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TASK ANALYSIS:
A DETAILED EXAMPLE OF STEPPING UP FROM JSA

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CONTENTS

EXHIBITS

1. INTRODUCTION

Job Safety Analysis (JSA) is a systematic process for the review of job hazards. Its purpose is to uncover inherent and potential hazards which may be encountered by an employee in his work environment. When properly used, the JSA can be an effective tool for training and orienting new employees and retraining existing workers, and for developing safe job procedures.

Proper performance of a JSA includes eight steps, the last two of which are often forgotten or not used.

1. Identify jobs which warrant systematic analysis.

2. Establish priority for analysis.

3. Select the method for job data collection and establish an appropriate form for recording it.

4. Break the job into steps.

5. Identify the hazards and contact possibilities at each step.

6. Determine and specify hazard control measures.

7. Incorporate results of analyses into safe job procedures.

8. Review periodically and update as appropriate.

JSA is really a specialized and simplified application of task analysis that analyzes job tasks with specific emphasis on work environment hazards.

The more encompassing task analysis looks at all of the significant elements that comprise a task. Tasks are defined as units of work, or human performance, that change or verify system status and contribute to the achievement of specific work system objectives. Task analysis is broadly defined as a systematic process for describing tasks in behavior and worker system terms, and identifying the human and equipment resources necessary to complete them successfully. Task analysis was originally developed by Robert B. Miller in 1953. It has been in use since then, and has provided a systematic, human factors basis for the development of a variety of systems involving people.

Differentiation is made between job analysis (which is simply the process of obtaining information about jobs) and task analysis, in that job analysis is a more global description of the tasks assigned to one category of worker. Task analysis, on the other hand, consists of a systematic examination of the set of actions or behaviors necessary and sufficient to complete a task, within a specific task environment and technology. Task analysis may be used to optimize the task performance environment and technology, as well as work selection, job design, training and drill, procedures, and other performance factors.

Task analysis may follow job analysis and be job based. In such cases, tasks are typically identified by interviewing, or otherwise surveying, the job incumbents (the people who are actually performing the work under study). For unique operations or facilities (such as the one discussed in this paper as an example of the use of task analysis in a real life application), the job-based approach is not appropriate, because there are few facilities of the type in existence, and few workers experienced in its operation. Moreover, as each of these facilities and operations is unique, the task requirements differ for each of them. When the goal is to optimize safety and performance in a particular facility, practices at other sites cannot necessarily be adopted. Also, the job-based approach is not optimal for development of procedures which reflect the total process flow, rather than task responsibility allocation.

For these reasons, a systems approach to task analysis was chosen for the proposed operational facility discussed herein. Under the systems approach, tasks are identified and described by top-down, iterative analyses of work system (facility) functions. This analysis focused on process functions (the mission of the facility) as contrasted with "maintenance" functions (administrative/support functions).

The ways in which process functions can be accomplished depend fundamentally on the facility design and equipment options. Decisions in those areas provide a basis for beginning the analysis of task requirements and risk. Design and equipment options may be reexamined as the task performance and risk implications are identified in progressively greater detail during the analysis.

The identification and description of task requirements are accomplished by focused interviewing and discussion with a team of subject matter experts (the people performing the tasks) representing the process engineering, operating, and safety perspectives.

Review and verification may then be performed by other individuals with professional credentials similar to those of the data collection team. Additionally, members of the procedures development, training, and industrial engineering groups participate in the review to evaluate the suitability of the data for their applications.

2. APPLICATION METHOD

This paper discusses a pilot task analysis of operations in a proposed facility for the cutting and packaging of radioactively contaminated gloveboxes, for long-term storage or burial. The analysis was done and reported by Paramore, Banks, Venesiano, Gilmore, and Coleman.

Objectives

The broad objective of the pilot project was to demonstrate how task analysis may be used as a tool for planning and risk management. As part of the demonstration, two specific products were generated--preliminary operating procedures and training requirements. The task data base, procedures list and training requirements developed in this project were only intended as first order categorizations. They will be expanded and refined as the new facility is developed and constructed.

Scope

The analysis was limited to tasks that will be performed within the boundaries of the operational facility and the associated load-out area. Tasks to be performed outside those areas were not analyzed (e.g., tasks of preparing gloveboxes and moving them to the facility).

The analysis, for the most part, documents tasks to be performed by "D&D (Decontamination and Decommissioning) Workers." However, the analysis included all tasks identified as an integral part of glovebox processing within the facility. Thus tasks involving Radiation Protection Technicians (RPTs) are included. Based on hazard assessments, it is planned that at least two RPTs will be assigned full-time to the facility, so they may be considered part of its crew. Similarly, supervisory/administrative tasks are included where they were determined to be directly part of process sequences, such as obtaining appropriate certification.

Summary of the Method

A systems approach to task analysis was used. Thus tasks were defined by a top-down, iterative analysis of the glovebox processing functions of the facility in consideration of facility design, equipment options, and personnel resources.

To perform this analysis, a multidisciplinary team was established which included:

- Operations experts to explain the functions and delineate the task requirements, hazards, and error potentials.

- Process engineering experts to identify the facility design and equipment options.

- Industrial health and safety specialists and radiation protection/radiation engineering experts to contribute to the delineation of hazards, error consequences, and means of minimizing same.

The data were developed in group sessions of this multidisciplinary team of subject matter experts, together with a human factors specialist who provided guidance on the method, coordinated the sessions, and formulated the data for analysis. The data were reviewed by additional subject matter experts in each area of expertise.

The major steps of the methodology used are listed below:

- Establish the data collection framework.

- Define facility functions/processes.

- Identify tasks.

- Specify the tasks in behavioral and system terms.

- o Construct an on-line data file.
- o Analyze and/or synthesize the data for applications.

Summary of Results

The results of this task analysis effort produced a first order sequence of procedures and a complete and integrated set of training requirements. The training requirements were broken down into systems, academic, and administrative knowledge necessary for task execution. In addition, all items of support equipment necessary to perform the process functions of the facility have been documented.

Risk profiles were provided to advise management on the potential for performance errors and to indicate where future resources should be focused to minimize hazards in the work environment.

Sequence of Steps

Exhibit 1 shows the sequence of steps performed to complete the project. There were three phases of work--the preparation phase (steps 1-4) the task analysis phase (steps 5-8) and the report generation phase (steps 10-11)--as described below.

Preparation Phase (steps 1-4)

Step 1. Establish Task Analysis Objectives and Scope. The objectives of the project were agreed upon at a preliminary meeting attended by representatives of operations, process engineering, safety, procedures, training, and industrial engineering groups, and the task analysis. Three primary objectives were approved:

- o Demonstrate the use of task analysis as a tool for integrated system development and risk management, familiarizing facility personnel with the method and potential applications of the data.

