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The NMT-5 Criticality Database

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Barbara Cort
Brad Perkins
Gary Cort

Los Alamos
NATIONAL LABORATORY
Los Alamos, New Mexico 87545

THE NMT-5 CRITICALITY DATABASE

by

Barbara Cort, Brad Perkins, and Gary Cort

ABSTRACT

The NMT-5 Criticality Database maintains criticality-related data and documentation to ensure the safety of workers handling special nuclear materials at the Plutonium Facility (TA-55) at Los Alamos National Laboratory. The database contains pertinent criticality safety limit information for more than 150 separate locations at which special nuclear materials are handled. Written in 4th Dimension for the Macintosh, it facilitates the production of signs for posting at these areas, tracks the history of postings and related authorizing documentation, and generates in Microsoft Word a current, comprehensive representation of all signs and supporting documentation, such as standard operating procedures and signature approvals. It facilitates the auditing process and is crucial to full and effective compliance with Department of Energy regulations. It has been recommended for installation throughout the Nuclear Materials Technology Division at Los Alamos.

I. INTRODUCTION

Radiological workers inside the Plutonium Facility (TA-55) at Los Alamos National Laboratory use glove boxes to handle large quantities of special nuclear material (SNM). For tracking purposes, each glove box, or other SNM handling area, is referred to as a MASS (for Materials Accountability and Security System) location. Currently, the Weapon Component Technology Group (NMT-5) has the responsibility for approximately 150 MASS locations throughout its work areas within the Plutonium Facility. Each MASS location's criticality limits are documented on a Criticality Safety Limit Approval (CSLA) form.

One or more signs posted at each MASS location list the criticality limits applicable to that location. Approximately 250 signs, consisting of 24 different sign types, are in place at the 150 MASS locations. The appendix to NMT-5 administrative procedure 002-APP, NMT-5 Criticality Safety, contains copies of all signs. Each MASS location may also have applicable Safe Operating Procedures (SOPs) that provide instruction as to the correct use of that MASS location.

Previous generations of criticality limit signs were prepared manually and with Autocad. The signs were then photocopied for incorporation into NMT-5 administrative procedure 002-APP as an appendix. The CSLA forms were prepared manually. This manual approach, while sufficient, presented two significant problems: a significant amount of time was required to create each sign, CSLA form, and appendix document and the potential for human error was great.

The NMT-5 Criticality Database was conceived to ease the management of criticality information and the maintenance of the criticality limit signs and their associated documentation. The database is written in 4th Dimension (4D), a relational database for the Macintosh. This tool provides powerful search and sort capabilities that facilitate auditing of the posted signs. The database stores all information for

each MASS location's CSLA forms and signs. Printing the CSLA forms and signs is easily accomplished from the database, which can also be used to generate the appendix in Microsoft Word format.

The creation of the appendix illustrates the complexity of the documentation requirements and demonstrates the ability of the database program to facilitate the process by automation. The appendix consists of a “chapter” for each room that has MASS locations (Fig. 1). Each “chapter” begins with an alphabetized list of the room’s MASS locations. The remainder of each “chapter” consists of a graphic (one per page) showing each sign. The sign pages appear alphabetized by sign name within each chapter.

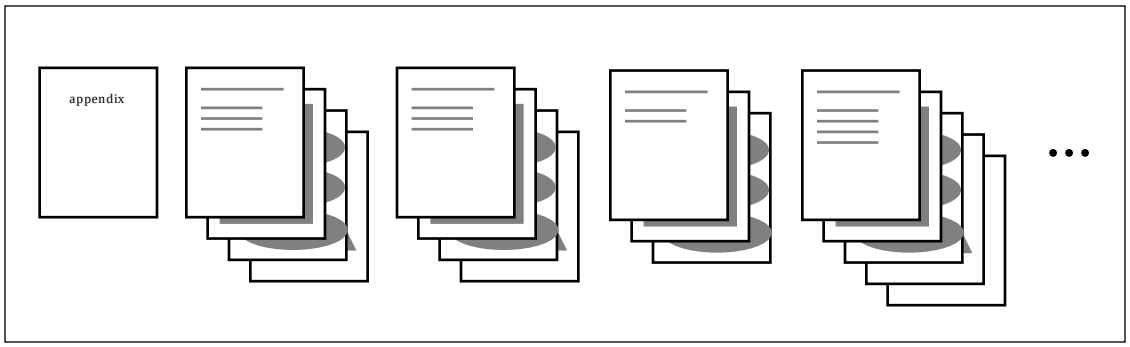


Fig. 1. Organization of administrative procedure 002-APP, NMT-5 Criticality Safety.

Before the database was developed, creation of the appendix required that each of the approximately 250 signs be photocopied and manually inserted into the final document. For each room, the user identified and sorted the room's MASS locations, created its alphabetized MASS location list, and created and properly inserted each sign page into the document. Manually creating this large document was time-consuming and potentially error-prone. Using the database to create this document saves time and ensures document accuracy.

II. DATABASE DESIGN

A. Relational Structure

The database is designed around MASS locations—the primary goal being the management of the signs, SOPs, and CSLA forms associated with each MASS location managed by NMT-5. For each MASS location the user of the database must be able to assign and retrieve the associated signs and SOPs for that MASS location. The user must also be able to determine the MASS locations for which a single SOP applies. A MASS location must have at least one sign and may have no or many SOPs. Figure 2 shows the primary organizational structure for the database. The arrows represent the relationships between the major database areas.

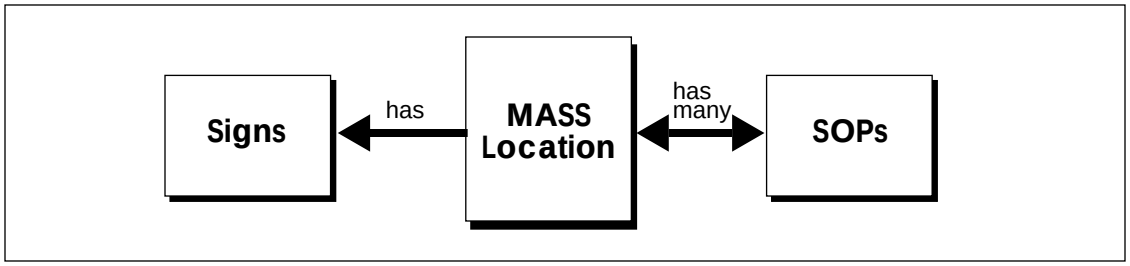


Fig. 2. Organization of primary database.

B. Signs

The database contains information necessary to print the sign or signs for each MASS location. This information is also used to generate the appendix document. Because many signs share the same format, signs are categorized by sign type. An example of a common sign is shown in Fig. 3.

The information appearing below the title “CRITICALITY LIMITS” is unique to the MASS location This unique information consists of the MASS location and the location or workstation diagram, which may detail an entire glove box, part of a glove box, a safe drawer, or a floor location such as a diagnostic instrument. Currently, there are 24 sign types in the database; an example of each is provided in Appendix A. For some sign types, many signs exist; for others, only one sign exists.

For each sign, the following information is stored:

- unique identifier,
- MASS location,
- diagram,
- sign type, and
- sign date.

For each sign type, the following information is stored:

- unique identifier and
- special instructions for using the sign type.

The sign type is used to determine the background used when printing the sign. Each of the 24 sign types has a specific background. The sign’s diagram is placed on this background in a predetermined location. A sign type’s special instruction is used for issuing guidance when printing a sign. For example, some signs require printing on special colored paper. Special instructions, such as those alerting the user to print on special colored paper, appear before these signs are printed.

