peaceful use of OLR.

   - Learn about the calibration of D_2O measuring systems.

5. Code 10 - Report Forms and Explanations for their Use

   - Learn to perform records examination activities at item facilities.

   - Become familiar with the translation of information in facility records into reports to the Agency.

   - Be able to make comparisons between data in Agency and data in facility records.

6. Computer Printouts

   - Identify which printouts are useful.

   - Learn how to use the printouts.

7. Non-NPT Accounting

- Distinguish differences in records examination and comparison activities in NPT versus Non-NPT states.

8. Auditing Activities/Exercise

- Actually perform different types of auditing activities.

9. Sampling Plans

- Prepare appropriate sampling plans.
- Understand stratification and classification of measurement methods.
- Understand the basic concepts underlying the Agency's sampling procedures.
- Be able to determine the appropriate input terms for sample plan calculations as well as the mechanics of performing calculations for the different situations referenced in the criteria.
- Know procedures for making random samples, demonstrate that they can select samples in training session.

10. Applications of Agency Containment Surveillance (C/S)

- Understand how these skills are used in actual inspections.
- Apply and evaluate both single and dual C/S systems for the types of facilities listed.

11. Seals

- Know the Criteria relating to seals; know how to perform the various seal verification activities including preparing sample plans for seals.

12. Sampling Plans for Non-Destructive Assay (NDA) Measurements

- Understand the procedures for sample plan calculations and able to develop sample plans for specific NDA verification methods by working with several examples.
- Identify the proper NDA measurement method for the different verification activities included in the Criteria.

- Determine the appropriate (inverted e) values for these methods, be able to calculate sample plans for cases with one, two, and three verification methods.

13. Hand-Held Assay Meter (HM-4)

    - Able to use the HM-4 to make active fuel length measurements.

14. Assay of Enriched Uranium in Materials Testing Reactor (MTR) Fuel

    - Learn to use the portable multichannel analyzer (PMCN) to perform both gross and partial defect tests on MTR fuel assemblies and have the opportunity to practice these two types of verifications.

15. Portable Multichannel Analyzer (PMCA)

    - Understand that the PMCN can be used to perform both gross and partial defect test measurements on bulk depleted, natural or LEU material and gross defect tests on low enriched uranium (LEU) fuel rods and bundles.

    - Simulate one gross defect tests and one partial defect test using the PMCN.

16. Spent Fuel Measurements

    - Learn how the GRAND-1 instrument can be used to perform both gross and partial defect test measurements on LWR or research reactor spent fuel.

17. Cerenkov Glow Observation

    - Learn how to use the CVD to perform gross defect tests on spent fuel from various types of reactors. Observations under different circumstances are explained.

18. High Level Neutron Coincidence Counter (HLNCC)

    - Learn how the HLNCC can be used to perform gross and partial defect tests on bulk plutonium materials. Simulate at least one gross defect test and one partial defect test using HLNCC.

19. Cicero 8K Multichannel Analyzer

    - Learn how to use the SLNC to determine plutonium isotopics are part of partial and bias defect tests on bulk plutonium materials. Simulate at least one isotopic measurement on a partial or bias defect test.

20. UF_6 Assay Simulations

- Learn how to use the PMCA to make both group and partial defect measurements for UF_6. These measurements are simulated in exercises using the PMCA user program.

21. Load Cell Based Weighing System - Ultrasonic Thickness Gauge

- Learn how to use both devices as part of partial or bias defect tests on UF_6 cylinders.

22. Calorimetry

- Learn how calorimetry can be used in bias defects tests on bulk plutonium.

23. Safeguards Approach (for a LEU fuel fab. plant)

- Learn the Criteria requirements for the frequency of PIVs and interim inspections.
- Learn requirements for flow verification, the types of anomalies and the appropriate follow-up actions when these anomalies are found.
- Learn about the activities involved in design verification and re-examination.

24. Auditing Activities

- Learn to perform auditing activities in a bulk facility in terms of the Criteria requirements.
- Learn about the types of anomalies that might be encountered and the appropriate follow-up actions in each case.

25. Verification of the Operator's Measurement System

- Learn the procedures for conducting SRD, MUF, and MUF-D evaluations.
- Learn what information they should collect and how this information is processed and evaluated.
- Learn the requirements for item counting in a bulk facility to make measurements meaningful.
- Review examples of how to go about item counting in difficult circumstances.

- Learn about the possible anomaly conditions that might arise from verification activities and the appropriate follow-up actions.

26. Inspection of MOX Fuel Fabrication Plants

- Learn requirements for inspection activities at LEU fuel fabrication plants.
- Learn what is accomplished in a mixed oxide (MOX) facility and what is different about performing in this facility compared to information provided about LEU plants.

27. Inspection of Reprocessing Plants

- Learn about the inspection activities that are unique to this type of plant versus other bulk handling plants.

28. Inspection of Enrichment Plants

- Learn about the inspection activities that are unique to these types of plants versus other bulk handling plants.

29. Bulk Measurement Instrumentation

- Learn about the basic characteristics of installed bulk measurement instrumentation.
- Learn how they should perform verifications specified in the Criteria for different types of materials at different levels (gross, partial, or bias defect detection).
- Learn about the specific activities involved in verifying the quality and functioning of an operator's measurement system.

30. Analytical Procedures for Inspection Samples

- Learn how procedures for destructive analysis are performed for different types of materials at the specified facilities and learn how to perform their part of the verifications.
- Develop an understanding of the accuracies obtainable for the different verification methods as well as the (inverted e) values they will need to use in sample plan calculations involving DA methods.

Comprehensive Inspection Exercise (This exercise is an integral part of the ICAS. Students have the opportunity to apply the knowledge they have acquired in the formal ICAS classroom training.)

