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A Materials Database for Li(Si)/FeS_2 Thermal Batteries

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Abstract

The establishment of a database for the materials that are used in production Li(Si)/FeS_2 thermal batteries designed at Sandia National Laboratories is described. The database is a Hewlett-Packard (HP) network type (IMAGE) designed to run on an HP3000 computer. Heavy emphasis is placed on the use of screen forms for entry, editing, and retrieval of data. Custom screen forms were used for the various materials in the battery. For the purposes of the materials database, each battery is composed of four mixes: cathode, separator, anode, and heat (pyrotechnic) powders. A consistent lot-numbering system was adopted for both the mixes and the discrete components that make up the mixes. Each serial number of a particular battery is linked to the lot numbers of the four mixes used in the battery. Each mix, in turn, is linked to the lot numbers of the discrete components that are contained within the mix. This allows traceability of each of the components used in any given serial number of a particular battery. The materials database provides the necessary traceability, as required by the Department of Energy, for the lifetime of the program associated with the battery.

Acknowledgments

The author wishes to acknowledge the following persons for their assistance regarding the materials database: J. Bouchard (formerly of 2526) for writing the TRANSACT code that allowed the use of computer screen forms for data entry and retrieval; L. Hernandez, Jr. (2825) for generating the paper data forms and for making many helpful suggestions for improving the forms; D. Sgro, C. Bucklen, W. Pletzner, and A. Morella from General Electric Neutron Devices Dept.; and J. Flaxbeard and S. Mack from Eagle-Picher Industries for providing many useful suggestions regarding the implementation of the materials database.

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Acronyms

ASCII	American Standard Code for Information Interchange
DF	data form
DOE	Department of Energy
EB	electrolyte binder
EPI	Eagle-Picher Industries
GENDD	General Electric, Neutron Devices Department
HP	Hewlett-Packard
MC	major component
MLN	Materials Lot Number
SN	serial number
SNL	Sandia National Laboratories
SS	specification sheets

Software Associated with Database

IMAGE	Network-type database designed to run on HP3000 computer.
VIEW/3000 (V/3000)	Software used for screen forms with IMAGE database. VIEW/3000 consists of two software packages: FORMSPEC and ENTRY.
FORMSPEC	Software for the design of screen forms to interact with IMAGE database.
ENTRY	Program for entry of data into screen forms for IMAGE database.
MIRACLE	Program for data entry and retrieval for database that runs on a VAX computer.
TRANSACT	HP's programming language used with IMAGE database for entering, editing, and retrieval of data through the use of screen forms generated via FORMSPEC.

A Materials Database for Li(Si)/FeS_2 Thermal Batteries

Introduction

Lithium-silicon/iron disulfide (Li(Si)/FeS_2) thermally activated batteries (commonly referred to as thermal batteries) employ four mixtures of powdered materials:

- an Li(Si) alloy anode (typically 44 wt.% Li)
- a separator or electrolyte-binder (EB) mixture composed of magnesium oxide (MgO) and electrolyte [typically lithium chloride-potassium chloride (LiCl-KCl) eutectic]
- a catholyte composed of FeS_2 (iron pyrite) and EB
- a pyrotechnic or heat powder [typically an iron-potassium perchlorate (Fe-$KClO_4$) mixture] to heat the battery to its operating temperature. In the case of the lithiated catholytes, lithium oxide (Li_2O) will also be present.

Thermal batteries for the Department of Energy (DOE) are designed and developed at Sandia National Laboratories (SNL). Each battery is manufactured to SNL specifications at either General Electric Neutron Devices Dept. (GENDD), St. Petersburg, FL, or Eagle-Picher Industries (EPI), Joplin, MO. The materials that are more commonly used in the batteries are produced at each facility. For certain applications, however, GENDD will provide select materials for batteries constructed at EPI.

The purified FeS_2 and mixes of electrolyte, EB, or catholyte are normally used by blending small batches of material (typically, 0.5 to 1.0 kg for the mixes) into master lots. A given master lot might be used for more than one major-component (MC) battery. Occasionally, an individual serial number (SN) of a particular MC battery can fail a qualification test during production. What is more important, however, is a failure of, or an anomaly in, a unit returned from the field. If the problems are related to the active materials used in the construction of the battery, troubleshooting would be greatly facilitated if characterization data for these materials could be readily retrieved for evaluation purposes. It would be desirable to flag all SNs of a given MC battery that were built with the suspect material(s). Furthermore, it would be additionally desirable to flag any SNs of any other MC batteries that used these materials. To meet these goals requires a comprehensive database containing key characterization data for the various materials used in Li(Si)/FeS_2 thermal batteries.

Evaluation of the materials database that was in place at SNL on a VAX computer at the time of this study showed it to be inadequate. Materials property data were not available for all of the mixes used in the battery (e.g., the separator mix). Or, in the case of FeS_2, multiple lot numbers were being used for essentially the same material; each time the material was processed in a series of sequential purification operations, it was given a new lot number that made the traceability task unnecessarily cumbersome. Examination of data that had been entered for heat powder showed inconsistencies in the lot numbering that made the real identities of several lots uncertain. This made traceability extremely difficult and raised serious questions as to the validity or usefulness of the data. In addition, each of the manufacturing facilities (EPI and GENDD) had its own lot-numbering system which made relative comparison of data difficult without some means of cross-referencing. In some instances, data for certain lots of material were incomplete.

Data were being entered into the VAX system by keypunching information from data forms (DFs) for the various materials. These forms were generally lacking in specific instructions as to the manner in which data were to be entered. Because of the potential for confusion, some of the data may have been compromised.

The traceability of materials data for specific SNs was being accomplished through use of the Materials Lot Number (MLN) DF shown in Figure 1. (This traceability must be maintained for the life of the weapons program associated with the battery, which can be in excess of 25 yr.) This DF contains lot-number data for specific components and for some of the mixes used in a particular SN of an MC battery. Fields are provided for only some of the components used in the mixes. In addition, more lot numbers are

DWG. CLASSIFICATION LEVEL
UNCLASSIFIED

SF 2342-6 (6-78)

ITEM	DATE MO DAY YR	SOURCE CODE	DWG. SYSTEM	TYPE
M, IDb GE347720 ,	TDb - - ,	DSb S ,	TIE/SC/GE	C1

PART NUMBER / SUFFIX	TEST SPECIFICATION	MFR. CODE
PNb GE347720-000- ,	PSb - - ,	MFb ,

TEST CODES

Material Lot Numbers For Li(Si)/FeS_2 Batt. TCbAA,

REMARKS PAGE

S-, Battery Designation FA-MC ,

ITEM	MFR. LOT NO.	SERIAL NO.	DATE CODE
T, IDb GE347720 ,	LNb - ,	SNb	DMb

INSTRUCTIONS FOR PREPARING DF347720 (Sheet 2)

DATA SET

S	N	b					,
D	I						
S	I						
S	P						
P	I						
P	P						
L	S						
M	I						
M	S						
C	S						
L	Ø						
H	P						

ITEMS TO BE ENTERED

SN - Battery Serial Number
DI - Incoming Lot Number for Iron Disulfide
SI - Incoming Lot Number for Iron Disulfide, sized
SP - Process Lot Number For Iron Disulfide, sized
PI - Incoming Lot Number for Iron Disulfide, sized and purified
PP - Process Lot Number for Iron Disulfide, sized and purified
LS - Incoming Lot Number for Lithium Silicon
MI - Incoming Lot Number for Magnesuim Oxide
MS - Sub Lot Number for Magnesuim Oxide
CS - Incoming Lot Number for Calcium Silicon
LØ - Incoming Lot Number for Lithium Oxide
HP - Lot Number for Heat Powder

COMMENTS:

Draw a line through entry if material is not used.

Repeat Data Page as needed.

DISTRIBUTION INSTRUCTIONS:

1. Original to Sandia Laboratories, Data Operations Division, within three working days of lot acceptance and a copy retained by manufacturer.
2. One copy to GEND Buyer.

RELEASE IDENTIFICATION	ENGR.	ORG.	DATE	TEST AGENCY	AUTHORIZED SIGNATURE
8C07573 LYNN WILSON 3-7-83	CRB	2426	2/82		

CONT. SUFF.	ISSUE	A	B	C	DWG. CLASSIFICATION LEVEL	SIZE	CODE IDENT NO.	DWG. NUMBER
000	D				**UNCLASSIFIED**	**A**	14213	DF347720 SHEET 1 OF 2

Figure 1. Original Materials Lot Number Data Form (DF347720)

used for the processed FeS_2 than are really necessary. In short, the form is incomplete and inefficient.

A comprehensive evaluation of the MLN DF suggested that a new approach was needed if the entry and retrieval of materials property data were to be facilitated and if increased reliability of the materials traceability were to be realized. Consequently, a multistage effort was undertaken to identify inadequacies in the current materials database and to develop satisfactory alternatives.

The objectives of the study were to

- Improve the reliability of the traceability of materials used in SNL-designed MC thermal batteries.
- Simplify the current data entry/retrieval system and eliminate unnecessary paperwork.
- Reduce confusion by developing a systematic lot-numbering system that could be used by both production facilities.
- Overhaul the specification sheets (SSs) and DFs associated with materials and processes related to the production of $Li(Si)/FeS_2$ thermal batteries.