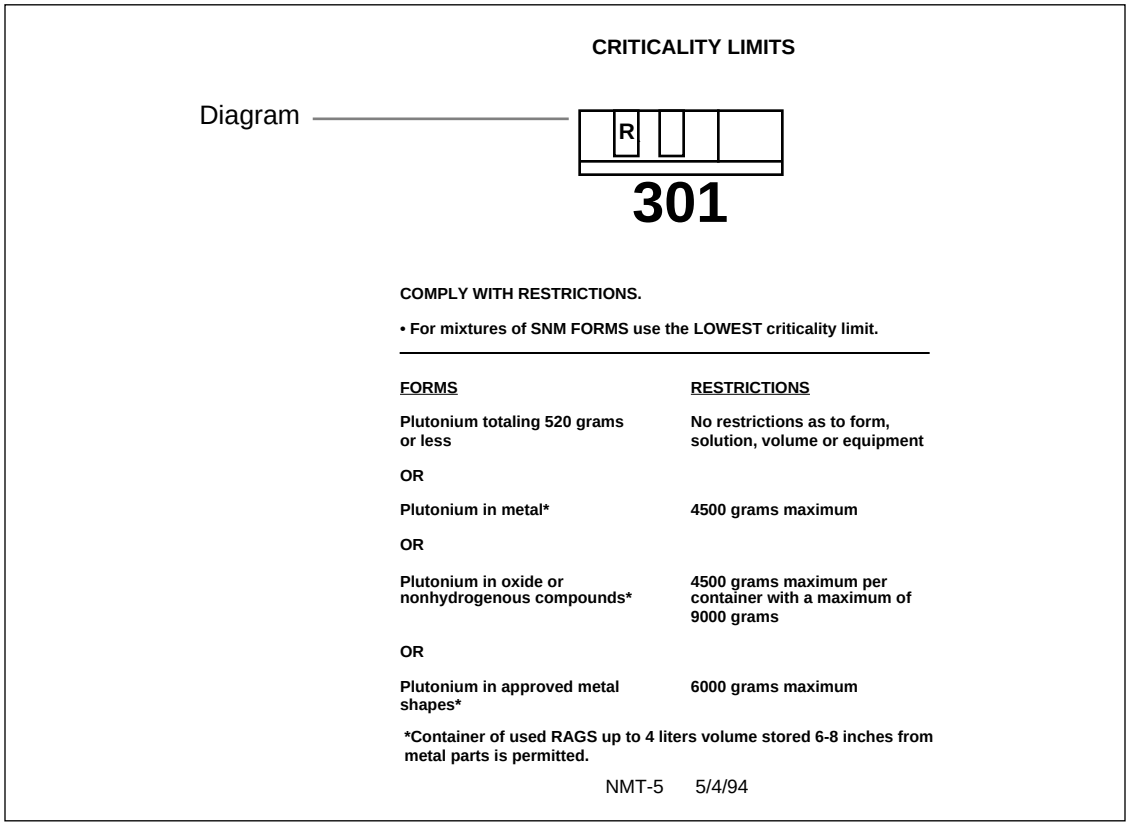


Fig. 3. Example of MASS location sign.

C. MASS Locations

For each MASS location, the following information is stored:

- unique MASS location identifier and
- room number.

Signs and SOPs related to MASS locations are indicated by the unique mass location identifier.

D. SOPs

For each SOP, the following information is stored:

- date,
- unique SOP identifier,
- title,
- author, and
- expiration date.

Having this SOP information enables the user to locate documents based on when they were written (or put into service), identify SOPs written by a certain author, and easily identify SOPs that have expired.

E. CSLA Forms

A CSLA form is the parent documentation of approval for criticality safety limits for a particular MASS location and includes the required signatures. The generic limits and formats for the signs are specified by administrative document 522-GEN, NMT Criticality Safety.

For each CSLA form, the following information is stored:

- the date the form was requested,
- the name of the person who requested the form,
- the identifier of the MASS location the form applies to,
- the room number where the form's MASS location resides,
- a process description for the MASS location,
- a list of possible hazards for the MASS location's process,
- a list of the effects the MASS location's process has on or receives from adjacent operations,
- a list of proposed changes to the MASS location's criticality safety limits,
- limits to types and amounts of material that can pass through the MASS location,
- a list of all SOPs that apply to the MASS location, and
- a diagram of the MASS location's principal sign.

When a CSLA form is created in the database, it stores current information for a MASS location. If a MASS location's information changes, the CSLA form for that MASS location does not automatically change in the database. Therefore, one MASS location may have many CSLA forms. Each of these forms reflects the state of a particular MASS location at a specific point in time. When printed, a CSLA form has a signature and date area. Once signed and dated, the form becomes a permanent record of the MASS location's state at the time of signing.

III. DATABASE FUNCTIONALITY

Because the database runs on a Macintosh computer, information is accessed through a graphical user interface. The user navigates through the database by selecting an appropriate menu. There are three main menus: File, Edit, and Select (Fig. 4).

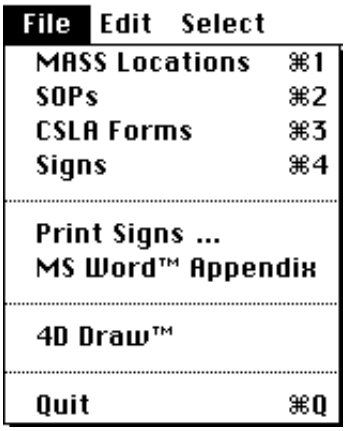


Fig. 4. File menu.

A. File Menu

The File menu enables the user to access the major database functions. Available menu items for data entry and display are MASS Locations, SOPs, CSLA Forms, and Signs. Additional menu items are available for printing signs, generating the Microsoft Word appendix document, and accessing 4D Draw.

1. MASS Locations Menu Item. The MASS Locations menu item enables the user to view a list of all MASS locations in the database. From this list the user can choose and modify an existing MASS location or create a new one. The list displays each MASS location and its room number (Fig. 5).

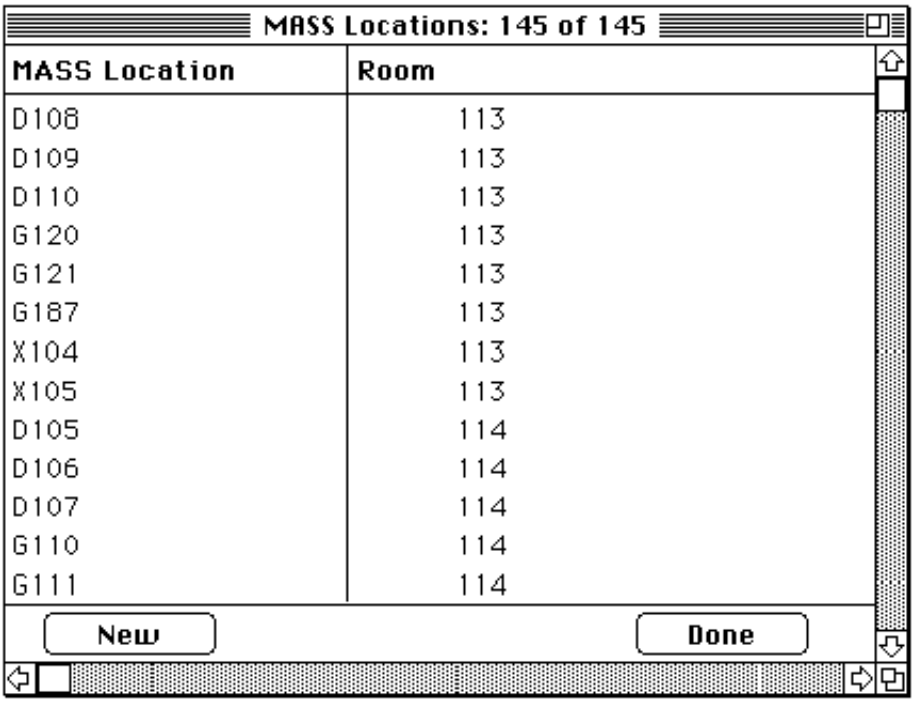


Fig. 5. MASS Locations List Window.

New MASS locations (Fig. 6) can be added to the database, and sign types, diagrams, and SOP information can be entered. The sign diagram is created with a drawing program, such as 4D Draw or MacDraw Pro, and pasted into the diagram window. The Signs list can be scrolled to accommodate as many signs as needed. Any existing SOP can be added to the SOP list. This list can be scrolled to accommodate as many SOPs as needed.

2. SOPs Menu Item. The SOPs menu item enables the user to view a list of all SOPs in the database. From this list the user can choose and modify an existing SOP or create a new one. The user can also easily query the database for expired SOPs. The list displays each SOP by date, identifier, title, author and expiration date (Fig. 7).

New SOPs can be added to the database using the entry window shown in Fig. 8. This window is also used to modify existing SOPs. Any existing MASS location can be added to the MASS Location list. This list can be scrolled to accommodate as many SOPs as needed.