- Learn about nuclear material accountancy and control from field training in a commercial power reactor.
- Acquire practical experience in simulation of a PIV inspection at a nuclear power plant, including an accounting exercise and fresh fuel measurement.
- Acquire practical experience in item counting and verification of spent fuel assemblies using the Cerenkov Viewing Device (CVD) and GRN1 with standard procedures.
- Acquire practical experience in servicing surveillance units.
- Acquire practical experience in verifying the seal on a reactor enclosure (may be simulated.
- Acquire practical experience in completing appropriate parts of a sample inspection logsheet.

Safeguards at Bulk Handling Facilities (requires a minimum of one year of experience to participate in this training course.)

- Learn about the safeguards applications at LEU conversion and fabrication plants and MOX fuel assembly plants and reprocessing facilities.
- Acquire practical experience at LEU conversion, fabrication, and MOX fuel assembly, enrichment plants, and reprocessing facilities.
- Learn about accounting techniques in each of the above plants and facilities.
- Acquire practical experience in inventory verification of LEU powder store.

APPENDIX D

PROLIFERATION INDICATORS PERTINENT TO SAFEGUARDS INSPECTIONS

WORKING NOTES

APPENDIX D

PROLIFERATION INDICATORS PERTINENT TO SAFEGUARDS INSPECTIONS WORKING NOTES[1]

Undeclared Facility or Activity	Behaviors	Equipment or Structural Features	Observed Operating Conditions	Measured Conditions
General	• Unsubstantiated complaints about individual inspectors • Exclusion of inspectors of certain nationalities • Denial of visas • Delay or denial of access to areas or facilities without a justifiable reason • Refusal to allow special inspection of suspicious facility	• Radiation detectors of any kind • Signs noting radioactive sources • Contamination zones • Protective clothing, paper, rubber gloves, rolls of tape	• Unusual and unexplained security arrangements • Evidence of a criticality accident	• Substantial or repeated MUF • Inconsistent records • Evidence of separate records system • Evidence of measuring equipment with capabilities beyond what's needed; e.g., evidence of criticality measuring equipment
Enrichment • Gaseous diffusion • Centrifuge • EMIS • Others	• Expertise in heavy ion physics • Expertise in diffusion membrane physics • Sensitive to questions about enrichment beyond 3-4% N=35 • Unusual care in material transfers	• Buildings or facilities with features inconsistent with their stated use, such as large power inputs and large cooling systems • UF_4 processing equipment • Maraging steel or other high strength materials • Corrosive resistant materials and components (high-alloy stainless steel sheet and tubing, storage vessels, gas valves, pressure or vacuum fittings) • Criticality (neutron) equipment • Neutron poison materials attached to shipping containers	• Piping changes between stages • Criticality detectors beyond that needed for low enrichment • Unusual electrical power input to facility	• Heat emissions (gaseous diffusion or calutron) • Acoustic or radiofrequency noise (centrifuge) • Electromagnetic signals at kilohertz frequencies (laser) • Indications of UCl_4, UF_6, UF_4, HF, or uranium metal • Depleted or enriched uranium in water or soil • Unexplained levels of neutron flux measured around material storage facilities

[1]These working notes are intended to be illustrative and not a comprehensive analysis. They are based on several sources (Paternoster, 1992; Brown, 1994; Libby, 1994; U.S. Congress, 1993).

Undeclared Facility or Activity	Behaviors	Equipment or Structural Features	Observed Operating Conditions	Measured Conditions
Enrichment (cont)		• Large iron electromagnetics, high voltage power supplies, large amounts of copper wire, large vacuum systems, nearby chemical processing plant (calutron) • Precision carbon composite cylinders, magnetic suspension bearings, high speed motors, inverter power supplies, uranium-to-UF_6 and UF_6-to-metal chemical conversion plants (centrifuge)		
Plutonium Production at Research or Power Reactors	• Sensitive about operating logs • Sensitive about spent fuel records • Sensitive about fuel changes • Sensitive about health-physics records	• Abnormally large spent fuel storage ponds or numerous fuel shipping casks at a research reactor	• Operation of a research reactor on a continuous rather than intermittent basis • Unusually frequent shutdown of a research reactor for refueling; repositioning of fuel not removed toward the outside of the core • Unnecessary placement of U-238 in or around a power reactor core • Frequent movement of material into and out of spent fuel ponds, in conjunction with frequent shutdowns	• Heat emissions (undeclared reactor of 40-50 MW) • Low burn-up or irradiation level of reactor fuel • Plutonium isotopic correlation • Inconsistent records • Power levels inconsistent with declarations • Evidence of dual record-keeping system

Undeclared Facility or Activity	Behaviors	Equipment or Structural Features	Observed Operating Conditions	Measured Conditions
Plutonium Reprocessing	• Sensitive about records • Sensitive about radioactive waste management • Sensitive about chemicals on site • Sensitive about unusual shielded facilities	• Unexplained hot cell operations • HEPA filters (indicating hot cell operations) • Irradiated fuel element chopping machines • Critically safe vessels (e.g., small diameter cylinders, annular tanks, slab tanks) • Criticality detectors, i.e., neutron detectors	• Presence of acids, inorganic and organic solvents, other chemicals characteristic of PUREX process • Unusual radioactive waste operations • Evidence of underground tanks	• Presence of acids, inorganic and organic solvents, other chemicals characteristic of PUREX process • Release of radioactive iodine, xenon, krypton, and possibly argon gases • Process effluents containing uranium, plutonium, and chemicals characteristic of the specific dissolution, solvent extraction, and chemical conversion processes involved

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