The new approach involved revision of the current DFs and, when necessary, development of new ones. Each of the DFs is associated with a materials specification document, called an SS drawing. Because of this, it was also necessary to modify these documents and, in some instances, to generate new ones. The final archiving of the materials property data is to be with the VAX computer in Dept. 2820 or possibly at GENDD. The use of Dept. 2520's HP3000 computer was elected for temporary interim storage. Computer screen forms were developed for use with this computer to facilitate data entry and review for materials used in DOE $Li(Si)/FeS_2$ thermal batteries. This report documents the results of that work.

Results and Discussion

IMAGE Database

Before getting into a detailed discussion of the materials database, it is helpful to understand how the IMAGE database functions. IMAGE is defined as a 2-level network structure, as opposed to a hierarchical or relational type. This is shown schematically in Figure 2.

The two types of data sets in IMAGE are (1) *master* data sets (e.g., Mstr. 1 in Figure 2) and (2) *detail* data sets. The bulk of the information is contained in the detail data sets, which contain data items fully describing the materials of interest. The data *items* are the smallest accessible data element and are represented by values that can be alphanumeric, integer, or real numbers. (An example of a data item for the materials database would be the lot number.)

The master data sets contain key-item values that serve as indices for fast access to specific information in one or more detail sets. Each master entry contains information about related detail chains, including the beginning and end, and the number of entries in the chain. A chain is simply a series of pointers which link together all detail-data-set entries having the same value for a particular key item (e.g., catholyte type). The first entry in a chain is the *chain head*. IMAGE automatically keeps track of the pointers necessary to link together the entries in a chain.

Each detail data set has one or more key items by which a data entry is identified or retrieved. Key items also tie together related data entries which have the same value for the key item. Key items act as links for information in *different* data sets. This is illustrated in Figure 2 by arrows from Mstr. 2 to Detail Set 1 and Detail Set 2. Mstr. 1, in comparison, is only linked to the entries of Detail Set 1.

A schematic diagram of the database structure is illustrated in Appendix A for materials based upon the LiCl-KCl eutectic. The structure would be expanded for other electrolytes (e.g., the LiCl-LiBr-LiF eutectic) as they are added. Only the EB and catholyte portions of the materials database would be affected as new electrolytes are added.

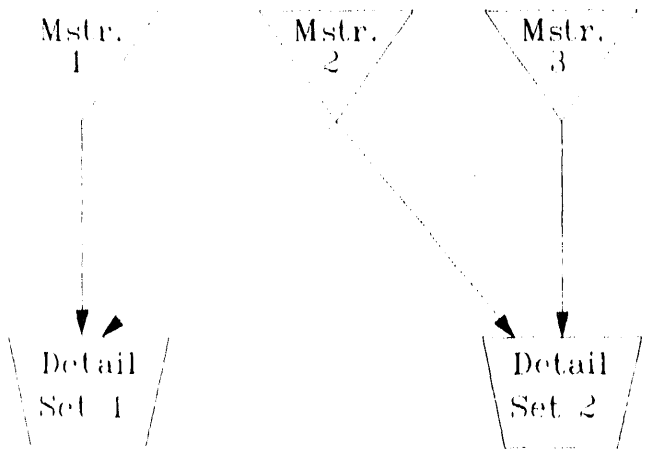

Figure 2. Example of IMAGE Network Structure

Lot Number Designation

A consistent lot-numbering system was adopted after considering a wide variety of options. Incoming material (i.e., chemicals that are used as received or as ingredients in the various mixes) and mixes are to use a 5-digit code with the format YYXXX. The first two characters of the code (YY) represent the last two digits of the calendar year and the last three digits (XXX) represent the sequential lot number of the material ordered in that calendar year. This system provides up to a maximum of 999 lots in a calendar year. When individual batches of material are combined into a master lot, an M suffix is added to the 6-digit code (i.e., YYXXXM).

Examples of incoming materials include: Li(Si) alloy (used in the anode), FeS_2 (used in the cathode), MgO (used in the EB mix), and heat powder. The mixes include: catholytes, EBs, and electrolytes.

To further identify the facility at which a mix was prepared or where material was processed, a range of lot numbers was exclusively assigned to each facility. GENDD, for example, was assigned lot numbers 001 to 499 and EPI was assigned 500 to 999. Thus, a catholyte lot number of 88010M signifies the tenth master lot of mix prepared at GENDD in 1988. (Such allocations of lot numbers have the effect of halving the maximum number of lots of material that can be prepared or processed per year by each facility. This still provides an adequate margin for anticipated needs, however.) This nomenclature eliminates much of the confusion or uncertainty associated with the previous lot-numbering systems, because it is consistent at both facilities.

Materials Lot Number DF

The first order of business was to replace the current MLN DF with a simpler version. As shown in Figure 3, the approach that was taken was to provide lot-data information for each of the four *mixes* used in an Li(Si)/FeS_2 thermal battery, rather than for a combination of components and mixes (see Figure 1). The revised format provides the absolute minimum number of entries necessary to describe the materials that are used in a particular SN of an MC battery.

The next order of business was to develop the necessary hierarchy to obtain information on the components that made up each of the four mixes. This is illustrated schematically in Figure 4. The heat powder, for example, is composed of Fe and $KClO_4$. If information is desired regarding the Fe that was used in a lot of heat powder, one refers to the DF for the lot of Fe used in that lot of heat powder.

Similarly, the catholyte—lithiated in this case—contains FeS_2, EB, and Li_2O. The characterization data for the lot numbers of these components are obtained from their respective DFs. The EB, in turn, is made up of MgO and electrolyte, each of which has its own DF. Finally, the electrolyte is composed of individual halides. These materials do not require a DF *per se*, as they are purchased to SS drawings which specify only purity. They are simply vacuum dried before use. In effect, there is an implicit dependence upon the vendor for the quality of these materials.

Thus, starting with the lot numbers for the four mixes used in a battery, one is able to trace the individual components that went into any of the mixes by linking through the material DFs. Most of the necessary DFs were already in place at the time of the study and only needed revision. In the case of the EB and electrolyte materials, however, it was necessary to create new DFs. The proposed database scheme provides the maximum traceability of materials used in a particular SN battery. In addition, by using MIRACLE on the VAX, it is possible to identify other SNs of a given MC battery—and other MC batteries, as well—that were built with particular lots of materials (i.e., mixes as well as discrete components).

Data Entry

Two basic modes enter information into the materials database. The first method involves filling out paper DFs. This information is then keypunched onto cards for processing by the VAX computer. The second method involves the use of screen or CRT forms, which are used with a terminal or computer linked directly with the HP3000.

The first method, currently in use, is time-consuming and inefficient and presents a risk of error in the transcribing of data during keypunching. It has the additional disadvantage that review of the data requires assistance by someone who is qualified to access the VAX materials database.

The second method is much simpler and faster, and is preferred, as it allows real-time, interactive access to the HP3000 for data entry. Read access to any of the materials data is readily available to anyone authorized to use the HP3000. However, DOE regulations prevent long-term (i.e., over a year) storage of such data on the HP3000.

Dwg. Classification Level
U N C L A S S I F I E D

Item	Form Completion Date (MO / DAY / YR)	Source Code	Dwg. System	Type
H, IDb M C	TDb	DSb S,	TIE/SC/GE	B

Part Number	Suff	Mfr. Code
PNb	,	MFb ,

Test Code

Material Lot Numbers for Li(Si)/FeS_2 Batt. TCb M L,

Item	Mfr. Lot No.
T, IDb M C ,	LNb - ,
Serial Number	SNb ,
Date Code	DMb ,

Description	I D	
Incoming Lot Number of Li-Si Alloy	L S b b b b	
Lot Number of Electrolyte Binder Mix	E B b b b b	
Lot Number of Catholyte Mix	C M b b b b	
Lot Number of Heat Powder	H P b b b b	

Notes:

1. Repeat non-standard identifiers including serial number and date code as needed.

2. Lot numbers reported on this data form shall be consistent with lot numbers reported on related material certification data forms. Specifically, **EPI** shall use **GEND** lot numbers when material was provided by **GEND** and vice versa.

3. Data shall be transmitted in accordance with the formatting requirements of **SC-M-72 0742A** (GEISHA manual). For clarification, an entry in the **suffix** position of the **Mfr. Lot No. field** (**LNb**) above is not required; if no suffix applies, the **standard entry terminator** (,) immediately follows the lot number in the transmission, e.g. LNb00001, (For all identifiers above, b = blank space)

Distribution Instructions:

1. Electronically transmit to SNLA, Data Operations Division, within ten working days of lot acceptance and a copy retained by the manufacturer.