3. CSLA Forms Menu Item. The CSLA Forms menu item enables the user to view a list of all CSLA forms in the database. From this list the user can choose and modify an existing CSLA form or create a new one. The user can also print selected CSLA forms from the list. The generic limits and the format for the signs are specified by administrative document 522-GEN, NMT Criticality Safety. The CSLA form is the parent document for the signs for each MASS location and includes the required signature approvals. The list displays each CSLA form by MASS location, room number, applicable SOPs, date, and requestor (Fig. 9).

New CSLA forms can be added to the database using the entry window shown in Fig. 10. This window is also used to modify previously entered CSLA forms. Note that because a CSLA form is a record of a MASS location at a particular point in time, modification of an existing CSLA form would occur only before signature approval. The CSLA Forms Entry Window allows data entry for request date, requestor, MASS location, process description, hazards (of process), effects (of process on or by adjacent operations), proposed change (in limits), pass-through limits, diagram, and SOPs used in the MASS location. An example of the CSLA form is shown in Fig. 11. The database contains all of the information required for this document and enables the user to search and sort for all fields on the form.

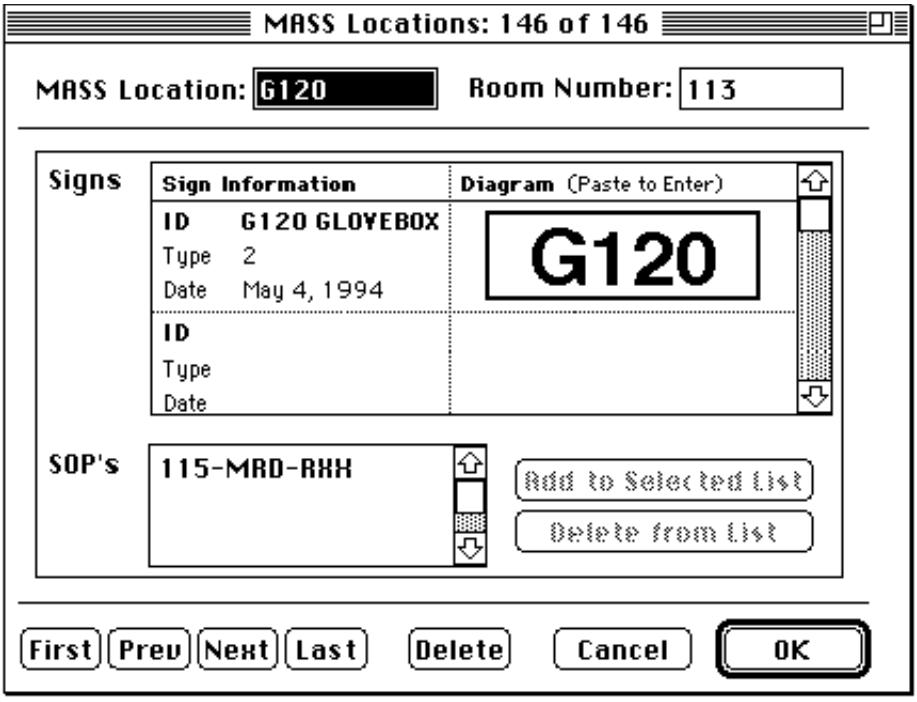


Fig. 6. MASS Locations entry window.

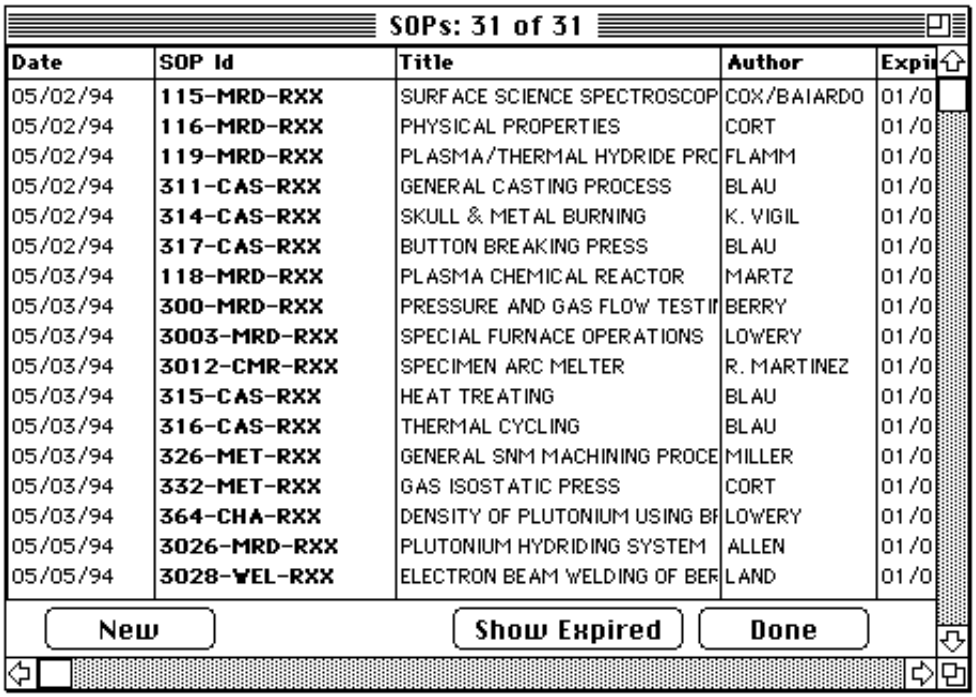


Fig. 7. SOPs list window.

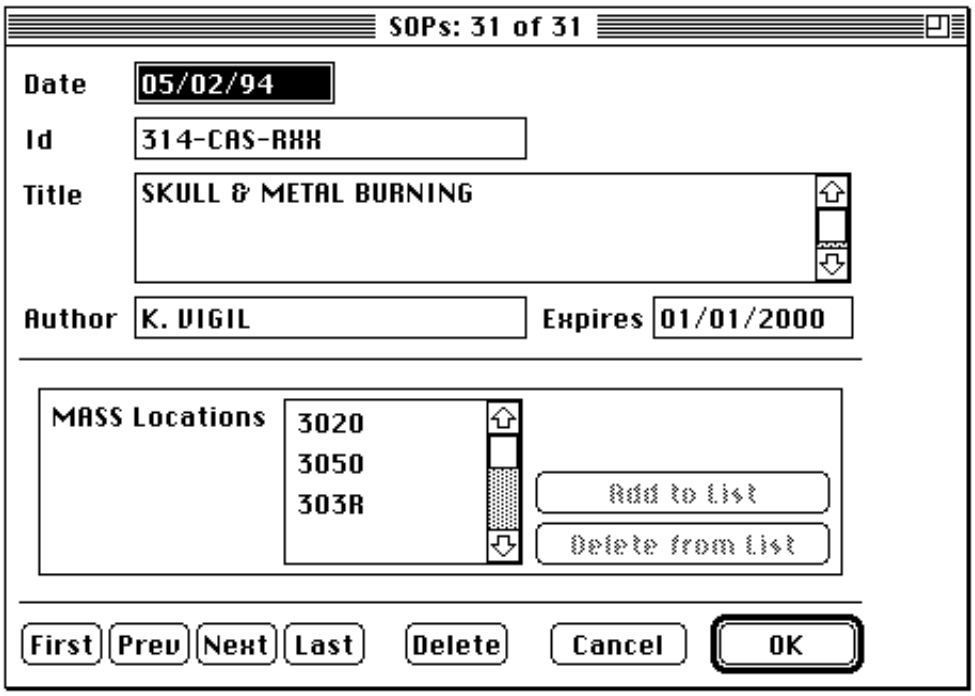


Fig. 8. The SOPs entry window.