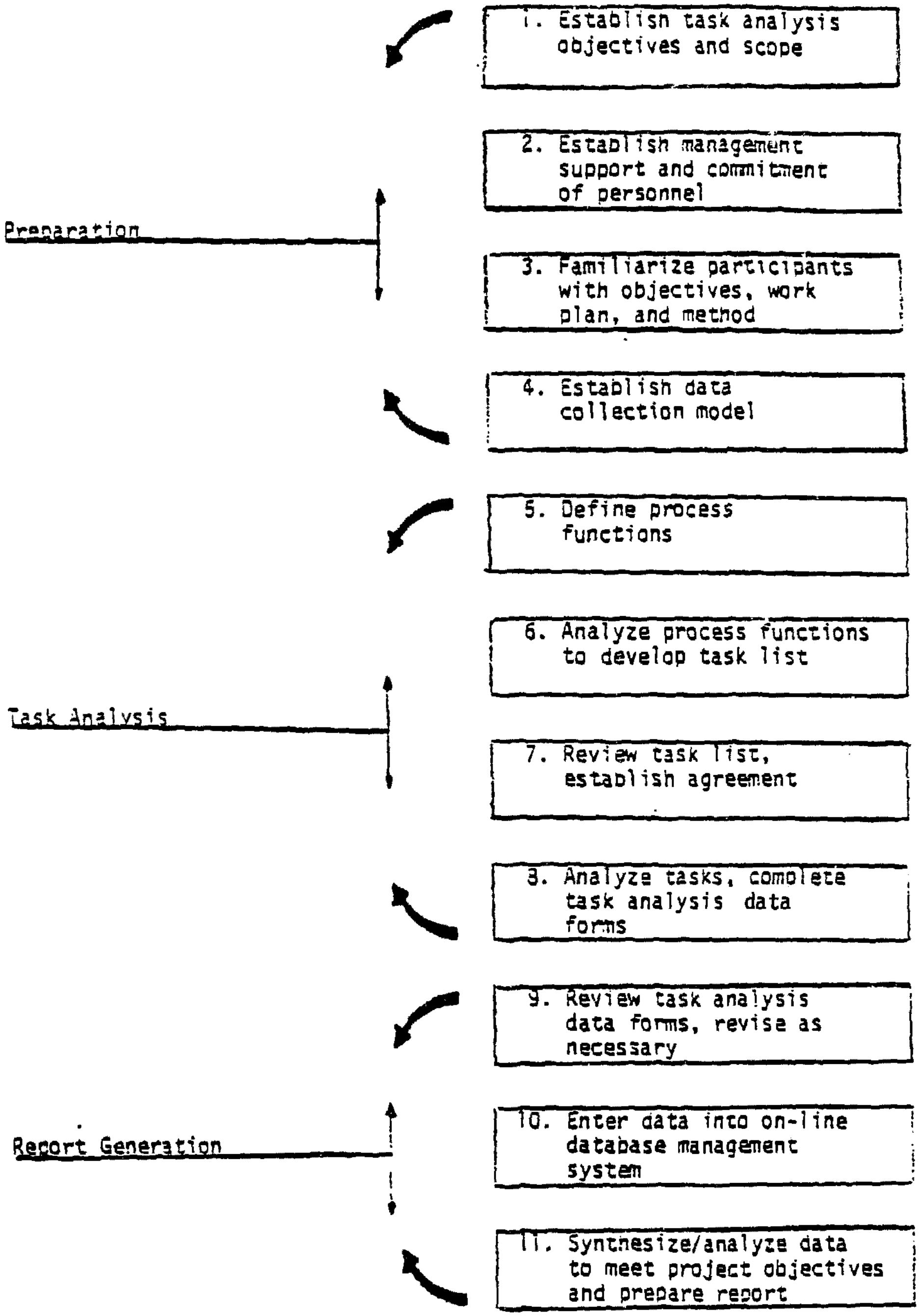


Exhibit 1. Overview of project activities and analysis steps.

- Produce a first order cut of procedures derived from task analysis.

- Produce a complete set of training requirements based upon the planned tasks and categorize training requirements into system, academic, and administrative knowledge/skill requirements.

It was further agreed that analysis would be limited to processes conducted within the proposed facility and that the tasks of the job category "D&D Worker" would be the primary concern. As the analysis progressed it was sometimes found that task actions expected to be performed by others were an integral part of a process sequence, and they were included in the analysis.

Step 2. Establish Management Support and Commitment of Personnel. This is a key preparation step that was accomplished in a joint meeting involving participants as described above, with followup contacts as the project progressed. A pool of resource personnel was identified, from which two working groups were drawn--one to develop the data and one to review this data.

Step 3. Familiarize Participants with Objectives, Work Plan, and Method. A kickoff meeting was conducted for participants in the data development and review. Objectives and scope were reviewed, an orientation to task analysis and its uses was provided, the steps of the work plan were reviewed, and scheduling issues were discussed.

Step 4. Establish Data Collection Model. The final item on the agenda of the kickoff meeting was to agree upon the types of data about a task that would be developed in the analysis. A data collection model used in previous task analyses conducted at Department of Energy facilities was introduced as a starting point. Data categories were deleted and added, and category definitions were modified to suit the work system under analysis and the objectives of this project. A preliminary agreement was reached. Certain data items were identified as questionable in terms of their applicability but left in to be tested as the analysis progressed. They were ultimately omitted during the course of the analysis. Additional modifications were made to clarify data category definitions as questions arose during the analysis.

The data collection model is embodied in the Task Analysis Data Form and a corresponding set of Task Analysis Category Definitions, which was used as a training and analysis aid. The data form and definitions are presented as Exhibits 2 and 3, which appear at the end of this section.

Task Analysis Phase (steps 5-8)

Step 5. Define Process Functions. Process functions were defined initially in the form of brief narrative statements that specify:

- Starting conditions
- Major activities resulting in changes in status of the glovebox or environmental conditions
- End conditions.

The process function descriptions served to bound the tasks to be included in each process and to indicate major task groupings. Modifications were made as the task list was developed; when filling in the detailed steps of a process, task groupings that may initially be overlooked are identified, and better ways of bounding processes and allocating or ordering activities within processes emerge. The final process definitions appear at the beginning of Section 3 in which analysis results are presented.

Step 6. Analyze Process Functions to Develop Task List. The initial task list was developed in three sessions by members of the data development team. The process function descriptions provided a framework for discussion. These descriptions identified the major changes in glovebox status or environmental conditions to be accomplished during the

TASK ANALYSIS DATA FORM

DECONTAMINATION AND DECOMMISSIONING (D&D) OPERATIONS

PROCESS:

1 Facility ID	2 Position ID	3 Sub-position	4 Task No.	5 Task Description	6 Task Purpose	7 Initiating Event	8 Plant Systems Affected

EXHIBIT II

Task Analysis Data Form
DRD Operation
page 2

Task No.	9 Support Equipment	10 Person. Time	11 System Time	12 Task Diff.	13 Task Freq.	14 Feedback	15 Most Likely, Serious Potential Human Errors	16 Potential, Significant Error Consequences	17 Error P Rating	18 Error Severity Rating

EXHIBIT II

Task Analysis Data Form
D&D Operations
page 3

	19	20	21 - 23				24			
			Preferred Way(s) To Lessen Risk				Preferred Mode(s) of Training			
Task No.	Others Involved in Task	How Others Involved	Equipment	Procedures	Training	Supervision	Drill	Class	OJT	Sim./Mockup
				/						

EXHIBIT II

Task Analysis Data Form
O&M Operations
page 4

Task No.	Knowledge Required To Perform this Task			28 Level of Supervision	29 Hazards	30 Performance Standards
	25 Academic Knowledge	26 Administrative Knowledge	27 System/Equip. Knowledge			

EXHIBIT II

process. The purpose of the group effort was to visualize and express the specific steps that would need to be performed by the workers. Discussion of the layout of the facility, the anticipated equipment, and contamination control requirements helped stimulate thinking. A schematic of the proposed facility design was prepared as an aid in visualizing the steps of the workers. The experience of team members with similar decontamination and decommissioning work facilitated task identification, as did observations made by operational personnel at other sites where similar operations are performed.

Step 7. Conduct Review of Task List. The completed task list was distributed to all members of both the data development and review groups for review and comment. Changes were agreed upon in a meeting involving both the data development and review groups. The resulting task list served as the starting point for completion of the task analysis data forms.

Needs for additions and other changes in the task list were identified as the forms were developed and additional information was obtained about the facility design and equipment options. Another iteration of task list development sessions was conducted involving all participants, to resolve issues identified in the detailed analysis, incorporate additional information, and establish a final task list.

Thereafter, minor modifications were made in the wording and grouping of task elements to meet the requirements of the data collection model. The final task list appears as Exhibit 4, presented in Section 3. The final task list constitutes a first order procedure, which is a specific deliverable product of the project.

Step 8. Analyze Tasks, Complete Task Analysis Data Forms. A series of group interview/discussion sessions were conducted to complete the task analysis data forms in accordance with the task category definitions (see Exhibit 3 at the end of this section).

Step 9. Review Task Analysis Data Forms. Review was performed by seven members of the operations staff in addition to those who participated in the detailed analysis and completion of forms. Review comments were incorporated in the on-line data base.

Report Generation Phase (steps 10-11)

Step 10. Enter Data into On-Line Data Base Management System. An on-line system for task data management and analysis has been developed by EG&G Idaho during task analyses conducted at other Department of Energy facilities. This system allows keyword search and rapid sorting and retrieval of selected data. The software includes routines for calculation and plotting of risk indicators and other quantifiable parameters of tasks.

Step 11. Synthesize/Analyze Data and Prepare Report. The final treatment of the data to meet project objectives was straightforward. The method of analysis was designed so that the task descriptors would constitute procedural steps which could simply be listed to provide the first order procedures. Training requirements were consolidated into a list of unique items that identifies all of the tasks and subtasks to which each training item is applicable. A risk profile was generated using the standard formulation of rated, relative probability of error in task performance times the rated severity of potential error consequences. In addition, lists of types of error and hazards intrinsic to task requirements were generated. The risk profile and descriptive lists of types of error and hazards may be used to identify tasks that should be given particular attention in procedures, training, and supervision. Human factors engineering evaluation of relatively high-risk tasks identified from the risk profile may also be warranted, to examine the possibility of reducing risk through facility design/equipment enhancement.

EXHIBIT 3

TASK ANALYSIS CATEGORY DEFINITIONS

The items of information to be recorded on the Task Analysis Data Form are explained below. The item numbers correspond to the column numbers on the form (Exhibit II). These numbers identify fields in the on-line task analysis data file. The field size is specified in parentheses after the explanation of each item. When analyzing a task, no information may be appropriate for some items (e.g., no "support equipment" is needed to perform a task). The first three fields or columns are used for identification purposes.

1. Facility ID - (20 characters)
2. Position ID - (30 characters)
3. Position ID - (10 characters)

4. Task Number - Each task and subtask must be assigned a number. This number identifies the process in which the task/subtask occurs and its position relative to other tasks/subtasks in the process. In the following example, the process is "4.0 Packaging:"

   4.1 Prepare the packaging lift table.

   4.1.1 Cover lift table with one layer of plastic.

   4.1.2 Position lifting straps over plastic.

   The Items 4.1.1 and 4.1.2 are two subtasks of the task of preparing the packaging lift table (4.1).