2. One copy to GEND Buyer.

Release Identification	Engr.	Org.	Date	Authorized Signature
	CRB	2426	2/82	

Cont. Suff.	Issue ~~C~~ D ~~E~~ F	~~A~~ ~~B~~	Dwg. Classification Level	Size	Code Id	Dwg. Number
						DF347720
001			U N C L A S S I F I E D	A	14213	Sheet 1 of 1

Figure 3. Revised Materials Lot Number Data Form (DF347720)

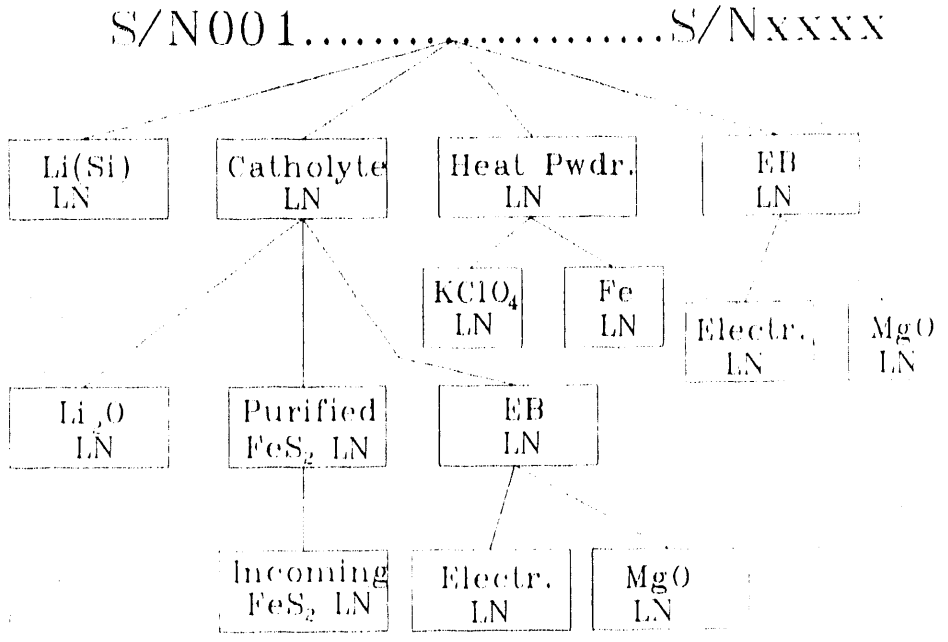

Figure 4. Schematic Diagram Showing Linking of Materials Lot Data Through Data Forms

The screen forms used for data entry into the HP3000 can be custom tailored for a given material. The entry fields are highlighted when a screen form is invoked. The type of entry for each field can be specified to be alphanumeric (ASCII) or numeric, with a designated decimal format. The field can be required, optional, or for display (information) purposes only. If data entry into the the computer is attempted when required fields remain empty, an error message is displayed on the screen and the empty required fields are highlighted.

The screen forms also allow screening of entries to be made for the various fields. If an improper entry is attempted, the field is highlighted and a custom error message is displayed to tell the operator the choices that are permitted for that field. An improper decimal format for a numeric field is similarly trapped. The error-trapping capabilities of the screen forms (via HP's V/3000 software) increase the integrity of the materials database by avoiding the problem of incomplete or erroneous entry.

In the case of electrolyte, EB, and catholyte mixes, individual lots (batches) of material are commonly combined into a larger batch called a master lot. The use of screen forms facilitates the entry of data for master lots, by allowing two options for obtaining the chemical analysis of the master lot.

The first choice involves combining of individual lots for which data exist in the database. The user simply specifies the lot numbers of the individual batches and the relative amounts of each that make up the master lot. The master lot screen form is shown in Figure 5. (This general form is used for any mix that is blended into a master lot.) The composition of the master lot is then calculated programmatically and the results are placed into the appropriate chemistry fields of the screen master DF for that particular mix (see, for example, Figure 13b, in the next section).

(The bracketed fields become highlighted when the screen form is activated. The names shown within the brackets are those of the entry fields. V/3000 requires a unique field name for each field.)

The alternate choice is to combine individual lots of material that have not been previously analyzed. The resulting master lot of material is then analyzed as required by the particular DF and the results are entered in the master DF. This approach, while simpler, presents the possibility of compromising a large quantity of material if an individual lot is sufficiently out of specification to cause the master lot to be rejected.

```
**********DATA FORM FOR MASTER LOTS OF MATERIAL**********

        DF Number:  DF[DFNUM ]      Master Lot Number: [MASTLN]

Lot No.      Amt., kg      Lot No.      Amt., kg      Lot No.      Amt., kg
[LN1   ]     [AMT1  ]      [LN14  ]     [AMT14 ]      [LN27  ]     [AMT27 ]
[LN2   ]     [AMT2  ]      [LN15  ]     [AMT15 ]      [LN28  ]     [AMT28 ]
[LN3   ]     [AMT3  ]      [LN16  ]     [AMT16 ]      [LN29  ]     [AMT29 ]
[LN4   ]     [AMT4  ]      [LN17  ]     [AMT17 ]      [LN30  ]     [AMT30 ]
[LN5   ]     [AMT5  ]      [LN18  ]     [AMT18 ]      [LN31  ]     [AMT31 ]
[LN6   ]     [AMT6  ]      [LN19  ]     [AMT19 ]      [LN32  ]     [AMT32 ]
[LN7   ]     [AMT7  ]      [LN20  ]     [AMT20 ]      [LN33  ]     [AMT33 ]
[LN8   ]     [AMT8  ]      [LN21  ]     [AMT21 ]      [LN34  ]     [AMT34 ]
[LN9   ]     [AMT9  ]      [LN22  ]     [AMT22 ]      [LN35  ]     [AMT35 ]
[LN10  ]     [AMT10 ]      [LN23  ]     [AMT23 ]      [LN36  ]     [AMT36 ]
[LN11  ]     [AMT11 ]      [LN24  ]     [AMT24 ]      [LN37  ]     [AMT37 ]
[LN12  ]     [AMT12 ]      [LN25  ]     [AMT25 ]      [LN38  ]     [AMT38 ]
[LN13  ]     [AMT13 ]      [LN26  ]     [AMT26 ]      [LN39  ]     [AMT39 ]
                (NOTE:  Use xx.xx format for Amt fields.)

                Press ENTER when form is completed.
```

Figure 5. Screen Data Form Used for Master Lots of Materials

If the same component lots are used for each of the lots that make up the master lot—e.g., the same FeS_2 and EB lots for a catholyte—it is not necessary to fill out a DF for each catholyte lot. In essence, the master lot is treated as a large single batch. If different lots of components are used for the various individual lots making up a master lot, a DF must then be filled out for each lot. Only the lot number fields, however, need to be filled out in this case; the chemistry fields are left blank, since the chemistry of the master lot will be determined directly.

Main Menu—The main menu that appears when the materials database is accessed is shown in Figure 6. Selecting f1 allows the user to access information regarding the materials that are used in a particular MC number thermal battery; selecting f2 to f5 allows access to information regarding the various mixes; and selecting f6 allows access to information regarding the various discrete components.

```
**********MAIN MENU**********

Select desired option and press Function Key.

    f1 = MATERIAL LOTS

    f2 = CATHODE MIX

    f3 = EB MIX

    f4 = ELECTROLYTE MIX

    f5 = HEAT POWDER

    f6 = DISCRETE COMPONENTS

    f8 = EXIT PROGRAM
```

Figure 6. Main Menu for Accessing Materials Database

Battery Menu—When f1 is selected from the main menu, the battery menu shown in Figure 7 appears. At this point, the user has a choice of entering data (f5) or reviewing data (f6) for a particular S/N of a certain MC battery. Or, he can list all of the S/Ns in the database for a particular MC battery (f7). For data entry, a screen version of the form in Figure 3 appears.

Cathode Menu—The main cathode menu is shown in Figure 8. The various options are displayed, along with the SNL names and SS numbers of the catholyte mixes for which information can be accessed via the materials database. Since catholyte mixes are generally prepared in master lots, provisions are provided for entering data for a master lot (f2).

EB-Mix Menu—The main EB menu is shown in Figure 9. It is very similar in format to the main cathode menu. Currently, mixes based on the LiCl-KCl, the all-Li (LiCl-LiBr-LiF eutectic) electrolyte, and the low-melting (LiBr-KBr-LiF eutectic) electrolyte are represented in the EB portion of the materials database.

Electrolyte Menu—The main menu for the electrolytes is shown in Figure 10. This menu is similar to that of the main EB menu.

Heat Powder Menu—The main heat powder menu is shown in Figure 11.

Discrete-Component Menu—The main menu for discrete components is shown in Figure 12. Here, data can be accessed for the components that make up the various mixes.

The individual data forms for the various mixes and components used in Li(Si)/FeS_2 thermal batteries are described in the following section.

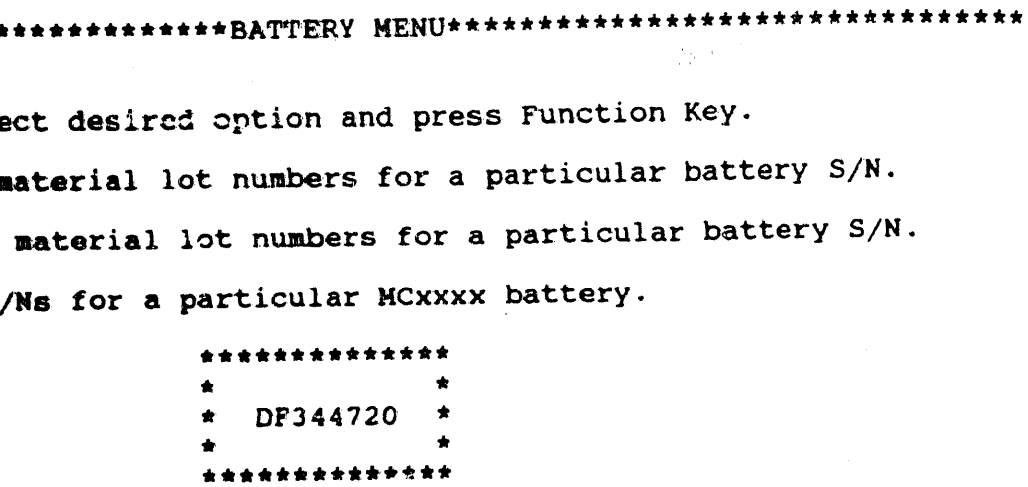

Figure 7. Main Battery Menu for Accessing Materials Data for a Particular Serial Number of an MC Battery

**********Cathode Mixes**********

Select desired option and press Function Key.

f1 = Enter materials data for an individual lot (DFxxxxxx).

f2 = Enter materials data for a master lot (DFxxxxxM).

f3 = Review materials data for an individual or master lot (DFxxxxxx).

f4 = List lot numbers for individual or master lots (DFxxxxxxx).