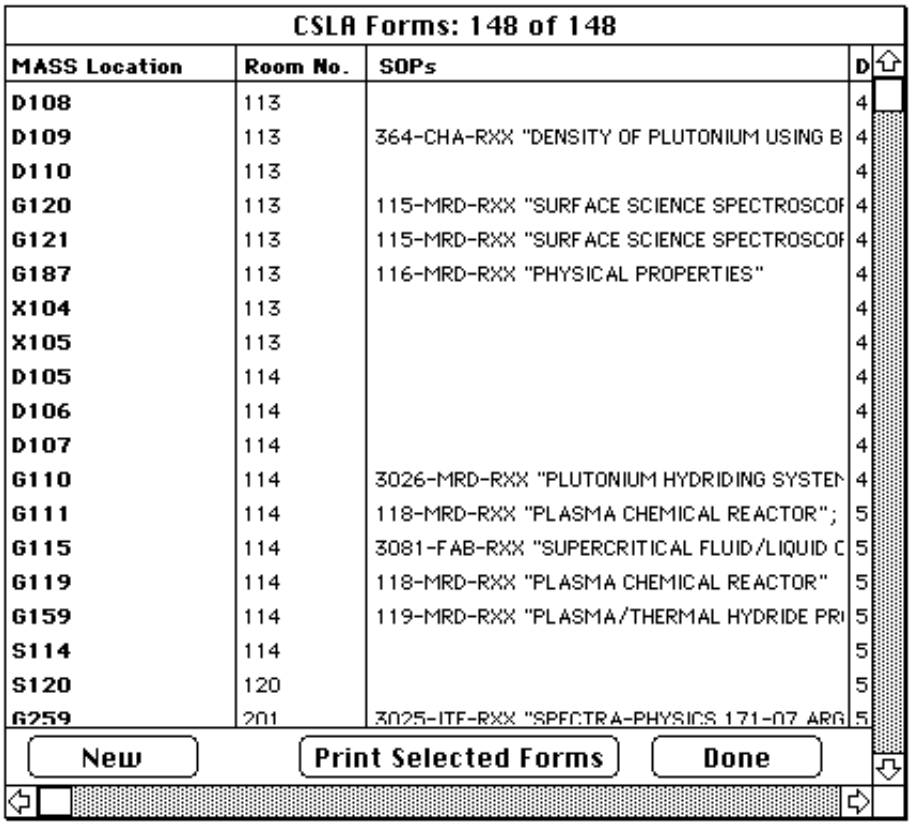


Fig. 9. CSLA Forms list window.

4. Signs Menu Item. The Signs menu item enables the user to view a list of all Signs in the database. From this list the user can choose and modify an existing sign or create a new one. The Signs List Window displays the sign identification, MASS location, sign type, and sign date (Fig. 12). For inventory purposes, the signs can be sorted by room to show the sign identification, MASS location, sign type, sign date, and diagram and then printed.

New signs can be added to the database using the entry window shown in Fig. 13. This window is also used to modify existing signs. Users can modify the diagram using 4D Draw by clicking the edit diagram button. The 4D Draw diagram edit window is shown in Fig. 14.

5. Print Signs Menu Item. The Print Signs menu item enables the user to select and print the actual MASS location signs using the information stored in the database. The selection of signs to print is created by using 4D's search editor. The standard search fields are MASS location and room number, but the user can also search by other fields such as sign identifier or sign date. Some sign types are printed on red paper; an alert appears on the screen if the signs selected for printing are of these sign types so the user can load the correct paper in the printer before printing.

6. Microsoft Word Appendix Menu Item. The Microsoft Word Appendix menu item enables the user to generate the appendix of NMT-5 administrative document 002-APP, NMT-5 Criticality Safety. This appendix contains copies of all criticality limit signs. The appendix is organized alphabetically by room number. Each sign is a graphic that occupies one page of the document, and each room is a generated as a separate appendix file. The files are then linked to form the complete appendix. The current appendix has approximately 250 pages. Generation of the complete appendix requires about 20 minutes and a sizable portion of the Macintosh resources, but this resource requirement is far less than the cost of the many person-days required for manual generation of the appendix.

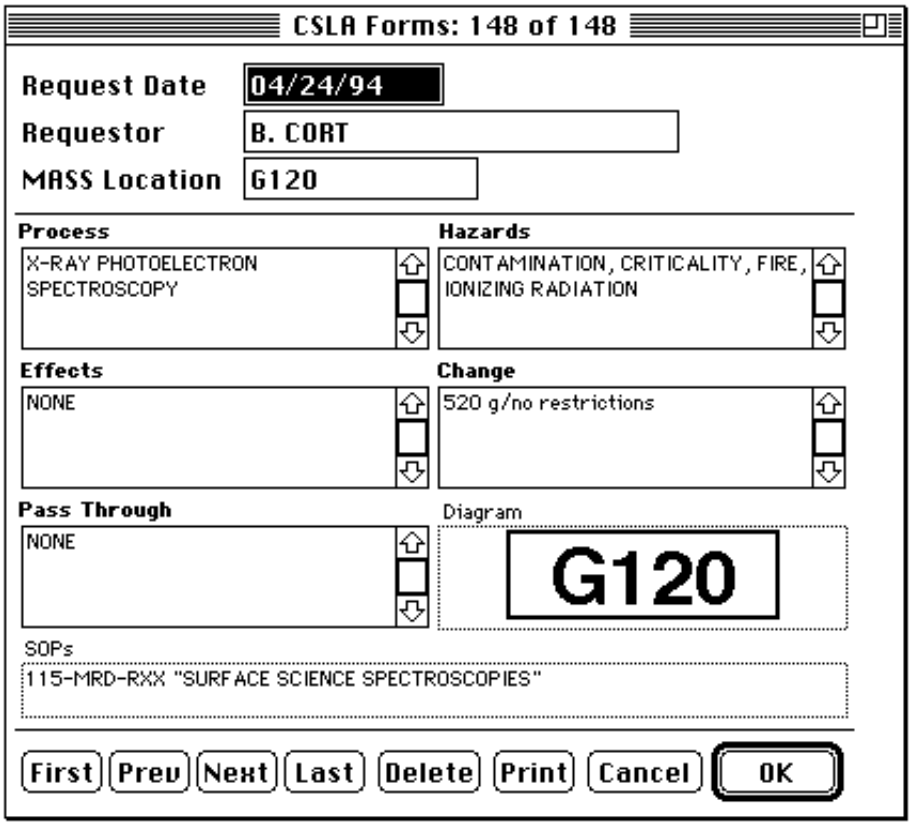


Fig. 10. CSLA Forms entry window.

Before generation starts, the user is presented with an option to selectively generate the appendix for specific rooms. While appendix generation is in progress, a status window appears so that the user can monitor progress. When generation is complete, the database produces a report. This report contains information that will assist the user in assembling the complete appendix document. For each room, the following information is reported:

- the name of the generated file,
- whether or not the room's appendix was generated,
- the number of pages in the room's appendix file, and
- the beginning and ending page numbers for the generated appendix relative to the overall document.

7. 4D Draw Menu Item. The 4D Draw menu item allows the user access to 4D Draw, 4th Dimension's powerful object-oriented drawing package. The user can use this feature to create sign diagrams or as a stand-alone drawing package for creating graphics for other applications. The 4D Draw window is shown in Figure 16.

B. Edit Menu

This menu provides the standard Macintosh editing features: Undo, Cut, Copy, Paste, Clear, Select All, and Show Clipboard. Items in this menu appear enabled or disabled, depending on the action being performed.

NMT-5 CRITICALITY SAFETY LIMIT APPROVAL

Room Number / MASS Location **113 / D109**

Change Requested by B. CORT Date 04/24/94

Standard Operating Procedure Numbers
(Include all SOPs that apply to the workstation.)
364-CHA-RXX "DENSITY OF PLUTONIUM USING BROMOBENZENE"

Brief Description of (each) Process:
STORAGE, ISOMET SAW, IMMERSION DENSITY

Hazards: CONTAMINATION, CRITICALITY, FIRE, IONIZING RADIATION, TOXIC CHEMICALS

Effects on or from Adjacent Operations:
NONE

Proposed Change in Criticality Limit:
520 g / no restrictions; Pu metal / 4500 g; Pu oxide or nonhydrogenous compounds / 3000 g per container, 9000 g maximum; Pu in approved metal shapes / 6000 g

Pass-Through Limits:
520 g / no restrictions; Pu metal / 4500 g; Pu oxide or nonhydrogenous compounds / 3000 g per container, 9000 g maximum; Pu in approved metal shapes / 6000 g

Diagram of Work Station:

Reviewed by _____ Date _____ Reviewed by _____ Date _____
Group CSO Group Section Leader

Reviewed by _____ Date _____ Approved by _____ Date _____
ESH-6 Group Leader

Fig. 11. CSLA Form example.