   The task number is repeated in the first column of each page of the data form. This is done to provide easy reference to the task across the separate pages. (20 characters)

5. Task Description - This column describes what must be done to complete each task/subtask. The task description column should be filled out first since all other columns refer to it. Each task should begin with a verb or verb-adverb combination that makes the worker behavior clear. (160 characters)

6. Task Purpose - The purpose should be a brief statement of what is to be accomplished by performing the task. The task description defines the behavior; the purpose defines the reason for the behavior--an operating objective. Do not say that the purpose of starting a tool is to make it run. An acceptable purpose for starting a tool would be to cut whatever component is being reduced in size. (420 characters)

7. Initiating Event - This statement explains why a particular task is undertaken at a specific time. Precursor events and situations that lend to the justification for performance of a task should be detailed here.

   For example: If the Task Description were to "decontaminate lift table," the initiating event would be "completion of survey: contamination above specified limit." The Initiating Event may also be a supervisor's order or a procedural requirement. (210 characters)

8. Plant Systems Affected - Leave blank. This column is applicable to tasks of remote process control. (350 characters)

9. Support Equipment - Support equipment is any nonstationary item that is required to perform the task identified in Column 4. Examples include bandsaw, crane, wrench, gloves, tape, checklist, and rags. (240 characters)

EXHIBIT 3 (Continued)

10. Performance Time - Performance time is the elapsed time that it takes the usual complement of workers to perform the task actions. The number of personnel involved is indicated in column 19. Man-hr/man-min can be estimated from columns 10 and 19. This is estimated average time, assuming no interruptions or unusual occurrences. Personnel should be assumed to be trained but fairly new in the job. (30 characters)

11. System Time - This is the time it takes for a system or equipment to respond to the task action performed by the worker. For example: If the Task Description were to "lower glove box on table," the difference between system time and personnel time could be significant. It may take the operator 2 seconds to set the hoist in motion. This would be the Personnel Time. However, it may take 30 seconds for the system to respond to the controlled input and come to the desired position. This would be the System Time. (30 characters)

    NOTE: It was found that no useful distinction could be made between personnel and system time in this analysis. Therefore, the System Time item was dropped from consideration.

12. Task Difficulty - This is a judgment by subject matter experts. Task difficulty is reported relative to all other tasks performed in the job. The most difficult task or tasks will be rated 5. The least difficult task or tasks will be rated 1. All other tasks will be rated between these extremes on the 1-5 rating scale in whole number values only. Task difficulty refers to a combination of both mental and physical effort, so rank each task accordingly. (1 character)

13. <u>Task Frequency</u> - In this column, the frequency of task performance should be ranked from 1-5 according to the following scale:

1 = Once per glovebox
2 = More than once per glovebox
3 = More than once per week
4 = One or more times per day
5 = Continuous--intermittent throughout process.

The scale definiti s are based on the assumption of an average of two weeks processing time per glovebox. (1 character)

14. <u>Feedback</u> - Leave blank. This column is applicable to tasks of remote process control.

This column is used to identify the form and source of information about system response to task actions. Such data are most relevant in analysis of remote process control operations. The column will not be used in this analysis. (350 characters).

15. <u>Potential Human Errors</u> - This column requires documentation of the most likely serious human errors that could be made in regard to the task being analyzed. There are three basic categories of task error: omission of the task, improper performance, and/or improper timing (delay in beginning or completing the task, or introduction of the task when it is inappropriate).

The seriousness of an error depends upon the potential consequence. Sometimes the consequence of an error depends upon system conditions or other situational factors when the error occurs. For example, it may be likely that D&D workers will forget to check the direction of airflow. Most of the time this error of omission would not matter because the plant ventilation system is highly reliable. The omission could be serious, however, if the ventilation system were not operating properly. Thus, in defining a potential error, it may be necessary to specify conditions under which the error is serious; e.g., failure to check direction of airflow when the ventilation system is not operating properly. This error could have a significant consequence, whereas failure to check direction of airflow would, most of the time, have no consequence.

There may be many conceivable errors. As a rule, they can usually be limited to three that are both likely and serious. (120 characters)

16. Potential Significant Error Consequences - In this column, a statement that describes the effects of committing the error(s) stated in Column 15 should be indicated.

For example: If the Potential Human Error were "improper wrapping," the consequence could be "potential release of alpha contamination." (280 characters)

17. Error Probability Rating. This is also a judgment made by subject matter experts. The procedure for this internal rating scale is to rank the probability relative to all other Potential Human Errors in Column 15. The rating scale ranges from 1-5. Nominal values are assigned to the scale definitions as a guide:

1 = Almost no probability of occurrence, 10^{-5}
2 = Very low probability of occurrence, 10^{-4}
3 = Low probability of occurrence, 10^{-3}
4 = Medium probability of occurrence, 10^{-2}
5 = High probability of occurrence, 10^{-1}.

It is stressed that the probability rating should not be viewed as a prediction of error/consequence occurrence. The use of this rating and the others on this form is to identify tasks that may require special attention in design engineering, procedures, training, or supervision.

18. Severity of Consequence. In this column, a judgment should be made to rank the severity of the consequences of each error described in Column 15. The rating scale is defined below:

1 = No consequence to personnel safety or contamination control.

2 = Very minor severity

- Minor personal injury without contamination with no loss of time from work (e.g., pinch/bruise, contusion, strain).
- Airborne contamination or other significant spread or buildup of contamination in sectioning room.
- Significant contamination of anteroom (up to 3,000 dpm) requiring no more than 4-hour cleanup.

3 = Minor severity

- Personal injury resulting in loss of time from work but without contamination (e.g., broken finger or arm, sprained back muscle).
- Low-level skin contamination; no internal contamination.
- Dusting of contamination in clean area requiring no more than 2-day cleanup.

EXHIBIT 3 (Continued)

4 = Severe

- o Slight internal deposition not requiring medical treatment.
- o Wound with implantation requiring minor medical treatment.
- o Contamination of clean area requiring up to 2 weeks cleanup.
- o Controllable environmental release (up to 1000 dpm).
- o Injury resulting in long-term disability.

5 = Very severe

- o Fatality.
- o Heavy internal deposition or wound with implantation requiring extensive medical treatment.
- o Spread of contamination requiring more than 2-week cleanup.
- o Contamination of building, resulting in shutdown of building operations.
- o Large or uncontrollable environmental release.

19. Others Involved in Task. This column is used to identify other personnel directly involved in performing the task. Involvement of others is defined as actual assistance the person receives. A D&D worker may require another workers help to perform a task. The person may also need information or directions from a supervisor to accomplish a task, or a supervisor may verify that the task has been performed to a satisfactory level, or an RPT may be involved. (120 characters)

20. How Others Involved. This column is used to indicate the roles of other personnel identified in Column 19 involved in the task. (210 characters)

EXHIBIT 3 (Continued)

21/23 Preferred Ways to Lessen Risk?--This column is used to indicate how the potential for human errors and their consequences can be minimized.

There are four categories to choose from: (1) Equipment (referring to equipment selection/design and workspace design), (2) Procedures, (3) Training, (4) Supervision. One or more may be chosen. The choices indicate where provisions can be made most effectively to assure safe and successful performance of the task. Checkmarks may be placed in the columns to identify the preferred means. If a specific provision can be suggested, it should be written in the column. (70 characters per subcolumn)

24. Preferred Mode(s) of Training. This column is used to suggest the mode(s) of training considered most effective for the task. There are four categories: (1) Drill, (2) Classroom, (3) On-the-Job (OJT), (4) Mock-up/Simulation (SIM). More than one may be chosen. Choices should be indicated by checkmarks. (50 characters)

Mockup/simulation in this analysis refers to a training environment including fabricated facsimiles of gloveboxes where the sequences of tasks can be practiced. Drill is distinguished from mockup/simulation as follows.

Drill is a repeated practice activity that does not require use of a glovebox mockup. Drill could be, for example, cutting practice on pieces of sheet metal. (50 characters)

Knowledge Required to Perform This Task. In this section, subject matter experts are requested to determine the elements of knowledge essential to perform each task effectively. Knowledge requirements are broadly defined here to include knowing how to do something (i.e.; skill mastery) as well as knowing information and concepts. This section is composed of three columns (25-27). Each column identifies a specific category of knowledge. The three categories are summarized as follows:

25. Academic Knowledge. This category defines the knowledge of the kind generally acquired in formal education prior to job entry or in instructional programs (generally in a classroom setting) provided by the employer. For example, the person may need to understand or have a familiarity with aspects of radiation physics or environmental safety, or may need to know certain mathematical relationships and procedures. Basic requirements such as ability to read and understand technical documents may also be specified in the category of academic knowledge. (400 characters)

    Example: The knowledge of principles and procedures of contamination control helps the operator work safely and minimizes the problems in the course of D&D operations.