Mix Description	DF #	SNLA #
Unfused lithiated catholyte	382943	LC176D
Fused lithiated catholyte	379481	LC176B
Primary catholyte (SiO2 EB)	379480	CT162
All-Li catholyte #1	388204	XCT187B
Low-Melting, F-based catholyte	389644	XCT190

Figure 8. Main Menu for Accessing Catholyte Data

**********EB Mixes**********

Select desired option and press Function Key.

f1 = Enter materials data for an individual lot (DFxxxxxx).

f2 = Enter materials data for a master lot (DFxxxxxM).

f3 = Review materials data for an individual or master lot (DFxxxxxx).

f4 = List lot numbers for individual or master lots (DFxxxxxxx).

Mix Description	DF #	SNLA #
MgO-based EB, 35% MgO, -60, LiCl-KCl eut.	343183	EB119B
MgO-based EB, 40% MgO, -60, LiCl-KCl eut.	370633	EB172
SiO2-based EB, 12% SiO2, -60, LiCl-KCl eut.	344843	EB118A
MgO-based EB, 35% MgO, -100, LiCl-LiBr-LiF	388203	EB128C
Low-Melting, F-based EB	389646	XEB211

Figure 9. Main Menu for Accessing EB Data

**********Electrolyte Mixes**********

Select desired option and press Function Key.

f1 = Enter materials data for an individual lot (DFxxxxxx).

f2 = Enter materials data for a master lot (DFxxxxxM).

f3 = Review materials data for an individual or master lot (DFxxxxxx).

f4 = List lot numbers for individual or master lots (DFxxxxxxx).

Mix Description	DF #	SNLA #
LiCl-KCl eutectic (45%/55%)	343184	E1C
LiCl-LiBr-LiF eutectic (22%/68.4%/9.6%)	388205	XE33
LiBr-KBr-LiF eutectic (57.33%/42%/0.67%)	343366	XE80

Figure 10. Main Menu for Accessing Electrolyte Data

**********Heat Powder**********

Select desired option and press Function Key.

f1 = Enter materials data for an individual lot (DFxxxxxx).

f2 = Review materials data for an individual lot (DFxxxxxx).

f3 = List lot numbers of individual lots (DFxxxxxxx).

Description	DF #
Heat Powder	285835

Figure 11. Main Menu for Accessing Heat-Powder Data

```
**********************Discrete Components*********************

    f1 = Enter materials data for an individual lot (DFxxxxxx).

    f2 = Enter materials data for a master lot (DFxxxxxM).

    f3 = Review materials data for an individual or master lot (DFxxxxxx).

    f4 = List lot numbers for individual or master lots (DFxxxxxx).

    Mix Description                                          DF #
    Purified FeS2, -325+425 mesh                             370698
    Purified FeS2, -325 mesh                                 383017
    Incoming FeS2                                            344952
    LiSi Standard Anode (44%/56%) -40+230 mesh               344953
    LiSi Thin Cell Anode (44%/56%) -100+325 mesh             370711
    Li2O -100 mesh                                           344940
    MgO                                                      344954
    Fe                                                       344796
    KClO4                                                    388378
```

Figure 12. Main Menu for Accessing Data for Discrete Components

Data Forms for Mixes

All of the DFs have a number of fields in common. These include the manufacturer's code, the form completion date, the material name, the SS drawing number and drawing issue for the material, the lot size, the lot disposition, and comments.

The issue of a drawing can be quite important if the drawing has undergone any major changes. The manufacturer's code indicates the facility at which the material was processed (e.g., GBV for GENDI and EAY for EPI for catholytes). The form completion date is filled in automatically with the current date. The material name refers to the SNL name of the material. For production purposes, however, the SS number is necessary for proper identification of a mix or component. The lot disposition indicates whether the material meets all of the drawing requirements (A = Accept; R = Reject). A comment field is provided to make important notes regarding the material.

Catholyte DF—A typical form for a single batch of catholyte is shown in Figure 13a for the fused, lithiated version of the standard catholyte. The form provides fields for the catholyte lot number and the lot numbers of the FeS_2, EB, and Li_2O used in the catholyte.

The parameters used for characterization of the lot are described on the form under CHEMISTRY. These are the minimum analyses deemed necessary for proper qualification of the material. The chemistry required for a catholyte depends on whether it is lithiated and whether it has been fused. During fusion of the catholyte under argon (at 400°C for 16 h for the standard LiCl-KCl-based mix), chemical reactions occur between the FeS_2 and Li_2O to generate $Li_3Fe_2S_4$, Li_2SO_4, and $LiFe_5O_8$.[1]

Analysis of water-soluble sulfate gives a measure of the Li_2SO_4 that formed. Analysis of acid-soluble Fe provides a measure of the extent of lithiation, since the $Li_3Fe_2S_4$ and $LiFe_5O_8$ that form are soluble in hydrochloric acid (HCl), while FeS_2 is not. The Mg analysis is used to check for the proper content of MgO-based EB. The total S and total Fe analyses are used to verify the FeS_2 content is correct.

The suffix field after the Part No. (i.e., SS379481) provides information as to the FeS_2 used in the catholyte. In the example shown, a −200 suffix indicates a −325+425 mesh FeS_2 material, while a −201 suffix indicates a −325 mesh material.

The screen DF for the master lot of fused, lithiated catholyte is shown in Figure 13b. A field is provided to indicate whether the chemistry information was obtained by direct chemical analysis of the master lot or by programmatic calculation from the chemistries and amounts of the component lots.

*******DATA FORM FOR FUSED, LITHIATED CATHOLYTE (73.5/25/1.5) (DF379481)********

#######SINGLE LOT########

Part No./Suffix/Issue: SS379481-[SUFF]-[IS] Manufacturer's Code: [MCO]
Form Completion Date (MMDDYY): [FDATE] TC: LC Source Code: S

Material Name: [MNAME] Lot Disposition (A/R): [D]
SS number of Material: [SS_NUM]
Catholyte Lot Number: [FSLIC] CHEMISTRY
Std. EB Lot No.: [STDEB] Total Iron, %: [TOTF]
Li2O Lot No.: [LI2OLN] Total Sulfur, %: [TOTS]
FeS2 Lot No.: [FES2_1] Acid-Sol. Iron, %: [HSOF]
Catholyte Lot Size, in kg : [SIZE] Water-Sol. Sulfate %: [HSO4]
Magnesium, %: [MG]

Comments: [COMMENTS]

Press ENTER when form is completed.

a. Single Lot

****MASTER DATA FORM FOR FUSED, LITHIATED CATHOLYTE (73.5/25/1.5) (DF379481)****

-page 2-

Part No./Suffix/Issue: SS379481-[SUFF]-[IS] Manufacturer's Code: [MCO]
Form Completion Date (MMDDYY): [FDATE] TC: LC Source Code: S

Master Catholyte Lot Number: [MCALN] Master Lot Size, kg: [MLSIZ]

CHEMISTRY
Total Iron, %: [TOFE]
Total Sulfur, %: [TOTS]
Acid-Sol. Iron, %: [HSOF]
Water-Sol. Sulfate, %: [HSO4]
Magnesium, %: [MG]

Chemistry calculated or analyzed? (C/A): [C]

Comments: [COMMENTS]

Press ENTER when form is completed.

b. Master Lot

Figure 13. Screen Data Form for Standard, Fused, Lithiated Catholyte Mix (DF379481)

The corresponding paper DFs for the fused, lithiated, standard catholyte mix are shown in Appendices B-1 and B-2. Note that the names of the various fields are fairly self-descriptive (e.g., TOTS for Total Sulfur). This makes it much easier when searching the database on the VAX. The currently used field descripters such as AA, AB, AC, etc. (which are also used on the computer printouts) do not alone adequately describe the data. A copy of the DF must be on hand to translate these 2-character codes into meaningful information.

All the revised DFs for materials now contain the necessary instructions and required information (in the form of notes) for filling out the DFs. This avoids having to refer to the respective SS drawings for such instructions. These instructions and information were lacking in the past and led to confusion, at times, as to which information was to be entered into the various fields.

EB DF—The screen DFs for a single lot and master lot of standard EB are shown in Figures 14a and 14b, respectively; the corresponding paper DFs are shown in Appendices B-3 and B-4. Fields are provided for EB lot number and lot size and the lot numbers of the MgO and electrolyte that are used in the mix.

The two entry fields for the MgO are (1) the lot number of the incoming (raw) material and (2) the sublot number, which indicates which bag and can were used. (Each-50 lb bag of MgO is divided and stored in five 10-lb cans.) The sublot number is a 3-character field where the first two digits indicate the bag number; the third character is a letter from A to E which designates the can.