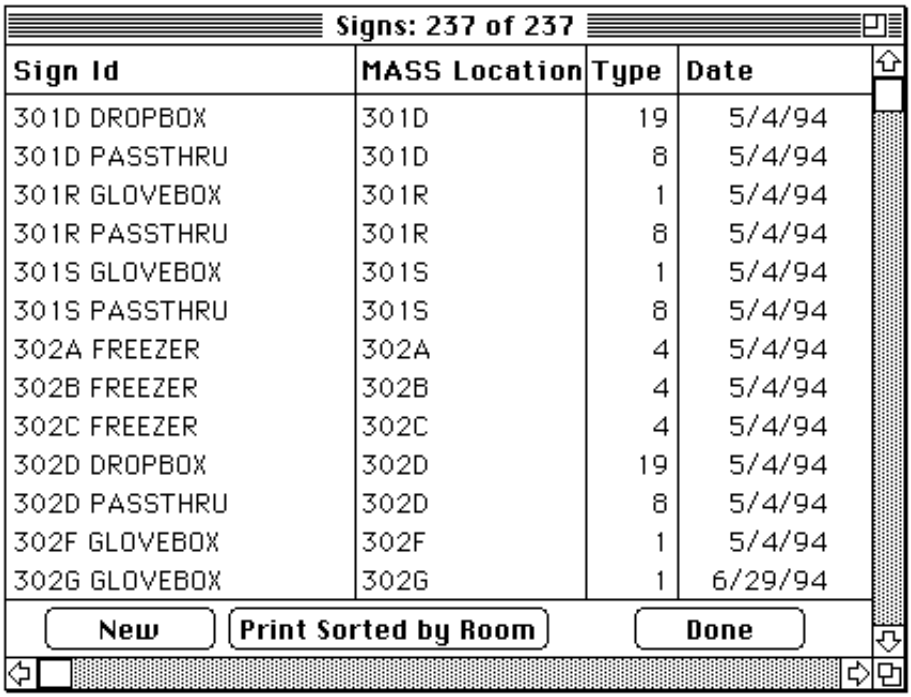


Fig. 12. Sign List window.

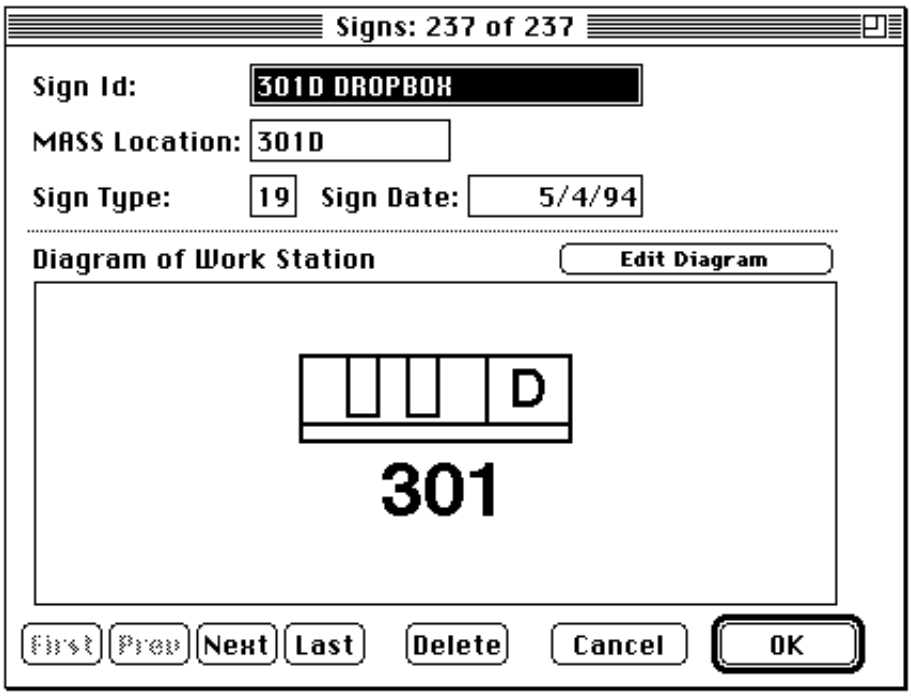


Fig. 13. Signs entry window.

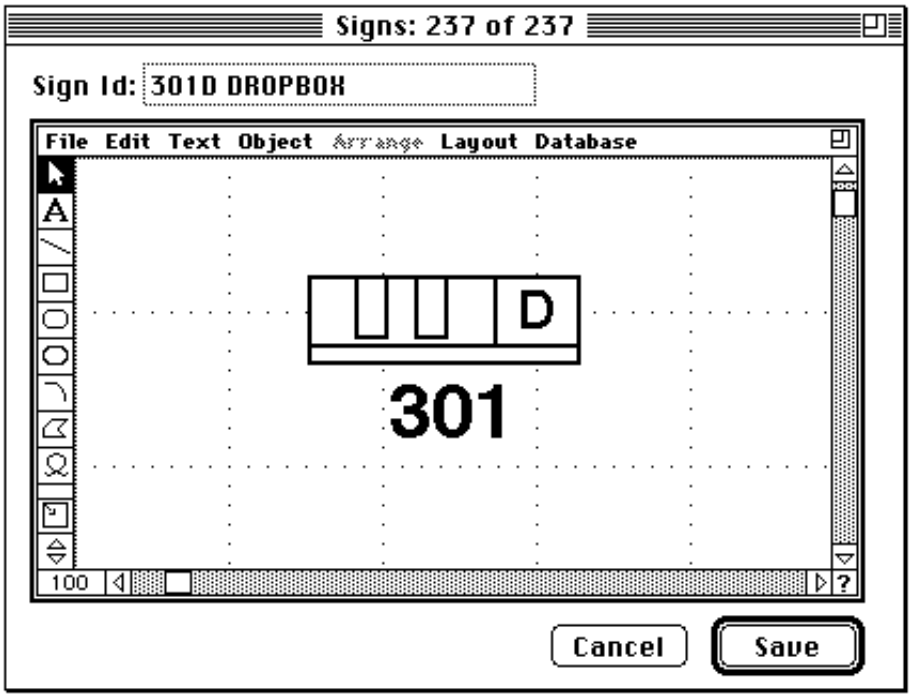


Fig. 14. Signs Diagram edit window.

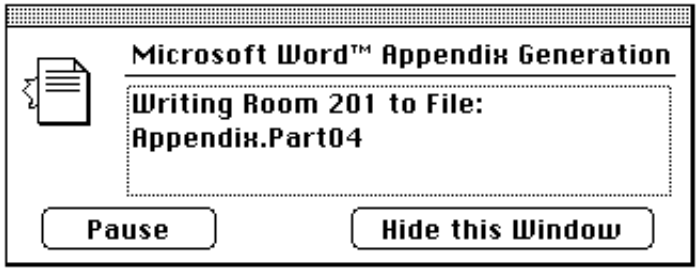


Fig. 15. Appendix Generation Status window.

C. Select Menu

The Select menu is used when working with MASS Locations, SOPs, CSLA Forms, and Signs. The items in this menu allow the user to easily find and arrange information for these four database areas. Because the database allows the user to work with more than one of these areas at a time, the Select menu items always apply to the frontmost window.

Show All restores the list of records to all of the file's records. The records appear in the order they were entered and saved in the database.

Show Subset enables the user to select individual records in a list. Choosing Show Subset reduces the listed records to those selected.

Search Editor... opens 4D's search editor. The user uses the search editor to find records that meet certain user-specified criteria.

Sort Editor… opens 4D's sort editor. The user uses the sort editor to determine the order that records appear in the record list.