26. Administrative Knowledge. This category refers to standard practices, procedures, and rules, and organizational relationships, resources, and constraints. (160 characters)

    Example: The knowledge of the chain of command gives the operator the information needed to properly obtain permission to remove or transfer a glovebox as well as document any problems that occur during this procedure.

27. Systems/Equipment Knowledge. This category refers to the types of knowledge needed to operate system components and tools, or to use other equipment and materials necessary for the task. (240 characters)

Example: The knowledge of the layout and ability to read schematics and operate a specific tool may be essential to complete a task successfully.

28. Level of Supervision. This is a rating reflecting the hazards involved in task performance and the potential consequences to personnel and the organization if the task is omitted or performed improperly. The rating scale includes 5 choices:

- 1 = No supervision required.
- 2 = Another worker should verify satisfactory completion of task.
- 3 = Satisfactory performance of task should be self-verified formally; e.g., by checklist, worker signoff.
- 4 = Supervisor should verify satisfactory completion of task.
- 5 = Supervisor should monitor performance of task.

29. Hazards. This column is used to specify hazards other than worker error that may be associated with performance of the task. An example would be flying debris or sparks during operation of cutting tool. (300 characters)

30. Performance Standards. This column is used to identify the criteria for satisfactory task performance. Performance standards should be objective, verifiable. They may be quantitative. A quantitative standard might specify, for example, task completion within a certain time period, task completion with a specified degree of accuracy, or completion of a minimum number of units of output within a certain time period. Examples of categorical standards include: "follows procedural steps exactly," "always tests security of rigging before raising load." (300 characters)

3. APPLICATION RESULTS

This section presents a sampling of the task analysis results specified by the project objectives, including:

- A list of procedural steps, which provides the framework for completion of the procedures document.
- A list of specific training requirements referenced to the tasks and procedural steps, along with profiles of relative task difficulty (which can be used with the risk profile to identify areas of emphasis in training); and a summary of recommendations as to training modes that were made during the task analysis.
- A risk profile, by which tasks can be selected for special attention in the design effort and in development of the training program and procedures. In addition, lists of potential performance errors and hazards are provided to summarize the major types of risk.

In addition, a list of equipment needed to perform the tasks is provided.

Description of Process Functions of the Facility

The descriptions of process functions, prepared as the first step of the analysis, serve to summarize the tasks addressed. The process descriptions are presented here to provide a frame of reference for the analysis results.

Process 1. Staging

Staging begins as the doors are shut after receiving the glovebox into the staging room. The activities include: (a) verification of proper conditions within the sectioning room (ventilation system, equipment readiness, contamination control); (b) verification of personnel readiness (dress and position); and (c) assurance of control over access to the facility. This phase ends when all verifications are complete and access control is established.

Process 2. Transport

The transport process begins when the end conditions of staging are met. Transport includes (a) the preparatory activity of protecting the anteroom from possible contamination; (b) movement of the glovebox through the anteroom into the sectioning room and the transfer of the glovebox from the load-in lift table to the sectioning lift table (using an overhead hoist); (c) removal of the load-in lift table, and the securing of the anteroom (removal of plastic runner, surveying and decontamination as necessary). End conditions are as follows: glovebox is in the work position in the sectioning room and the anteroom is secured, with curtains properly adjusted for airflow control.

Process 3. Size Reduction

Size reduction initially begins when the end conditions of the transport process are met. Size reduction will in most cases continue over a number of days, integrated with packaging and transfer and certification of packages until the glovebox is disposed of completely. When size reduction is continued over successive days, the process will be reinitiated at the start of each day as well as when a package has been removed from the facility. In all cases, the anteroom will be secured with curtains properly adjusted before size reduction operations begin. Other aspects of readiness, as identified in the staging process, will be verified as necessary.

The activities include: (a) verification of readiness for sectioning; (b) unwrapping the glovebox; (c) immobilization of the glovebox and sections to be removed; (d) the removal of panels, gaskets, holddown strips, and unfastening of bolted sections (as required); (e) the cutting of sections of the glovebox in accordance with a work plan (prepared prior to movement of the glovebox into the facility); and (f) maintenance of contamination control and proper working conditions within the sectioning room. The size reduction process will be integrated with other processes over a number of days, as stated above. It will stop each day with securing of the sectioning room. Other intermediate stop points will occur each time a sufficient amount of material is removed from the glovebox to make up a package for burial. The ultimate end conditions are complete disposal of a glovebox and securing of the work areas.

Process 4. Packaging

The packaging process begins when sufficient glovebox elements have been removed to make up a package. The activities include: (a) banding, padding and taping of the package elements; (b) wrapping/bagging the package; (c) surveying and decontaminating the package exterior to meet contamination control criteria; (d) transfer of the package from sectioning room to anteroom to staging room (in stages, interspersed with wrapping, surveying and decontamination); and (e) surveying, cleanup, and securing of work areas as required. Packaging ends when the package is free of exterior contamination and suspended on the tripod hoist in the staging room, ready to be moved to the loading dock outside the facility.

Process 5. Transfer and Certification

The end conditions of packaging are the starting conditions of transfer and certification. Activities in this process include: (a) movement of the package to the loading dock outside the facility; (b) obtaining verifications and certifications; (c) placement of package in burial box; (d) securing and sealing of burial box lid and formal release of box for transport as required. The end conditions for this process are: burial box lid temporarily secured or, when a burial box is full, box permanently secured, sealed, and released for transport.

Procedures

Based upon the task analysis, the first order procedures for the facility are displayed in Exhibit 4. The procedures list is divided into groups according to process, as follows:

1. STAGING
2. TRANSPORT
3. SIZE REDUCTION
4. PACKAGING
5. TRANSFER AND CERTIFICATION

Only representative excerpts from Exhibit 4 and subsequent exhibits are included in this paper.

This is a sequential list of procedural steps that are completely integrated with the tasks to be performed and the anticipated equipment to be used. As more information and definition of the facility are obtained, this initial list of procedures can be modified or added to as necessary.

Additional data from the task analysis will be helpful in the preparation of the complete procedures document. For example,

- o The task-initiating event (field 7) may indicate a hold point or precondition for a procedural step.

- o Potential human errors, error consequences, and hazards (fields 15, 16, and 29, respectively) provide information that may be incorporated as procedural cautions and warnings.

- o Involvement of more than one person in procedural step may need to be specified. This information is available from fields 19 and 20.

EXHIBIT 4

PROCESS: 3.0 SIZE REDUCTION

3.1 Prepare for size reduction.

3.1.1 Verify availability of tools in sectioning room.

To avoid delay during cutting.

3.1.2 Remove all plastic layers covering glovebox.

To provide worker access to glovebox.

3.1.3 Survey and bag plastic covering and set aside in designated waste container or storage area.

To ascertain contamination level and assure proper disposition of plastic.

3.1.4 Immobilize glovebox.

To assure glovebox does not shift or fall from lift table during sectioning.

3.1.4.1 Raise hoist to remove slack, and position hoist and lift table.

To prevent glovebox from falling while it is being secured to table.

3.1.4.2 Brake wheels of lift table and hoist.

To assure lift table and hoist remain stationary during subsequent operations.

3.1.4.3 Secure glovebox to lift table according to work plan.

To assure glovebox and sections to be cut will be supported and stable as cuts are made.

3.1.4.4 Release tension on slings and remove lifting hooks from slings.

To free hoist (gantry) for handling sections of box during cutting process.

3.2 Make access cuts in glovebox (saw off corners, notch edges, and cut access holes) according to Work Plan.

To provide openings for cutting with nibbler.

3.3 Smear and survey interior of glovebox.

To determine exposure rates and working conditions.

3.4 Cut straight sections of glovebox.

To allow sections to be removed.

3.4.1 Attach hoist to lifting points on section to be cut.

To stabilize section to be cut.

3.4.2 Nibble between access cuts.

To section glovebox with minimal generation of dust.

3.4.3 Tape cut edges.

To control contamination, provide insulation, and protect workers from cuts.

3.4.4 Smear and survey taped edges and exterior surface.

To control contamination.

3.4.5 Fix (paint with fixative or tape over) contaminated areas.

To control contamination.

3.4.6 Cut through ribs, welds, and stabilizing sections (tabs left from nibbling)

To free section to be stacked for packaging.

3.4.7 Stack flat sections as removed on 4 x 4 supports.

To prepare for packaging.

3.5 Periodically take air samples, smears, surveys of work area, tools, and equipment as cutting occurs.

To control contamination and environmental exposure.

3.6 Clean/fix work area, tools, and equipment to acceptable contamination levels.

To control contamination and environmental exposure.

EXHIBIT 4 (Continued)

3.7 Cut through and remove external bracing, brackets, and protruding pieces (sinks, drains, exhaust, filter boxes, airlocks, etc.)

To meet packaging dimension requirements.

3.8 Cut through hold-down strips/gaskets.

To meet packaging dimension requirements.

3.9 Cut tops and bottoms of wider gloveboxes.

To meet packaging dimension requirements.