The only analysis required for the EB mixes is the percentage of MgO. This is used to verify that the binder (MgO) content is within specification. The drawing associated with the DFs of Figure 7a and 7b specifies an MgO level of 35% with LiCl-KCl eutectic. Other EB compositions with this electrolyte are handled by separate drawings. Similarly, the use of other electrolytes requires the generation of new drawings.

Electrolyte DF—The screen DFs for a single lot and master lot of electrolyte are shown in Figures 15a and 15b, respectively, for the LiCl-KCl eutectic electrolyte; the corresponding paper DFs are shown in Appendices B-5 and B-6. In addition to the electrolyte lot number, fields are provided for the vendor lot numbers of the halide components (LiCl and KCl, in this case). Since the drawings for the halide salts permit a number of sources, a suffix field is provided on the DF to allow traceability to the vendor. For example, a suffix of −200 in the LiCl suffix field indicates that the material was manufactured by J. T. Baker Chemical Co.; a suffix of −201 indicates that Fisher Scientific was the vendor.

The required chemistry fields will vary for each electrolyte, depending on the composition. The DF for the LiCl-KCl eutectic electrolyte, for example, only requires LiCl analysis, since KCl can be obtained by difference. In comparison, the DF for the LiCl-LiBr-LiF eutectic (all-Li) electrolyte requires analysis for % Cl, % Br, and % F. Similarly, the DF for the LiBr-KBr-LiF eutectic (low-melting) electrolyte requires analysis for % K, % Br, and % F. The analyses that are specified are the minimum required to qualify the material.

Heat Powder DF—The screen DFs proposed for heat powders are shown in Figures 16a and 16b. (These forms are only tentative and subject to change, depending on the outcome of heat-pellet ignition studies currently underway.) The first part of the form (Figure 16a) contains fields for tester information. A suffix field is provided to indicate the heat powder composition. Fields are provided for the lot number and vendor number of the heat power, as well as the lot numbers of the Fe and $KClO_4$ used in the heat powder.

Fields are provided for the mean and standard deviation of the required physical properties of standard pellets made from the heat powder, along with the associated disposition fields. This differs radically from the format used in the original multipage forms, where the masses and physical dimensions of each individual test pellet were recorded.

The second part of the DF (Figure 16b) involves the ignition properties of the heat pellets (i.e., the ignition sensitivity and burn rate.) The final statistical method that is to be used for this form is uncertain at this time, but will most likely involve a standard probit[2] or Bruceton[3], or possibly a modified Bruceton. Fields are provided for recording the burn rate when a successful ignition is achieved, and the overall average burn rate. Fields are provided for the 50% and 90% fire levels, which are required by the heat-powder drawing.

```
**********DATA FORM FOR STANDARD EB (65% E/35% MgO) (DF343183)**********

                    #######SINGLE LOT#######

        Part No./Suffix/Issue:  SS343183-200-[IS]  Manufacturer's Code:  [MCO ]
Form Completion Date (MMDDYY):  [FDATE ]      TC:  EB      Source Code:  S

                Material Name:  [MNAME ]
        SS Number of Material:  [SS_NUM]
                EB Lot Number:  [SEBLN ]        Lot Disposition (A/R):  [D ]
     Std.-Electrolyte Lot No.:  [STELLN]
         MgO Incoming Lot No.:  [MGOI  ]
            MgO Sublot Number:  [SUB ]              CHEMISTRY
          EB Lot Size, in kg:   [SIZE  ]          MgO, %:  [MGO ]

Comments:  [COMMENTS                                                        ]

               Press ENTER when form is completed.
```

a. Single Lot

```
******MASTER DATA FORM FOR STANDARD EB (65% E/35% MgO) (DF343183)******

                                -page 2-

        Part No./Suffix/Issue:  SS343183-200-[IS]  Manufacturer's Code:  [MCO ]
Form Completion Date (MMDDYY):  [FDATE ]    TC:  EB      Source Code:  S

         Master EB Lot Number:  [MEBLN ]     Master Lot Size, kg:  [MLSIZE]

                           CHEMISTRY
                         MgO, %:  [MGO ]

            Chemistry calculated or analyzed? (C/A):  [C ]

Comments:  [COMMENTS                                                        ]

               Press ENTER when form is completed.
```

b. Master Lot

Figure 14. Screen Data Form for Standard Electrolyte-Binder Mix (DF343183)

```
**********DATA FORM FOR LiCl-KCl EUTECTIC (45%/55%) (DF343184)**********

                    #######SINGLE LOT#######

        Part No./Issue/Suffix:  SS343184-200-[IS]   Manufacturer's Code:  [MCOD]
Form Completion Date (MMDDYY):  [FDATE ]     TC:  EU        Source Code:  S

                      Material Name:  [MNAME ]      Lot Disposition (A/R):  [D ]
                 SS Number of Material:  [SS_NUM]
                 Electrolyte Lot Number:  [STELL ]
                 LiCl Vendor Lot Number:  [LICLLN]-[SU1 ]
                  KCl Vendor Lot Number:  [KCLLN ]-[SU2 ]     CHEMISTRY
               Electrolyte Lot Size, kg:  [SIZE  ]          LiCl, %:  [LICL]

Comments:  [COMMENTS                                                        ]

                    Press ENTER when form is completed.
```

a. Single Lot

```
***********MASTER DATA FORM FOR LiCl-KCl EUTECTIC (45%/55%) (DF343184)*********

                              -page 2-

        Part No./Issue/Suffix:  SS343184-200-[IS]   Manufacturer's Code:  [MCOD]
Form Completion Date (MMDDYY):  [FDATE ]   TC:  EU         Source Code:  S

 Master Electrolyte Lot Number:  [MELLN ]     Master Lot Size, kg:  [SIZE  ]

                                  CHEMISTRY
                                LiCl, %:  [LICL]

                  Chemistry calculated or analyzed? (C/A):  [C ]

Comments:  [COMMENTS                                                        ]

                    Press ENTER when form is completed.
```

b. Master Lot

Figure 15. Screen Data Form for Standard LiCl-KCl Electrolyte (DF343184)

**********DATA FORM FOR HEAT POWDER (DF285835)**********

		Suffix	Compn.
Part No./Suffix/Issue:	265866-[SUFF]-[IS]	-200	88/12
		-201	86/14
		-202	84/16

Form Completion Date (MMYYDD): [FDATE] Manufacturer's Code: [MCOD]
Source Code: S Tester: [TESTER]-[S]
Tester Serial No.: [TESTSN] Adapter Serial No.: [ADAPTR]

Heat Powder Lot No.: [HTPWDR] Total Mixing Time, hr: [MT]
Heat Powder Vendor Lot No.: [VENDORLN] Iron Powder Lot No.: [FELN]
Weight This Lot, kg: [WT] Potassium Perchlorate Lot No.: [PPLN]
Disposition (A/R):

Average Calorific Output, cal/g:	[AVGCAL]	+/-	[STD1]	[D1]
Average Gas Evolution, ml/g:	[AVGGAS]	+/-	[STD2]	[D2]
Average Breaking Strength, lb:	[AVBK]	+/-	[STD3]	[D3]
Pellet Pressing Force, tons:	[PRES]			

COMMENTS: [COMMENTS]

Press ENTER when this page of form is completed.

a. Physical Properties

*****IGNITION-SENSITIVITY/BURN-RATE DATA FORM FOR HEAT POWDER (DF285838)*****

Part No./Suffix/Issue: 265866-[SUFF]-[IS]
Form Completion Date (MMYYDD): [FDATE] Heat Powder Lot No.: [HTPWDR]

Joules	Fire (Y/N)	Burn Rate, in/s	Joules	Fire (Y/N)	Burn Rate, in/s	
[J1]	[F1]	[BR1]	[J15]	[I5]	[BR15]	50% Fire Level:
[J2]	[F2]	[BR2]	[J16]	[I6]	[BR16]	[FIRE50] joules
[J3]	[F3]	[BR3]	[J17]	[I7]	[BR17]	
[J4]	[F4]	[BR4]	[J18]	[I8]	[BR18]	90% Fire Level:
[J5]	[F5]	[BR5]	[J19]	[I9]	[BR19]	[FIRE90] joules
[J6]	[F6]	[BR6]	[J20]	[R0]	[BR20]	
[J7]	[F7]	[BR7]	[J21]	[R1]	[BR21]	Avg. Burn Rate:
[J8]	[F8]	[BR8]	[J22]	[R2]	[BR22]	[AVGBRR] +/-
[J9]	[F9]	[BR9]	[J23]	[R3]	[BR23]	[BRRSTD] in/s
[J10]	[I0]	[BR10]	[J24]	[R4]	[BR24]	
[J11]	[I1]	[BR11]	[J25]	[R5]	[BR25]	Comments:
[J12]	[I2]	[BR12]	[J26]	[R6]	[BR26]	[COM1]
[J13]	[I3]	[BR13]	[J27]	[R7]	[BR27]	[COM2]
[J14]	[I4]	[BR14]	[J28]	[R8]	[BR28]	[COM3]
						[COM4]

Press ENTER when this page of form is completed.

b. Ignition Properties

Figure 16. Screen Data Forms for Heat Powder (DF285835)

Data Forms for Discrete Components

Purified FeS_2 DF—Over the years, the particle-size range of FeS_2 used in SNL catholytes has varied considerably. Today, all of the FeS_2 used in our catholytes is purified to remove SiO_2 and oxidized-iron impurities. In the past, unpurified FeS_2 was also used. Because of the wide range in properties, it was necessary to develop a drawing for each of the FeS_2 materials used. Currently, we are using purified FeS_2 with two different particle sizes: −325+425 mesh and −325 mesh.