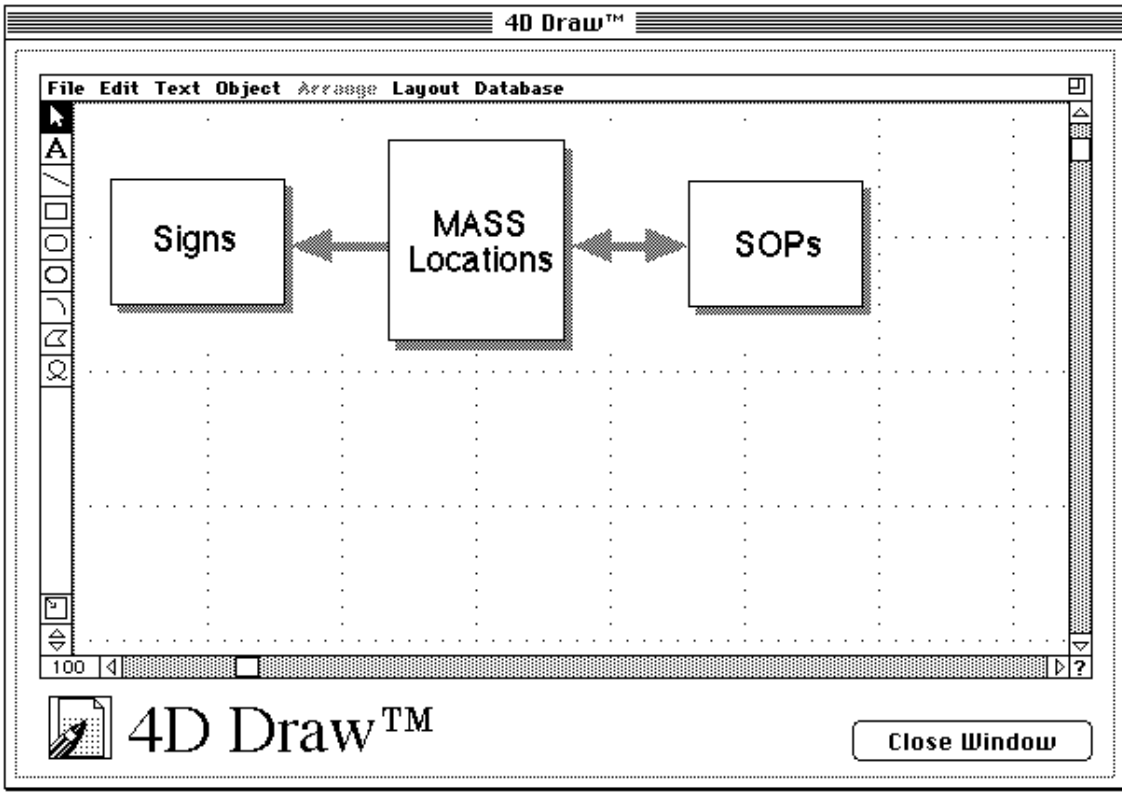


Fig. 16. 4D Draw window.

Print Selection sends the selected records to the printer. Records are printed using defined report formats.

Delete Selection deletes selected records from the database. The user is given the option to cancel the deletion.

IV. SUMMARY

The NMT-5 Criticality Database is a powerful tool for maintaining criticality-related data and documentation. It enables NMT-5 staff to easily produce and manage MASS location signs and the supporting documentation necessary for compliance with regulations of the Department of Energy and other agencies. It is designed to be user-friendly. Its search and sort capabilities provide ready access to pertinent information regarding criticality limit signs, which can be easily and quickly updated, produced, and posted. Generation of the appendix document is now simple and accurate, whereas in the past it was a tedious, time-consuming task.

The database facilitates audit of the signs and their supporting documentation. Reports that assist site audits can be produced quickly and used on the floor to ensure that MASS location signs and SOPs are present and correct. The database offers a complete approach for meeting regulatory requirements. The development and use of the database and the compliance methodology it supports have established NMT-5 as a criticality safety compliance leader within the Nuclear Materials Technology Division at Los Alamos National Laboratory, and the division director has suggested that the database be installed throughout the division.

APPENDIX A

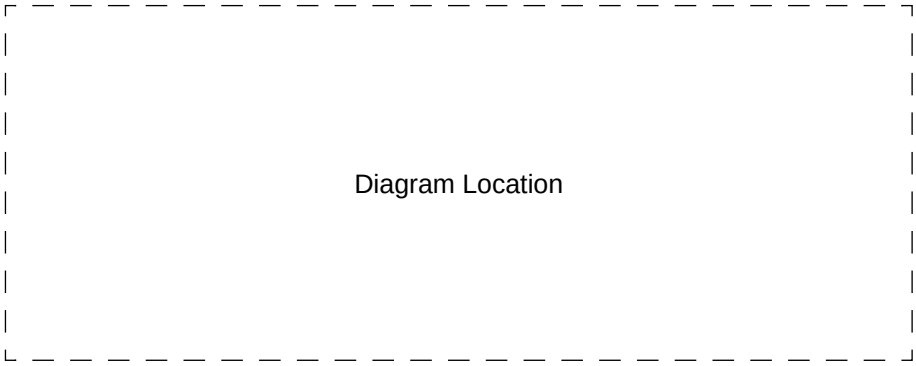
THE NMT-5 CRITICALITY DATABASE
SIGN TYPES

I. SIGN TYPES

This appendix shows each of the 24 sign types supported in the NMT-5 Criticality Database. Signs that have diagrams show the diagram placement location.

Sign Type 1

CRITICALITY LIMITS



COMPLY WITH RESTRICTIONS.

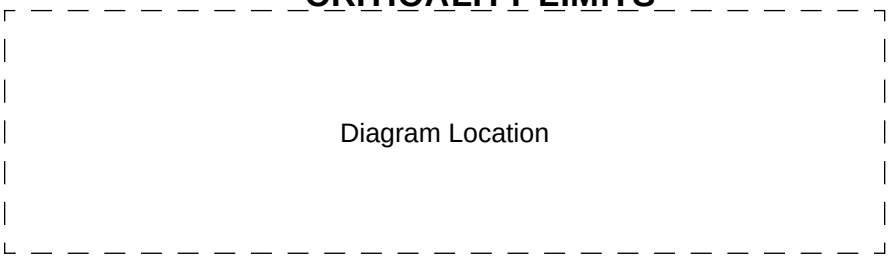
• For mixtures of SNM FORMS use the LOWEST criticality limit.

FORMS	RESTRICTIONS
Plutonium totaling 520 grams or less	**No restrictions as to form, solution, volume or equipment**
OR	
Plutonium in metal*	**4500 grams maximum**
OR	
Plutonium in oxide or nonhydrogenous compounds*	**4500 grams maximum per container with a maximum of 9000 grams**
OR	
Plutonium in approved metal shapes*	**6000 grams maximum**

***Container of used RAGS up to 4 liters volume stored 6-8 inches from metal parts is permitted.**

Sign Type 2

CRITICALITY LIMITS



COMPLY WITH RESTRICTIONS.

• For mixtures of SNM FORMS use the LOWEST criticality limit.

FORMS	**RESTRICTIONS**
Plutonium totaling 520 grams or less	**No restrictions as to form, solution, volume or equipment**

Sign Type 3

CRITICALITY LIMITS

COMPLY WITH RESTRICTIONS.

- **For mixtures of SNM FORMS use the LOWEST criticality limit.**

FORMS	**RESTRICTIONS**
Plutonium in solution and other hydrogenous materials	**1500 grams maximum**
OR	
Plutonium in metal	**1500 grams maximum**

Sign Type 4

CRITICALITY LIMITS

Diagram Location

COMPLY WITH RESTRICTIONS.

- **For mixtures of SNM FORMS use the LOWEST criticality limit.**
- **FREEZER: Tunnel storage must be CLOSED when other SNM is passed through.**

FORMS	RESTRICTIONS
Plutonium totaling 520 grams or less	**No restrictions as to form, solution, volume or equipment**
OR	
Plutonium in metal	**4500 grams maximum**
OR	
Plutonium in oxide or nonhydrogenous compounds	**4500 grams maximum per container with a maximum of 9000 grams**
OR	
Plutonium in approved metal shapes	**6000 grams maximum**

Sign Type 5

CRITICALITY LIMITS

Diagram Location

COMPLY WITH RESTRICTIONS.

• For mixtures of SNM FORMS use the LOWEST criticality limit.

• HOOD: NO STORAGE ALLOWED

FORMS	RESTRICTIONS
Plutonium totaling 520 grams or less	No restrictions as to form, solution, volume or equipment
OR	
Plutonium in metal	4500 grams maximum
OR	
Plutonium in oxide or nonhydrogenous compounds	4500 grams maximum per container with a maximum of 9000 grams
OR	
Plutonium in approved metal shapes	6000 grams maximum

Sign Type 6

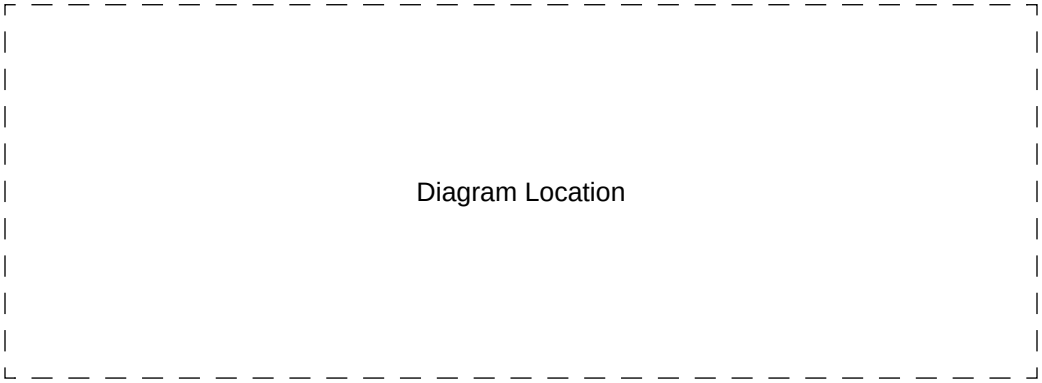
CRITICALITY LIMITS

COMPLY WITH RESTRICTIONS.