3.9.1 Position piece to be cut on two supporting lift tables or on 4 x 4 beams on floor, leaving space under cutting line.

To allow wide horizontal piece to be cut.

3.9.2 Cover horizontal piece with plastic and rubber mats.

To protect worker from injury and contamination.

3.9.3 Get on horizontal piece, nibble between obstructions, and cut through obstructions as necessary.

To complete sectioning.

3.10 Remove gasketed panels as required.

To avoid cutting through Plexiglass.

3.10.1 Put up greenhouse around panel.

To control contamination and ventilation.

3.10.2 Position prefabricated bag below/adjacent to panel and tape to hold in place.

To prepare for containment of panel with minimal spread of unfixed contamination.

3.10.3 Remove nuts and screws from hold-down panel, leaving sufficient number to hold panel securely in place.

To prepare for removing panel.

3.10.4 Maintaining panel position, remove final nuts and hold-down strips.

To prepare to remove panel.

3.10.5 Slowly pull or pry panel straight out, drape panel with wet rags, and gently place panel in containment bag.

To remove panel with minimal disturbance of unfixed contamination.

3.10.6 Slowly loosen and pull gasket from glovebox surface, wiping down gasket and surface beneath with wet rags, changing rags frequently.

To remove gasket with minimal disturbance of unfixed contamination.

3.10.7 Place rags and gasket in small plastic bag, remove air, seal bag with horsetail closure, and place in panel containment bag.

To control contamination.

3.10.8 Remove air from panel containment bag and seal with horsetail closure, repeating with additional bags until exterior is below contamination limit.

To control contamination.

3.10.9 Takes smears and survey inner and outer glovebox surface areas and work area (within greenhouse).

To control contamination and environmental exposure.

3.10.10 Clean/fix glovebox surfaces and work area to acceptable contamination levels.

To control contamination and environmental exposure.

3.10.11 Remove greenhouse

To clear work area for subsequent operations.

3.11 After cutting is finished for the day, decontaminate equipment, tools, and work area to acceptable levels.

To secure work area.

EXHIBIT 4 (Continued)

3.12 Return tools to proper locations, document room and equipment condition, and brief supervisor.

To complete cleanup and inform others of room, equipment, and work status.

- Where procedures were identified as a preferred way to lessen risk in task performance, a specific recommendation was generally made as to what should be included in the procedures. This information is found in fields 21-23 of the data file.
- Existing procedures that are applicable to a task/procedural step are identified as administrative training requirements (field 26 of the data file).

Training Requirements

An outline of the training content requirements for workers in the facility is presented in Exhibit 5. The material is displayed in three categories. The first category, "Systems Required Information," lists that knowledge which is necessary to perform each task from a technical or systems perspective. The second, "Academic Required Knowledge," lists knowledge necessary from a theoretical or academic perspective. The third category, "Administration Required Knowledge," includes knowledge of administrative procedures and organizational functions and relationships that workers in the facility will need to know.

The tasks from which the knowledge requirements derive are indicated by task number. Clusters of task numbers indicate common requirements.

As Exhibit 6 shows, most of the requirements are in the system category--knowledge of the facility and equipment, and skills in operating equipment, cleaning, and other kinds of manual tasks. Major subgroupings of system-required knowledge/skills might include, for example:

- Contamination control (room and equipment cleaning, fixing of contamination on exposed surfaces, etc.)
- General housekeeping
- Load movement
- Bagging, wrapping.

EXHIBIT 5

Task Number	System Required Knowledge
1.10	Understanding of negative pressure requirements How to set facility access alarm.
2.1.2	Understanding of need for task (covering floor of staging room and anteroom when glovebox is transferred on lift table).
2.1.3, 2.3.1, 3.1.4.4, 3.4.1, 4.2, 4.10	Rigging technique.
2.3.1, 2.3.2, 2.3.3, 3.1.4.1, 3.1.4.4, 3.4.1, 3.4.7, 3.9.1, 4.2, 4.6, 4.9	Gantry hoist operation.
2.3.1, 2.3.2, 2.3.3, 3.1.4.1, 3.1.4.4, 3.4.1, 3.4.7, 3.9.1, 4.2, 4.6	Load positioning stabilization. Coordination/communication between workers, role of signal man. Completion of existing class in material handling.
2.3.5	Concept of radiation zone boundaries, needed to respect zone boundaries.
3.1.1	Tool identification.
3.1.3	How to bag plastic and secure bag closure. Storage and disposal location for plastic.
3.1.4.1, 3.4.1, 3.4.6, 3.10.3, 3.10.4, 3.10.5, 3.10.6	How to operate personnel lift.
3.1.4.2	Operation of lift table brakes. Location of chocks. Selection of proper size and shape of chocks.
3.1.4.3	Use and limitations of different types of load stabilizing devices. Techniques of securing glovebox with different types of devices. Understanding of conditions that can result in load shift.

EXHIBIT 5 (Continued)

Task Number	System Required Knowledge
3.2, 3.4.6, 3.7, 3.8 3.9.3	How to operate cutting tools (porta-band, holesaw, reciprocating saw). Appropriate tool for material to be cut and location of cuts. Minor use-repair of cutting tools.
3.3, 3.4.4, 3.5, 3.10.8, 3.10.9, 4.9, 4.11	RPTS: Survey techniques (covered by existing training). Orientation to facility operations, special requirements.
3.4.2, 3.9.3	How to operate nibbler. Techniques to unjam nibbler. How to back nibbler out of cut.
3.4.3	Technique of taping.
3.4.5	Fixing technique using tape or fixative paint.
3.7, 3.8, 3.10.3, 3.10.4, 3.10.5, 3.10.6	Awareness of increased probability of unfixed contamination.
3.9.2, 3.10.1 thru 3.10.6	Location of tools/materials.
3.10.1	Technique of putting up and sealing greenhouse. Reason for use of greenhouse.
3.10.2	Reason for use of special containment bags for panels.
3.9.2, 3.10.3 thru 3.10.6	Reason for precautions.
3.10.4 thru 3.10.8, 5.1, 5.3	Coordination between workers.
3.10.7, 3.10.8	Technique for securing bag.
3.12	Expected/proper conditions and locations of tools, equipment, and materials.
4.1	Technique for handling plastic without spreading contamination.
4.3	Banding technique.

EXHIBIT 5 (Continued)

Task Number	System Required Knowledge
4.4	Need for padding. Padding and taping technique.
4.8	Need to keep lift table and package out of anteroom at this stage.
1.2.1, 1.2.2, 1.6, 1.8, 2.1.1, 2.4.1, 2.5, 3.1.1, 3.1.4.1, 3.1.4.3, 3.2, 3.4.1, 3.4.2, 3.4.6, 3.10.1, 3.11, 4.7, 4.9, 4.11, 4.13	None.
1.2.3, 2.1.1, 2.4.1, 2.5, 3.1.3, 3.3, 3.4.4, 3.5, 3.10.8, 3.10.9, 3.11, 4.7, 4.9, 4.11, 4.13, 4.14	RPTs: Completion of existing training.
1.3	Principles of contamination control.
1.5	APS 9.0, APS 8.
2.2.1, 2.2.2	General principles of ventilation system (vent and balance).
3.1.2	Understanding of hazards associated with breach of protective clothing and cut injury.
1.1	Who to call for authorization. General building functions, traffic flow.
1.2.2	Who to notify, what to do if air recirculation exhauster is not operating properly.
1.2.3	D&D workers: should know to stay out of zone until task is completed (CAM check by RPTs).
1.3	Procedures and standards pertaining to dress (GEN-0 and/or RWP specifying dress for size reduction operations).
1.4	Previous activities in room.
1.5, 1.6	Who to report to if equipment does not operate properly.

EXHIBIT 5 (Continued)

Task Number	System Required Knowledge
1.8, 3.1.1	Where to obtain needed items (sectioning room tools/equipment/supply sources). Procedure to obtain needed items.
1.10	Procedure/standard specifying when door check is required.
2.1.1, 2.5, 3.3, 3.4.4, 3.5, 3.10.9, 3.11, 4.7, 4.13	RPTs: Criteria for contamination levels in different areas of facility and during different process activities and personnel dress. Criteria for continuation of work (personnel exposure limits).
3.1.2	Emergency notification procedure (RHOMA 111).
3.1.3	RPTs: Contamination limits governing acceptability of plastic for reuse.
3.1.4.3, 3.2, 3.4.1, 3.4.6, 3.4.2, 3.7, 3.8, 3.9.1, 3.9.3	Familiarity with, understanding of work plan for sectioning.
3.10.1, 3.10.11	Familiarity with procedure ZO-170-300 (greenhouse construction).
3.10.8	RPTs: Contamination limit for disposal of panel containment bag.
4.9	RPTs: Acceptable contamination limit for movement of package into anteroom.
4.11	RPTs: Contamination control criterion for movement of package into staging room.