The screen DFs for the −325 mesh purified FeS_2 are shown in Figures 17a and 17b; the corresponding paper DFs are shown in Appendices B-7 and B-8. Fields are provided for the lot number of the purified FeS_2 and the lot number of the incoming (unpurified) FeS_2 used as the starting material. Since the purification may be carried out at elevated temperatures, a field is provided for the leach temperature used.

Four fields are provided for the chemistry of the purified FeS_2. The sum of total Fe and total S defines the pyrite content. The acid-insoluble residue is a measure of any acid-insoluble impurities, such as silica. And the acid-soluble Fe is a measure of any oxidized iron compounds that may be present.

The suffix field after the part number is used to indicate which purification process is employed and the size of the FeS_2 feed material. A suffix of −200 is used for coarse (e.g., −50 mesh) FeS_2 that is subjected to hydrofluoric acid (HF) leaching for silica removal. A suffix of −201 is used for the same material purified by flotation, which involves physical removal of the silica. In both cases, the coarse material must first be ground to −325 mesh before purification. A suffix of −202 is used for fine (−325 mesh) FeS_2 that is HF leached, while −203 is the flotation-treated counterpart. In all cases, the FeS_2 is also treated with HCl for removal of oxidized-iron impurities.

Incoming FeS_2 DF—The screen DF for the incoming (unpurified) FeS_2 is shown in Figure 18; the corresponding paper DF is shown in Appendix B-9. Fields are provided for the incoming lot number and the vendor's lot number. The chemistry requirements are somewhat similar to those for the purified FeS_2, in that both DFs require total Fe, total S, and acid-insoluble residue. The total Fe + total S (FeS_2 purity) must be at least 85% for the FeS_2 to be acceptable.

Additional fields are provided for the total metallic impurities and the percentage of particles greater than the coarse limit established by the SS drawing. The limit is different for the two different sizes of materials permitted by the drawing.

A suffix field is used to distinguish between the two sizes for the incoming FeS_2. A −200 suffix is used for coarse material that may be used from three different sources: −50 mesh (source 1), −60 mesh (source 2), and −60+200 mesh (source 3). A −201 suffix is used for fine (−325 mesh) material that has only a single source.

MgO DF—The screen form for incoming MgO is shown in Figure 19; the corresponding paper DF is shown in Appendix B-10. Fields are provided for the incoming lot number, sublot number, and vendor's lot number. The incoming lot number refers to a single lot of material that will contain multiple 50-lb bags. Once opened, a bag is divided and stored in five 10-lb cans. A bag (or, more appropriately, a can) is considered a sublot and is given a 3-character code: the first two characters correspond to the bag number and the third character is a letter from A through E which designates the can; a representative sublot number could be 40A. The size specified in this form is for the *sublot*.

The chemistry fields of the form refer to the MgO after it has been baked at 600°C for 4 h, and include: % total metallic impurities, % water, % CO_2, loss on ignition, and BET surface area. The loss on ignition is especially useful as a parameter for the amount of hydroxide and carbonate that were present in the sample.

Li_2O DF—The screen DF for Li_2O is shown in Figure 20; the corresponding paper DF is shown in Appendix B-11. Fields are provided for the lot number and vendor's lot number. Since the vendor's lot number can be quite long, in some cases, a note was added to the form to use the comment field, if necessary, for this information.

The chemistry of the Li_2O is defined by the % Li_2O, % total metallic impurities, and whether the x-ray diffraction pattern matches that of the standard.

```
**********DATA FORM FOR PURIFIED FeS2 (-325 Mesh) (DF383017)**********

                    #######SINGLE LOT#######

 Part No./Suffix/Issue:  SS383017-[SUFF]-[IS]      Manufacturer's Code:  [MCOD]
 Form Completion Date (MMDDYY):  [FDATE ]     TC:  IP       Source Code:  S

                      Material Name:  [MNAME ]   Leach Temp., deg. C:  [LT]
                 SS Number of Material:  [SS_NUM]
               Purified FeS2 Lot Number:  [FES2P ]
               Incoming FeS2 Lot Number:  [FES2I ]    Lot Disposition (A/R):  [DI]
                   FeS2 Lot Size, in kg:  [SIZE  ]

                            CHEMISTRY
                         Total Iron, %:  [TOTF]
                       Total Sulfur, %:  [TOTS]
              Acid-Insoluble Residue, %:  [HISR]
                    Acid-Soluble Fe, %:  [HSOF]

Comments:  [COMMENTS                                                          ]

                    Press ENTER when form is completed.
```

a Single Lot

```
*********MASTER DATA FORM FOR PURIFIED FeS2 (-325 Mesh) (DF383017)*********

                              -page 2-

 Part No./Suffix/Issue:  SS383017-[SUFF]-[IS]      Manufacturer's Code:  [MCOD]
 Form Completion Date (MMDDYY):  [FDATE ]     TC:  IP       Source Code:  S

      Master FeS2 Lot Number:  [MLOT  ]      Master Lot Size, kg:  [MSIZE ]

                            CHEMISTRY
                         Total Fe, %:  [TOTF]
                          Total S, %:  [TOTS]
                 Acid-Insol. Residue, %:  [HISR]
                     Acid-Soluble Fe, %:  [HSOF]

                     Chemistry calculated or analyzed? (C/A):  [C ]

Comments:  [COMMENTS                                                          ]

                    Press ENTER when form is completed.
```

b. Master Lot

Figure 17. Screen Data Form for Purified −325 Mesh FeS_2 (DF383017)

```
**********DATA FORM FOR INCOMING (UNSIZED, UNPURIFIED) FeS2 (DF344952)*********

   Part No./Suffix/Issue:  SS344952-[SUFF]-[IS]  Manufacturer's Code:  [MCOD]
 Form Completion Date (MMDDYY):  [FDATE ]    TC:  ID        Source Code:  S

                    Material Name:  [MNAME ]
              SS Number for Material:  [SS_NUM]
                 Incoming Lot Number:  [INLN  ]     Lot Disposition (A/R):  [DI]
                 Vendor's Lot Number:  [VENDLNO ]
                        Lot Size, kg:  [SIZE  ]

                              CHEMISTRY
                          Total Iron, %:  [TOTF]  Total Iron + Total S, %:  [PUR ]
                        Total Sulfur,%:  [TOTS]  (NOTE: This is calculated.)
                Acid-Insoluble Residue, %:  [HIRE]  Amt. Greater Than Coarse Limit
            Total Metallic Impurities, %:  [TMIM]  on Particle Size, %:  [PSLM]

Comments:  [COMMENTS                                                          ]

                          Press ENTER when form is completed.
```

Figure 18. Screen Data Form for Incoming (Unpurified) FeS_2 (DF344952)

```
**************************DATA FORM FOR MgO (DF344954)****************************

          Part No./Suffix/Issue:  SS344954-200-[IS]  Manufacturer's Code:  [MCO ]
Form Completion Date (MMDDYY):  [FDATE ]   TC:  MO          Source Code:  S

               Material Name:  [MNAME ]
         SS Number for Material:  [SS_NUM]
            Incoming Lot Number:  [MGOI  ]          Lot Disposition (A/R):  [DI]
            Sublot (Bag) Number:  [SUB ]
              Vendor Lot Number:  [VENDLN  ]
                Sublot Size, kg:  [SIZE  ]

                                  CHEMISTRY
                      Total Metallic Impurities, %:  [TMIM]
                                      Water, %:  [H2O ]
                                Carbon Dioxide, %:  [CO2 ]
                               Loss On Ignition, %:  [LOI ]
                            BET Surface Area, sq m/g:  [BET ]

Comments:  [COMMENTS                                                          ]

                          Press ENTER when form is completed.
```

Figure 19. Screen Data Form for Incoming (Unbaked) MgO (DF344954)

```
**********DATA FORM FOR Li2O (DF344940)**********

      Part No./Suffix/Issue:  SS344940-200-[IS]  Manufacturer's Code:  [MCOD]
Form Completion Date (MMDDYY):  [FDATE ]    TC:  LO        Source Code:  S

                                                          CHEMISTRY
          Material Name:  [MNAME ]                          Li2O, %:  [LI2O]
SS Number of Material:  [SS_NUM]     Total Metallic Impurities, %:  [TMIM]
          Li2O Lot Number:  [LI2OL ]     Does X-ray Diffraction Pattern Match
                    Size, kg:  [SIZE  ]          JCPDS 12-254? (A/R):  [XR]
      Vendor's Lot Number:  [VENDORLN]*

                        Lot Disposition (A/R):  [DI]

Comments:  [COMMENTS                                                    ]

                        Press ENTER wh  form is completed.

* Use COMMENT field for Vendor's Lot Number, if necessary.
```

Figure 20. Screen Data Form for Li_2O (DF344940)

Anode DFs—Screen DFs for the two type of Li(Si) anode material used in SNL thermal batteries are shown in Figures 21a and 21b; the corresponding paper DFs are shown in Appendices B-12 and B-13. The first screen form (Figure 14a) describes the coarse (−40+230 mesh) Li(Si) used in our power batteries. Fields are provided for the lot number and the vendor's lot number.

The chemistry of the Li(Si) is defined by the % Li, % Si, % O, and % total metallic impurities. The amount of material that is −230 mesh after sieving must also be specified.