FORMS	**RESTRICTIONS**
Plutonium in metal	**4000 grams**

Sign Type 7

CRITICALITY LIMITS

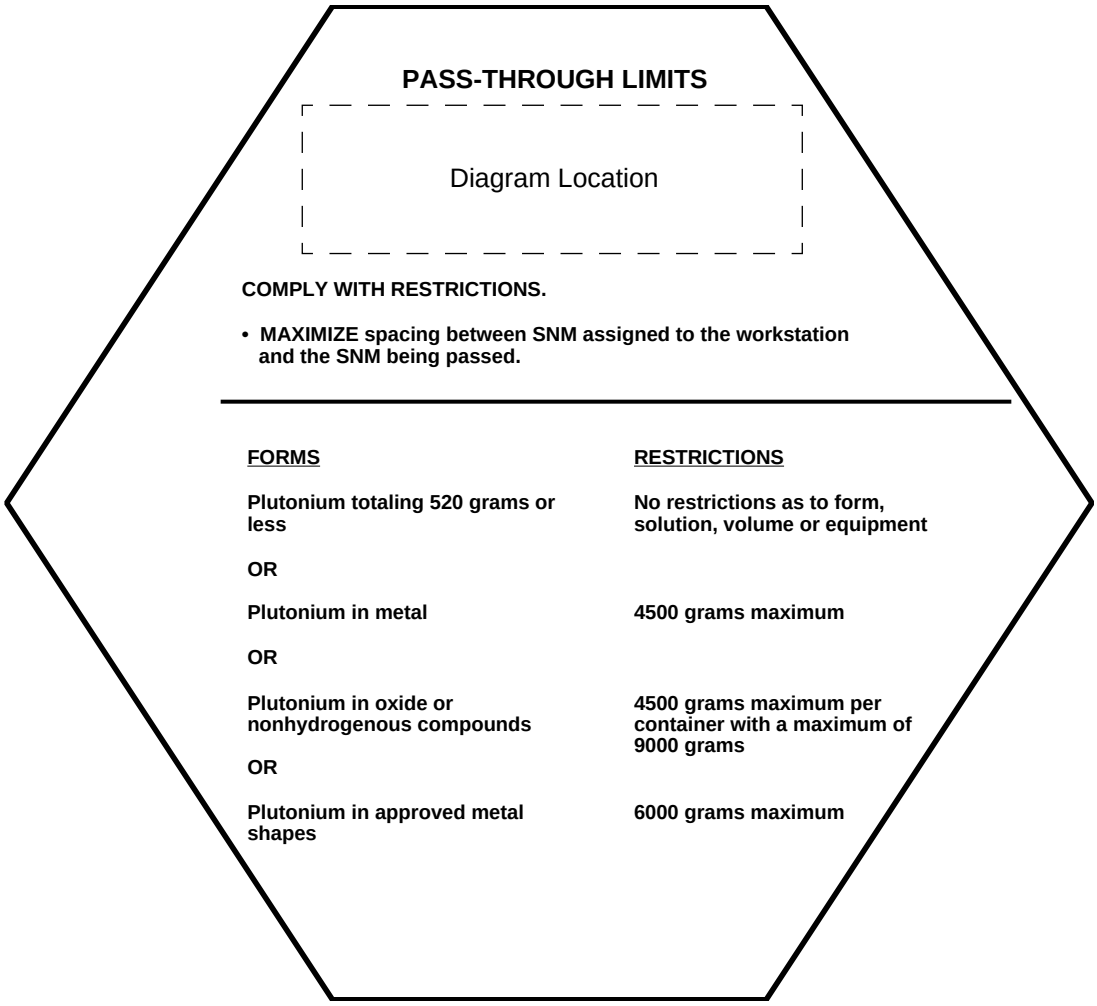


COMPLY WITH RESTRICTIONS.

- **No more than one press to be operated at one time, but either press may be used.**

FORMS	**RESTRICTIONS**
Plutonium in metal	**2000 grams**

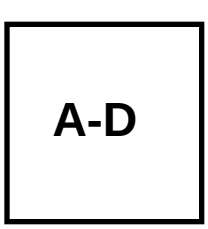
Sign Type 8


PASS-THROUGH LIMITS
Diagram Location
COMPLY WITH RESTRICTIONS.
• MAXIMIZE spacing between SNM assigned to the workstation and the SNM being passed.
FORMS
RESTRICTIONS
Plutonium totaling 520 grams or less
No restrictions as to form, solution, volume or equipment
OR
Plutonium in metal
4500 grams maximum
OR
Plutonium in oxide or nonhydrogenous compounds
4500 grams maximum per container with a maximum of 9000 grams
OR
Plutonium in approved metal shapes
6000 grams maximum

Sign Type 9

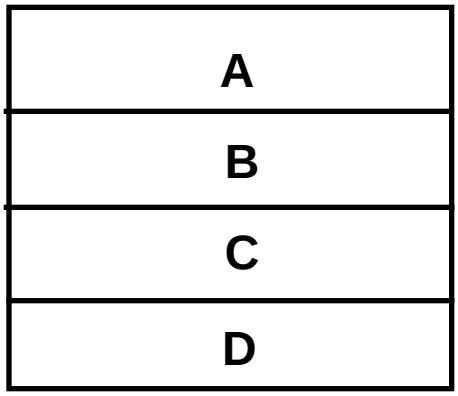
CRITICALITY LIMITS

FOR SAFE
PF4-114 677473



NORTHWEST
PF4-114

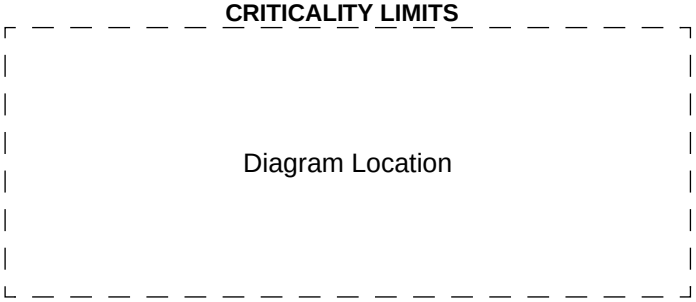
S114



SEE SAFE FOR INDIVIDUAL CRITICALITY LIMITS

Sign Type 10

CRITICALITY LIMITS



COMPLY WITH RESTRICTIONS.

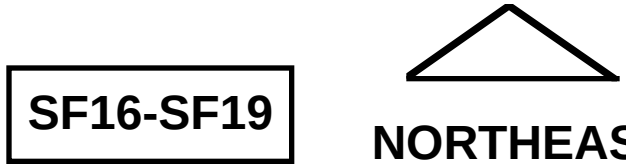
- **For mixtures of SNM FORMS use the LOWEST criticality limit.**
- **MAXIMIZE SPACING.**
- **NO STACKING.**

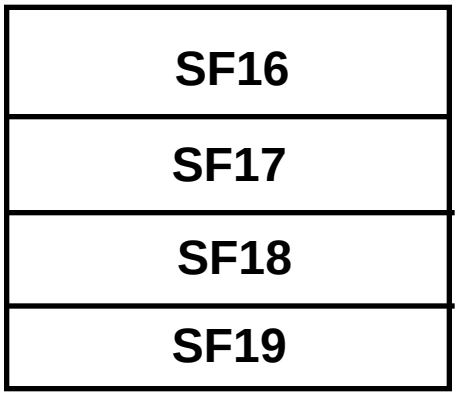
FORMS	RESTRICTIONS
Plutonium totaling 520 grams or less	No restrictions as to form, solution, volume or equipment
OR	
Plutonium in metal	4500 grams maximum
OR	
Plutonium in oxide or nonhydrogenous compounds	3000 grams maximum per container with a maximum of 9000 grams
OR	
Plutonium in approved metal shapes	6000 grams maximum