A modest amount of administrative knowledge is required of D&D workers in the facility. The administrative knowledge required is primarily familiarity with the organization structure and functions, as necessary to obtain materials, plus knowledge of procedures applicable to D&D operations in general. Requirements related to obtaining authorization and certifications belong to the supervisor. (There will be substantially greater administrative knowledge requirements for the supervisor than were identified in this analysis, as it addressed only glovebox processing sequences within the facility.)

Very few "academic" training requirements are called for by the tasks of D&D workers. Any general principles were assigned to that category, but even they could be considered system-related. The work requirements in themselves would not appear to require more than an eighth grade education in academic areas. Manual/physical coordination skill, strength, endurance, and attitudinal factors appear to be more important prerequisites for the job than educational background. This should be kept in mind when developing training materials (and procedures) and in the selection of modes of training.

Task Difficulty

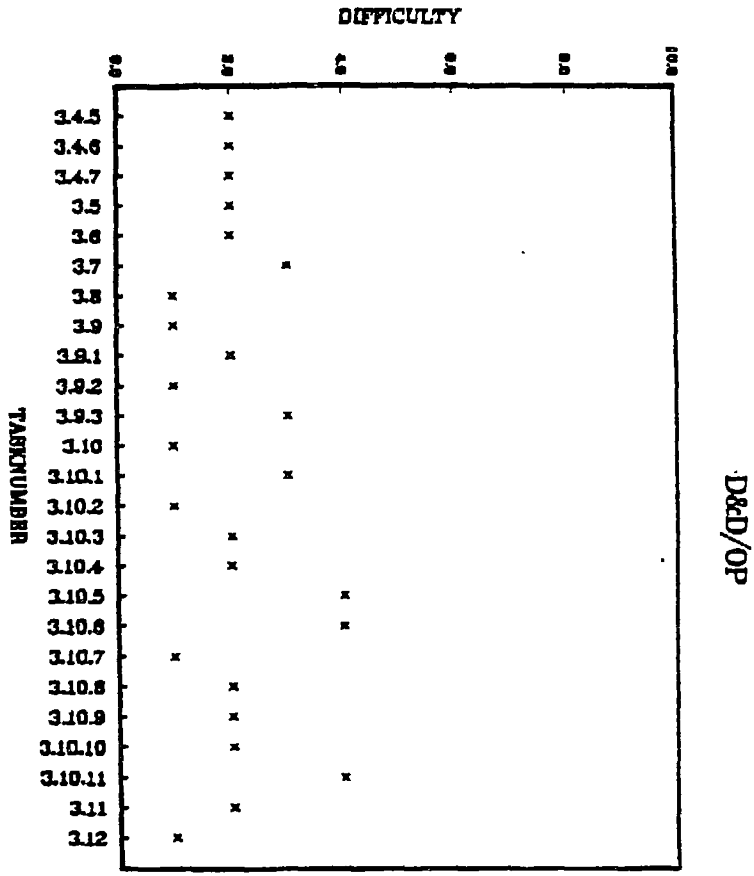
Exhibit 6 is a series of plots that provides a profile of rated task difficulty. A relative rating scale was used, with choices from 1 (easy) to 5 (most difficult).

Exhibit 6 shows that most of the tasks were considered relatively easy to perform. All but 9 of the 94 tasks analyzed received a difficulty rating of 1 or 2.

Tasks rated moderately difficult (rating of 3) were mostly cutting tasks--access cuts, nibbling, cutting through structural supports, etc. (Tasks 3.2, 3.4.2, 3.8, 3.9.3). The task of putting up a greenhouse (3.10.1) and that of placing packages in the burial box (5.4) were also rated moderately difficult. The difficulty factor in these cases has to do

EXHIBIT 6

TASK DIFFICULTY PROFILES



with physical effort and control requirements in the operation of power tools (especially in view of protective clothing) and the tripod hoist.

Greenhouse removal (Task 3.10.11) was one of three tasks that were considered difficult (rating 4). The other two were steps in the removal of gasketed panels (Tasks 3.10.5 and 3.10.6). The difficulty factor in these cases is the extreme care required to control unfixed contamination. No task received the highest difficulty rating (5).

The tasks identified above are candidates for further study. It may be possible and desirable to simplify the requirements through design/equipment strategies; or these tasks may need to be spelled out in greater detail in procedures and/or training.

In general, a low difficulty profile indicates relatively low training time and cost requirements. However, other factors should be taken into consideration. This analysis divided tasks into small steps to accomplish the procedures objective. Difficulty was rated at the subtask level when subtasks were involved. Steps may individually be easy, but when they must be integrated in the task flow, difficulty may be evaluated differently. Another factor to consider is that in many cases, the consequences of task performance error could be substantial, even though the task is considered relatively easy. It may be desired to commit more training time and resources than might be given to similar tasks in other contexts, to emphasize and assure reliability of performance.

Training Mode Recommendations

Preferred modes of training were also considered in the analysis. Four modes were considered. They are listed below, ordered according to frequency of recommendation:

- o On-the job·training (OJT)--recommended for 44 tasks
- o Simulation/mockup--recommended for 30 tasks

- o Drill--recommended for 24 tasks

- o Classroom--recommended for 18 tasks.

In many cases more than one mode of training was considered acceptable or desirable.

The training mode recommendations reflect the physical/manual nature of the work and correspond to the distribution of types of knowledge requirements (primarily system/equipment related). Classroom training, where it is recommended, would often be more in the line of orientation than formal instruction. In some of the cases in which classroom training was recommended, the program already exists. Independent study was not included as a choice on the task analysis data form but could be evaluated as a possible substitute for classroom training.

When OJT was recommended it was in most cases stipulated that the training should not occur in the course of facility operations. It was suggested that there would be opportunities for OJT in less critical operations.

A combination of OJT and simulation/mockup exercises appears desirable. Workers could learn the task requirements in other settings and then practice integrating and applying what they learned in a mockup where they could simulate size reduction processes.

Drill refers to repeated practice that need not or cannot occur using a mockup. For example, drill in cutting stainless steel with a nibbler was recommended.

Exhibit 7 identifies the specific tasks for which each mode of training was recommended.

EXHIBIT 7

PREFERRED MODES OF TRAINING

Task Number	Training Mode
1.1, 1.2.2, 2.1.4, 2.4.2, 3.1.3, 3.4.4, 3.5, 3.10.9, 5.6, 5.8	No training required for D&D workers
1.2.1-1.2.3, 1.3-1.10, 2.1.1-2.1.3, 2.3.1, 2.3.3-2.3.5, 2.4.1, 2.5 3.1.1, 3.1.2, 3.1.4.1-3.1.4.4, 3.4.1, 3.4.2, 3.4.5, 3.9.3, 3.101-3.104, 3.10.11, 3.11, 3.12, 4.1, 4.4, 4.5, 4.7, 4.8, 4.11, 4.13, 4.14	OJT
2.1.1, 2.3.1-2.3.3, 3.1.4.1-3.1.4.4, 3.2, 3.3, 3.4.1-3.4.3, 3.4.6, 3.4.7, 3.7, 3.8, 3.9.1-3.9.3, 3.10.1, 3.10.5, 4.6, 4.9 4.10-4.14	Simulator/mockup
1.3, 2.2.1, 2.2.2, 3.2, 3.4.6, 3.4.7, 3.6-3.8, 3.9.1, 3.9.3, 3.10.1, 3.10.5, 3.10.10, 3.10.11, 4.2, 4.3, 4.6, 4.10, 5.1, 5.3-5.5, 5.7	Drill
1.3, 1.4, 1.7, 2.2.1, 2.2.2, 2.3.1, 2.3.3, 3.1.1, 3.4.2, 3.6, 3.9.2, 3.10.2, 3.10.6-3.10.8, 3.10,10, 4.2, 5.2	Classroom

Risk Analysis

The graphs provided in Exhibit 8 plot the relative risk of the tasks to be performed in the facility. Risk, as previously defined, is the product of rated "Severity of consequence" times "Probability of Error." (P(E) x S(C)) The following tasks were identified as involving substantial risk:

1.2.3
3.1.2
3.1.4.2
3.3
3.4.7
3.9.1
3.9.2
5.4

Note that most of these tasks are performed during process Step 3 (size reduction) which therefore will required close control due to the substantial level of risk involved.

The types of potential performance error identified in the analysis are summarized in Exhibit 9. In addition, hazards intrinsic to the tasks (not generated by performance error) were identified (see Exhibit 10). Although they do not figure in the quantitatively-based risk profile, they represent another dimension of risk that should be taken into account in the planning and operation of the facility.

Support Equipment

Exhibit 11 is a comprehensive list of support equipment needed to execute specific tasks. Task number are provided indicating where particular tools are used in the process sequence.