The screen form for the finer (−100+325 mesh) Li(Si) that is used in thin-cell batteries (Figure 14b) is much like that for the coarse material (Figure 14a), except that the amount of −325 mesh material after sieving must be noted.

Fe Powder DF—The screen DF for the Fe powder used in heat powders is shown in Figure 22; the corresponding paper DF is shown in Appendix B-15. Fields are provided for the lot number and vendor's lot number.

The data for the Physical Properties and Chemistry sections are normally provided by the manufacturer, as is the Fisher Sub-Sieve Size datum. This latter physical property is determined by measuring the pressure across a packed bed of powder, and makes a number of assumptions as to the particle shape and packing. This information is of only limited value. Because of this, three fields are provided under the Particle-Size Analysis section to define the relative distribution of the powder as measured by a standard sedimentation technique (e.g., Sedigraph). The particle sizes at 25%, 50%, and 75% cumulative mass percentages can be used to generate a nominal profile of the relative distribution of the Fe powder. This can be quite useful when trying to track down causes for differences in burn rates among different lots of heat powder.

$KClO_4$ DF—The screen DF for the $KClO_4$ used in heat powders is shown in Figure 23; the corresponding paper DF is shown in Appendix B-16. Fields are provided for the lot number and vendor's lot number. The data for the chemistry of the $KClO_4$ are normally provided by the manufacturer. The current DF for the heat powder contains a field for the particle size of the $KClO_4$. This is determined by a modified turbimetric technique. The new screen form also contains fields for particle-size analysis by the sedimentation technique, as is specified in the screen form for the Fe powder (Figure 15). It is planned to record both types of information until correlations can be made between them for heat-powder characterization purposes.

```
***DATA FORM FOR STANDARD ANODE (-40+230 Mesh, 44% Li/56% Si) (DF344953)***

        Part No./Suffix/Issue:  SS344953-200-[IS]  Manufacturer's Code:  [MCOD]
Form Completion Date (MMDDYY):  [FDATE ]    TC:  LS        Source Code:  S

                     Material Name:  [MNAME ]
               SS Number for Material:  [SS_NUM]
                    Anode Lot Number:  [ANLN   ]
                   Vendor Lot Number:  [VENDLN  ]   Lot Disposition (A/R):  [DI]
                Anode Lot Size, in kg:  [SIZE  ]

      PARTICLE-SIZE ANALYSIS                              CHEMISTRY
Rel. Amt. of -230 Mesh After Sieving, %:  [M230]      Lithium, %:  [LI   ]
                                                      Silicon, %:  [SI   ]
                                                       Oxygen, %:  [O2   ]
                                          Total Metallic Impurities, %:  [TMIM]

Comments:   [COMMENTS                                                      ]

                          Press ENTER when form is completed.
```

a. -40+230 Mesh Material (DF344953)

```
***DATA FORM FOR THIN-CELL ANODE (-100+325 Mesh, 44% Li/56% Si) (DF370711)***

        Part No./Suffix/Issue:  SS370711-200-[IS]  Manufacturer's Code:  [MCOD]
Form Completion Date (MMDDYY):  [FDATE ]     TC:  LS      Source Code:  S

                     Material Name:  [MNAME ]
               SS Number for Material:  [SS_NUM]
                    Anode Lot Number:  [ANLN   ]
                   Vendor Lot Number:  [VENDLN  ]   Lot Disposition (A/R):  [DI]
                Anode Lot Size, in kg:  [SIZE  ]

      PARTICLE-SIZE ANALYSIS                              CHEMISTRY
Rel. Amt. of -325 Mesh After Sieving, %:  [M325]      Lithium, %:  [LI   ]
                                                      Silicon, %:  [SI   ]
                                                       Oxygen, %:  [O2   ]
                                          Total Metallic Impurities, %:  [TMIM]

Comments:   [COMMENTS                                                      ]

                          Press ENTER when form is completed.
```

b. -100+325 Mesh Material (DF370711)

Figure 21. Screen Data Forms for Li(Si) (44% Li) Anode Materials

```
**********DATA FORM FOR Fe POWDER (DF344796)**********

 Part No./Suffix/Issue:  SS344796-200-[IS]  Manufacturer's Code:  [MCO ]
 Form Completion Date (MMDDYY):  [FDATE ]    TC:  FE        Source Code:  S

              Material Name:  [MNAME ]     Lot Size, kg:  [SIZE  ]
      SS Number for Material:  [SS_NUM]
         Incoming Lot Number:  [INLN  ]     Lot Disposition (A/R):  [DI]
         Vendor's Lot Number:  [VENDLNO ]

          PHYSICAL PROPERTIES                        CHEMISTRY
        Green Strength, psi:  [GRST]          Total Iron, %:  [TOTF  ]
              % -325 Mesh:  [P325]          Metallic Iron, %:  [MEFE  ]
              % +100 Mesh:  [P100]    Wt. Loss on H2 Redn., %:  [WTLS]
        Appar. Density, g/cc:  [ADEN]

     PARTICLE-SIZE ANALYSIS BY SEDIMENTATION        FISHER SUB-SIEVE SIZE
   Particle Dia. @ 25 Cum. Mass %, microns:  [DI25]  Avg. Dia. from Fisher
   Particle Dia. @ 50 Cum. Mass %, microns:  [DI50]  Sub-sieve Sizer,
   Particle Dia. @ 75 Cum. Mass %, microns:  [DI75]  microns:  [FSZ ]

Comments:  [COMMENTS                                                    ]

                    Press ENTER when form is completed.
```

Figure 22. Screen Data Form for Fe Powder (DF344796)

```
**********DATA FORM FOR KClO4 POWDER (DF388378)**********

       Part No./Suffix/Issue:  SS388378-200-[IS]  Manufacturer's Code:  [MCOD]
Form Completion Date (MMYYDD):  [FDATE ]     TC:  XX      Source Code:  S

            Material Name:  [MNAME ]          Lot Size, kg:  [SIZE  ]
    SS Number of Material:  [SS_NUM]
        Incoming Lot No.:  [INLN  ]          Lot Disposition (A/R):  [DI]
        Vendor's Lot No.:  [VENDLNO ]
                          CHEMISTRY
         Moisture, %:  [H2O ]                  Sodium, as % NaClO4:  [NA  ]
  Chlorides, as % KCl:  [KCL ]        Ca and Mg Salts, as % Oxides:  [CAMG]
Chlorates, as % KClO3:  [KCLO]         Water Insoluble Material, %:  [WINS]
    Hypochlorites, %:  [CLO ]               pH of Water Solution:  [PH  ]
 Bromates, as % KBrO3:  [KBRO]                    KClO4 Assay, %:  [ASSY  ]

    PARTICLE-SIZE ANALYSIS BY SEDIMENTATION       TURBIMETER PART. SIZE
  Particle Dia. @ 25 Cum. Mass %, microns:  [DI25]  Avg. Dia. from Modified
  Particle Dia. @ 50 Cum. Mass %, microns:  [DI50]  Turbimetric Measurement,
  Particle Dia. @ 75 Cum. Mass %, microns:  [DI75]  microns:  [FSZ ]

Comments:  [COMMENTS                                                    ]
```

Figure 23. Screen Data Form for $KClO_4$ Powder (DF388378)

Data Qualification

Once the data have been entered into the materials database, they will be certified by the Quality Control (QC) representative from GENDD before they are archived. This was not done in the past and contributed to the current problems encountered with the database. The QC representative will "lock" or secure the database and examine the data for any inconsistencies (e.g., numbers out of range). Once the integrity of the data has been assured, the QC representative will then notify the HP3000 database manager that the data can be electronically transmitted for archiving. [Initially, the data were to be formatted in a special manner (i.e., GEISHA-coded). The final data format for archival purposes has not been decided at this time.] A special field on each of the screen DFs indicates whether the data for that material have been transmitted for archives.

Data Retrieval

Materials data can be stored on the HP3000 for up to a year. Anyone wanting materials data for mixes or batteries can readily access the information through the HP3000. However, accessing data that are older than this will require assistance from the database manager at the archives location (most probably GENDD). Accessing the materials database on the HP3000 involves the same screen forms that are used for entering data (i.e., Figures 6–23).

Data Editing

Editing of any of the data in the materials database is performed while in the data-retrieval mode, as described above. Only those persons that have "write" capability can edit the data. The database manager controls the capabilities of all the persons that have access to the materials database. Most users will have "read only" access.

Modification of the Database—The existing screen forms and associated fields are easily modified by running HP's FORMSPEC and then recompiling the database. However, for the modified screen forms to interact properly with the database will require appropriate changes to the TRANSACT code that does the actual data entry and retrieval from the materials database. New screen forms can be added to the materials database, as needed, by similar procedures. The corresponding paper DFs must also be appropriately modified, to maintain overall consistency for the database.

Implementation

The materials database has been successfully implemented at EPI and now contains materials data for two MC production Li(Si)/FeS_2 thermal batteries. No serious problems in implementation were encountered after the operators were properly trained in the use of the database.

Conclusions

A network-type database (based on HP's IMAGE) was developed for storing the physical- and chemical-characterization data for the materials used in the construction of production Li(Si)/FeS_2 thermal batteries designed at SNL, with the goal of ensuring materials traceability over the lifetime of the weapons programs associated with the batteries. This period can exceed 25 yr.