Sign Type 11

CRITICALITY LIMITS

FOR SAFE
PF4-329 836280



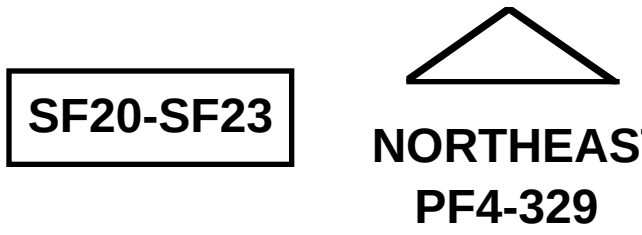


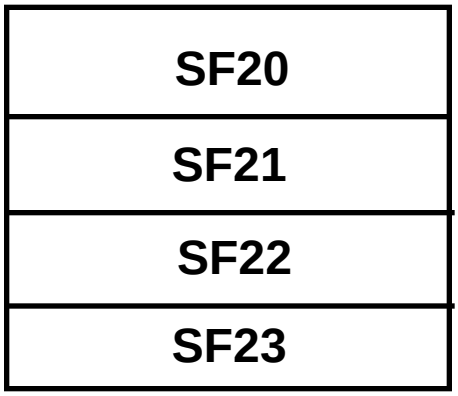
SEE SAFE FOR INDIVIDUAL CRITICALITY LIMITS

Sign Type 12

CRITICALITY LIMITS

FOR SAFE
PF4-329 836278



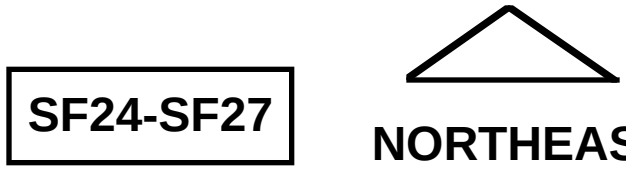


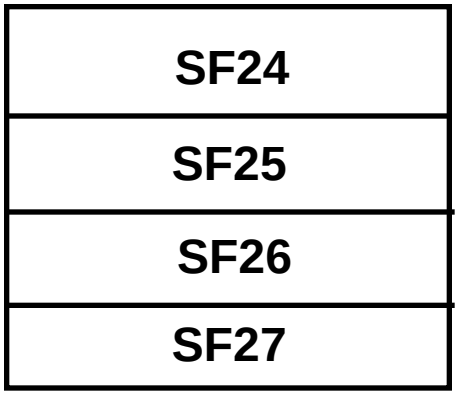
SEE SAFE FOR INDIVIDUAL CRITICALITY LIMITS

Sign Type 13

CRITICALITY LIMITS

FOR SAFE
PF4-329 836277





SEE SAFE FOR INDIVIDUAL CRITICALITY LIMITS

Sign Type 14

CRITICALITY LIMITS

DIEBOLD SAFE

SF01	SF02	SF03
SF04	SF05	SF06
SF07	SF08	SF09
SF10	SF11	SF12
SF13	SF14	SF15

SEE INDIVIDUAL DRAWER FOR CRITICALITY LIMITS

Sign Type 15

CRITICALITY LIMITS

Diagram Location

COMPLY WITH RESTRICTIONS

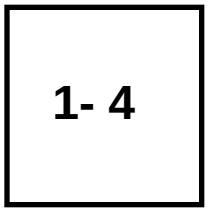
- **For mixtures of SNM FORMS use the lowest criticality limit.**
- **SAFE: Drawer contains THREE MASS locations; EACH location has the limits listed below.**

FORMS	**RESTRICTIONS**
PITS	**SNM Value of one PIT**

Sign Type 16

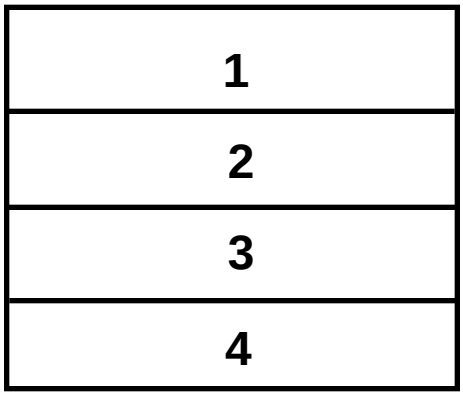
CRITICALITY LIMITS

FOR SAFE
PF4-317 711085



NORTHWEST
PF4-317

S317



SEE SAFE FOR INDIVIDUAL CRITICALITY LIMITS

Sign Type 17

CRITICALITY LIMITS

F	A
	B
	C

F329

SEE INDIVIDUAL LOCATIONS INSIDE CAGE FOR LIMITS

Sign Type 18

CRITICALITY LIMITS

Diagram Location

COMPLY WITH RESTRICTIONS.

• For mixtures of SNM FORMS use the LOWEST criticality limit.

FORMS	RESTRICTIONS
Plutonium totaling 520 grams or less	No restrictions as to form, solution, volume or equipment
OR	
Plutonium in metal*	4500 grams maximum
OR	
Plutonium in oxide or nonhydrogenous compounds*	4500 grams maximum per container with a maximum of 9000 grams
OR	
Plutonium in approved metal shapes*	6000 grams maximum

Sign Type 19

CRITICALITY LIMITS

Diagram Location

COMPLY WITH RESTRICTIONS.

• For mixtures of SNM FORMS use the LOWEST criticality limit.

FORMS	RESTRICTIONS
Plutonium totaling 520 grams or less	No restrictions as to form, solution, volume or equipment
OR	
Plutonium in metal*	4500 grams maximum
OR	
Plutonium in oxide or nonhydrogenous compounds*	4500 grams maximum per container with a maximum of 9000 grams
OR	
Plutonium in approved metal shapes*	6000 grams maximum

***Container of used RAGS up to 4 liters volume stored 6-8 inches from metal parts is permitted.**

Sign Type 20

CRITICALITY LIMITS

Diagram Location

COMPLY WITH RESTRICTIONS.

- **For mixtures of SNM FORMS use the LOWEST criticality limit.**
- **SAFE: Drawer contains TWO MASS locations separated by a file divider; EACH location has the limits listed below.**

FORMS	RESTRICTIONS
Plutonium totaling 520 grams or less	No restrictions as to form, solution, volume or equipment
OR	
Plutonium in metal	4500 grams maximum
OR	
Plutonium in oxide or nonhydrogenous compounds	3000 grams maximum per container with a maximum of 9000 grams
OR	
Plutonium in approved metal shapes	6000 grams maximum

Sign Type 21

CRITICALITY LIMITS

Diagram Location

COMPLY WITH RESTRICTIONS

- **For mixtures of SNM FORMS use the lowest criticality limit.**
- **SAFE: Drawer contains THREE MASS locations; EACH location has the limits listed below.**

FORMS	RESTRICTIONS
PITS	SNM Value of one PIT

Sign Type 22

CRITICALITY LIMITS

FOR SAFE
PF4-327 674448

S327

1
2
3
4

SEE SAFE FOR INDIVIDUAL CRITICALITY LIMITS

Sign Type 23

CRITICALITY LIMITS

Diagram Location

COMPLY WITH RESTRICTIONS

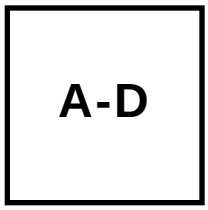
- **For mixtures of SNM FORMS use the LOWEST criticality limit.**

FORMS	RESTRICTIONS
PIT	SNM Value of one PIT

Sign Type 24

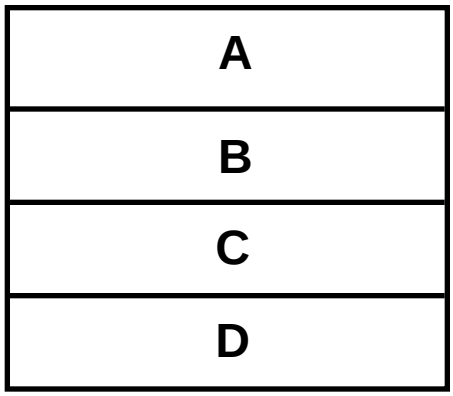
CRITICALITY LIMITS

FOR SAFE
PF4-113 676645



NORTH
PF4-113

S113



SEE SAFE FOR INDIVIDUAL CRITICALITY LIMITS

Los Alamos
NATIONAL LABORATORY
Los Alamos, New Mexico 87545