EXHIBIT 8

RELATIVE RISK PROFILES

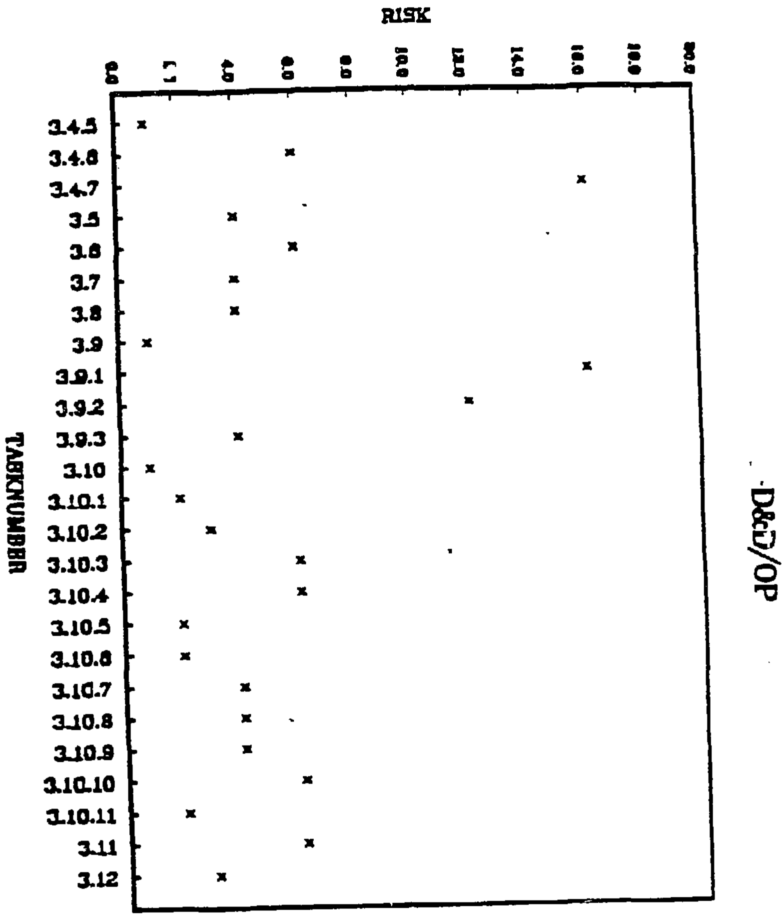


EXHIBIT 8
RELATIVE RISK PROFILES

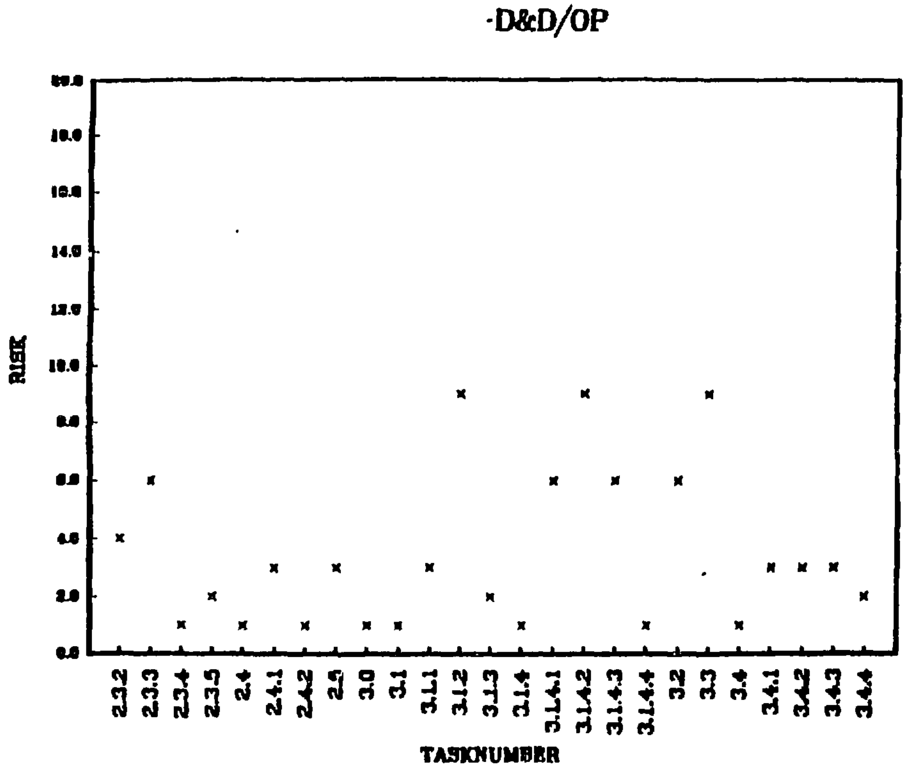


EXHIBIT 9

Task Number	Most Likely, Serious Potential Human Errors
3.10.5	Gasket pierced or disturbed in removing panel
3.10.6	Tearing gasket
3.10.7, 3.10.8	Sudden uncontrolled expulsion of air from bag
3.10.10, 3.11, 4.7 3.6	Inattention to task, e.g., tracking contamination to clean area, touching clean area with contaminated gloves
3.10.11	Sudden uncontrolled collapse of greenhouse
3.4.6, 3.7, 3.8, 3.9.3	Misuse of saw
3.4.6	Failure to stabilize section while cuts are made
3.4.7, 2.3.3	Leaving hands/feet under load when set down
3.4.7, 3.9.1, 4.10	Tipping hoist over
3.4.7, 3.9.1, 4.6 3.10.5	Dropping load
3.10.1	Loss of integrity during construction
3.1.4.1	Too much tension on lift raising glovebox off of table
3.1.4.2	Wheels not chocked or improperly chocked
3.1.4.3	Poor choice, positioning or securing of stabilizing devices
3.2	Cut through area with covered but unfixed contamination
3.2	Insufficient attention to industrial hazards
3.3	Accidental contact with sharp metal edge when taking smear
3.4.2, 3.9.3, 3.4.5	Getting nibbler stuck
3.12	Misinformation given

EXHIBIT 10

HAZARD SUMMARY

Task Number	System Required Knowledge
3.2	Sparks and hot metal segments generated by cutting High noise from saw operation Electrical shock Tripping
3.3, 3.4.3, 3.4.6, 3.4.7, 3.9.1 4.3	Sharp metal edges
3.4.2	Noise
3.4.6	Potential for section to shift when cut free
3.6, 3.10.10, 3.11 4.7	Slipping hazard (caustic liquid or chemicals on floor)
3.7, 3.8	Loss of containment resulting in spread of contamination due to unfixable contamination
5.1	Doorsills, if present, may impede safe movement of loaded hoist through doorway

EXHIBIT 11

SUPPORT EQUIPMENT

Task Number	Equipment
1.3	Procedure and/or RWP specifying D&D dress requirements, or checklist incorporating general and specific requirements
1.7	Tape measure
1.10	Facility access control sign
2.1.2	Plastic runner
2.1.2, 3.10.11, 4.4	Scissors and/or knives
2.1.2, 3.1.3, 3.10.7, 3.10.11, 4.4, 4.7, 4.9	Tape
2.2.1, 2.2.2, 2.3.3 4.10	Lift table
2.3.1, 2.3.3, 4.2, 4.9	Gantry hoist
2.3.1, 2.3.3	Hoist rigging
2.3.1, 2.3.3, 3.4.6, 4.2, 5.3, 5.5	Leather gloves
2.4.1, 3.1.3, 3.3, 3.4.4, 3.6, 3.10.9, 4.7, 4.9	Muslin
2.4.1, 3.1.3, 3.3 3.4.4, 3.6, 3.10.7, 3.10.9, 4.7, 4.9	Plastic bags
2.4.1, 3.10.9, 4.7	Radiation detection instruments
2.4.1, 3.6, 4.7	D&D chemicals
3.1.1	Tool checkoff list
3.1.3, 3.3, 3.4.4, 4.9	Survey instruments (poppy)
3.1.3, 3.10.11	Waste container drum (55 gallon)

4. CONCLUSIONS

This paper demonstrates how task analysis can be used to anticipate and assess risk factors related to human performance. It also demonstrates how task analysis can be used to ensure integration of design, procedures, and training, by examining all three from the perspective of what the workers must do to accomplish work systems objectives.

Task analysis goes beyond JSA in depth, thoroughness and scope of factors considered; and it is more consistent with current trends in safety, control and risk management in integrating safety-related matters into the total work performance and management picture. It can be tailored to the needs and capabilities of the organizations using it, as well as to the complexity or simplicity of the operations or facilities being evaluated. As with other systems analysis methods, it is best and most effective when applied early in the life-cycle; but also it must be periodically reviewed for currency and completeness, and revised or redone to meet system changes. It is another effective and proven tool that organizations should add to their repertoire of methods to attain and maintain the highest levels of human performance, operational readiness and organizational efficiency.

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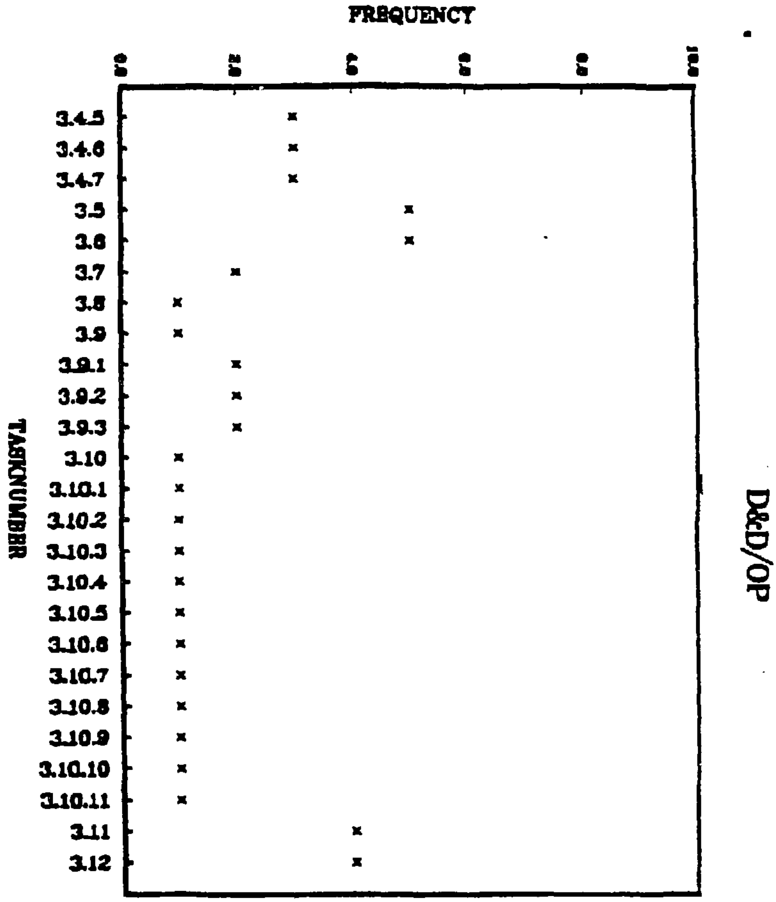
APPENDIX

This appendix contains examples of additional data from the task analysis. Included are plots of (a) task frequency ratios, (b) relative probability of task performance error, and (c) rated severity of error consequence. (Items b and c show the risk calculation terms individually.)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3.7
3.8
3.9
3.9.1
3.9.2
3.9.3
3.10
3.10.1
3.10.2
3.10.3
3.10.4
3.10.5
3.10.6
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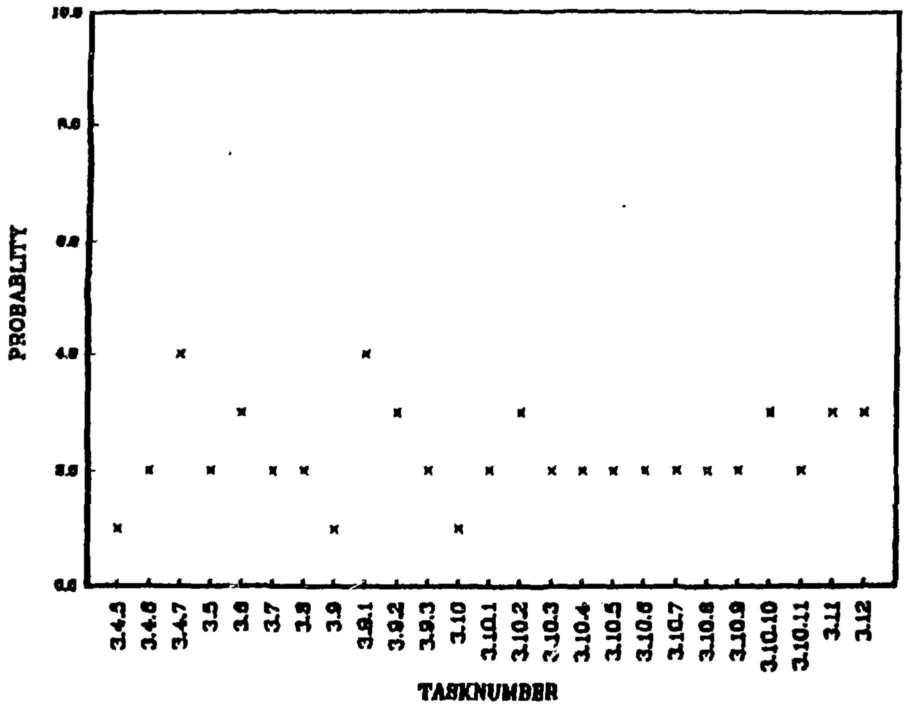
3.10.11
3.11
3.12
D&D/OP

D&D/OP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3.4.6
3.4.7
3.5
3.6
3.7
3.8
3.9
3.9.1
3.9.2
3.9.3
3.10
3.10.1
3.10.2
3.10.3
3.10.4
3.10.5
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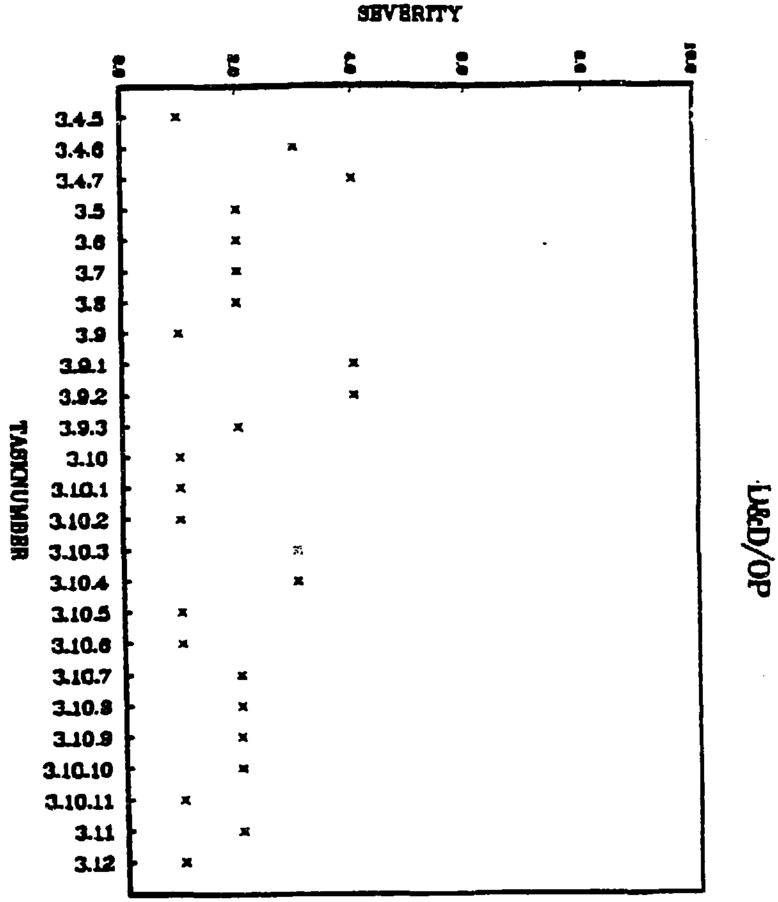
TASKNUMBER


SEVERITY
TASKNUMBER
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3.10
3.10.1
3.10.2
3.10.3
3.10.4
3.10.5
3.10.6
3.10.7
3.10.8
3.10.9
3.10.10
3.10.11
3.11
3.12
LR&D/OP

TASK NUMBER	TASK DESCRIPTION
1.5	VISUALLY CHECK CABLES AND ACTIVATE HOIST (PUSH BUTTON CONTROL)

TASK NUMBER	TASK DESCRIPTION
1.6	RAISE AND LOWER LEFT TABLES IN SECTIONIN-G ROOM, AND TEST WHEEL BRAKES

TASK NUMBER	TASK DESCRIPTION
1.7	VISUALLY ESTIMATE OR MEASURE GLOVEBOX DI-MENSIONS

TASK NUMBER	TASK DESCRIPTION
1.8	VISUALLY CHECK THAT TOOLS, EQUIPMENT, & SUPPLIES ARE IN PLACE IN SECTIONING ROOM IN SUFFICIENT QUANTITY & COVER SEC-TION-ING LIFT TABLE WITH 3 LAYERS OF PLAS

TASK NUMBER	TASK DESCRIPTION
1.9	VERIFY PERSONNEL ARE IN POSITION FOR TRA-NSPORT OF GLOVEBOX

TASK NUMBER	TASK DESCRIPTION
1.10	POST OUTER DOOR TO STAGING ROOM AND ACTI-VATE ALARM

TASK NUMBER	TASK DESCRIPTION
2.0	TRANSPORT

TASK NUMBER	TASK DESCRIPTION
2.1	PREPARE FOR TRANSPORT

TASK NUMBER	TASK DESCRIPTION
2.1.1	SURVEY AND, AS NECESSARY, CLEAN ANTE- RO-OM

TASK NUMBER	TASK DESCRIPTION
2.1.2	CUT PLASTIC RUNNER, TAPE EDGE TO FLOOR I-N STAGING ROOM, AND ROLL RUNNER TO INNER CURTAIN OF ANTE-ROOM