The existing materials database was deficient, incomplete, paper intensive, and contained inconsistencies in the manner in which materials were assigned lot numbers. Portions of the archived data were compromised as a result of the lack of any quality assurance associated with the database after data entry. It was generally not possible to trace materials used in the MC batteries without consulting with a number of people at the various production agencies and sorting through large amounts of data stored on paper.

The new database was designed to use screen (CRT) data forms in conjunction with an HP3000 computer (in lieu of paper data forms) for the entry, retrieval, and editing of data. The data are to reside on the HP3000 for up to a year before they are archived on a VAX at SNL or the production agency. Before electronic transfer and archiving, the data will be checked for integrity by a quality assurance representative from GENDD.

Custom screen forms were designed for each of the mixes (e.g., a catholyte) used in the battery, and the discrete components (e.g., FeS_2) that make up the mixes. The screen forms have built into them the capability of trapping errors, which further enhances the integrity of the data. The use of menu-driven screen forms greatly facilitates the use of the materials database.

A key aspect of the materials database was the adoption of a uniform lot-numbering system for all the various materials. This consists of a 5-character code (YYXXX), where the first two digits (YY) represent the last two digits of the current year and the last three digits (XXX) represent the sequential lot number of the material ordered in that calendar

year. An M-suffix is added to the 5-character code in the case of a master lot (e.g., YYXXXM).

The materials database ties the serial number of a particular MC battery to the lot numbers of the four mixes that are used in that battery: cathode, separator, anode, and heat powders. Each of these, in turn, is tied to the lot numbers of the discrete components that make up the respective mixes. This allows traceability of all of the materials used in a battery.

The materials database was successfully implemented at EPI with little or no difficulties, after proper training of the users.

References

[1]R. A. Guidotti and F. W. Reinhardt, "Screening Study of Lithiated Catholyte Mixes for a Long-Life Li(Si)/FeS_2 Thermal Battery," SAND85-1737 (Albuquerque, NM: Sandia National Laboratories, December 1988).

[2]D. J. Finney, *Probit Analysis*, 2nd ed., Cambridge University Press, London, 1962.

[3]W. J. Dixon and A. M. Mood, "A Method of Obtaining and Analyzing Sensitivity Data," *J. Amer. Stat. Soc.*, 43:102 (1948).

APPENDIX A

Schematic Diagram of the IMAGE Materials Database Structure

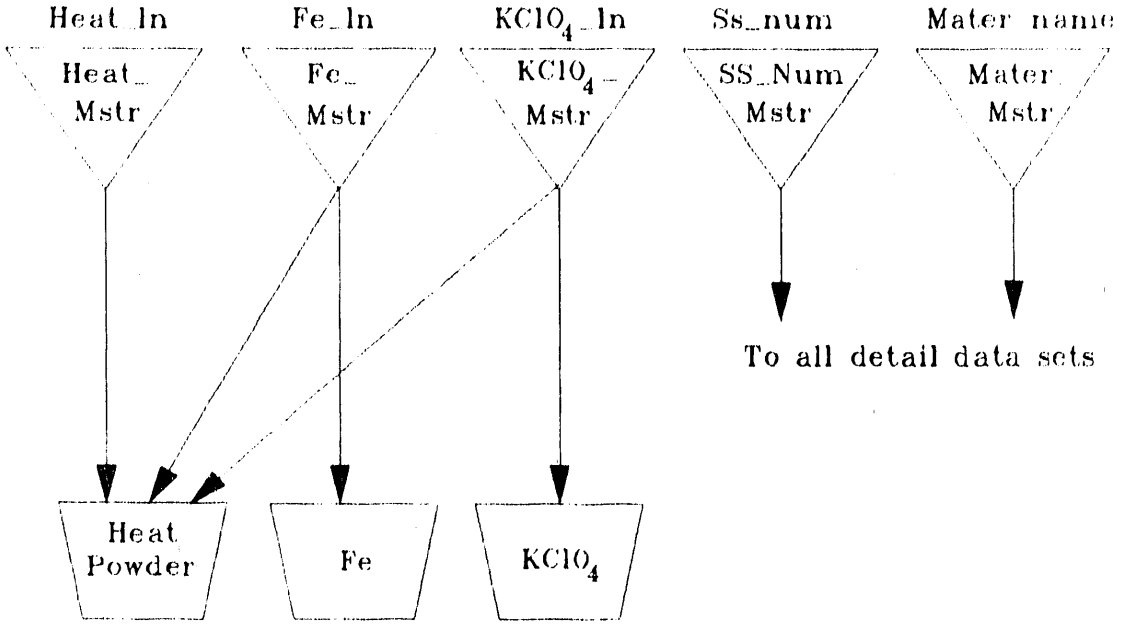

Figure A1. Heat-Powder Portion of Database Structure

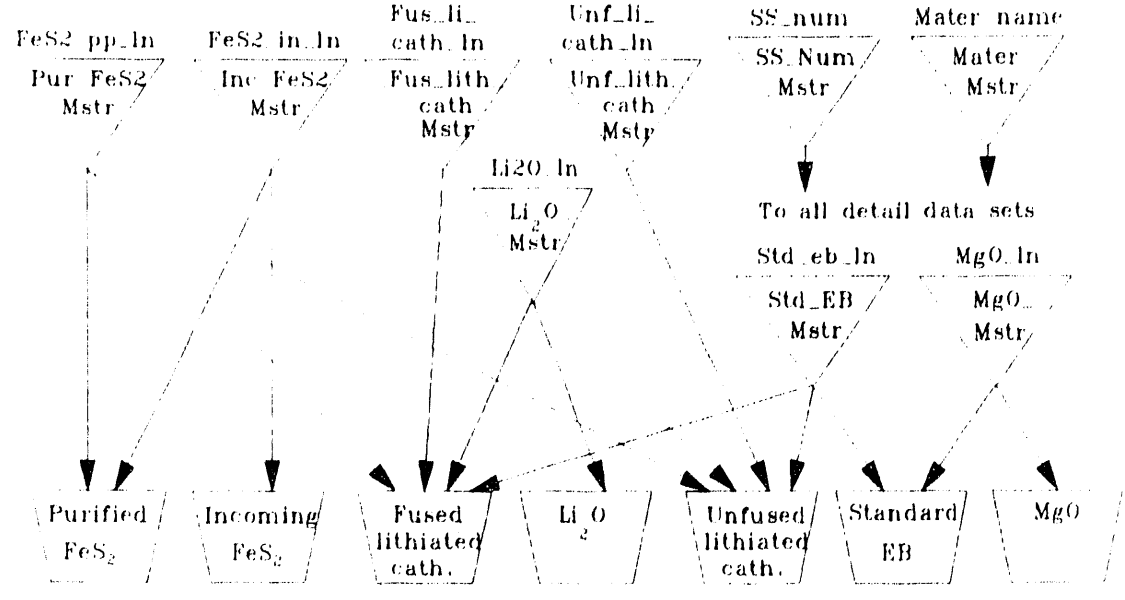

Figure A2. Catholyte Portion of Database Structure

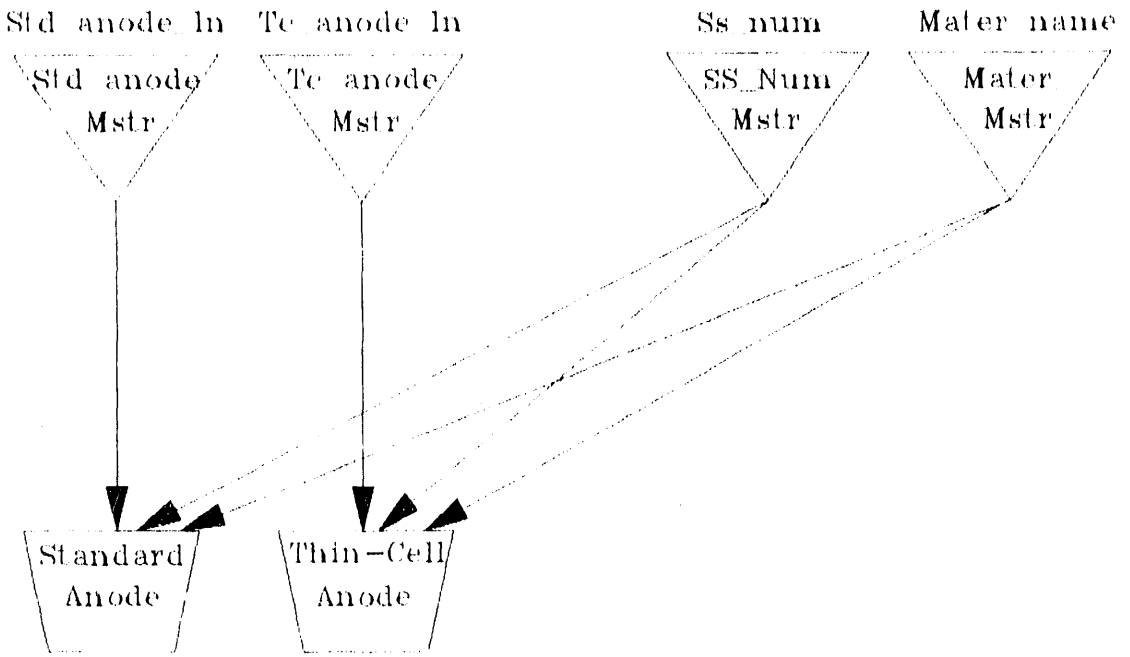

Figure A3. Anode Portion of Database Structure

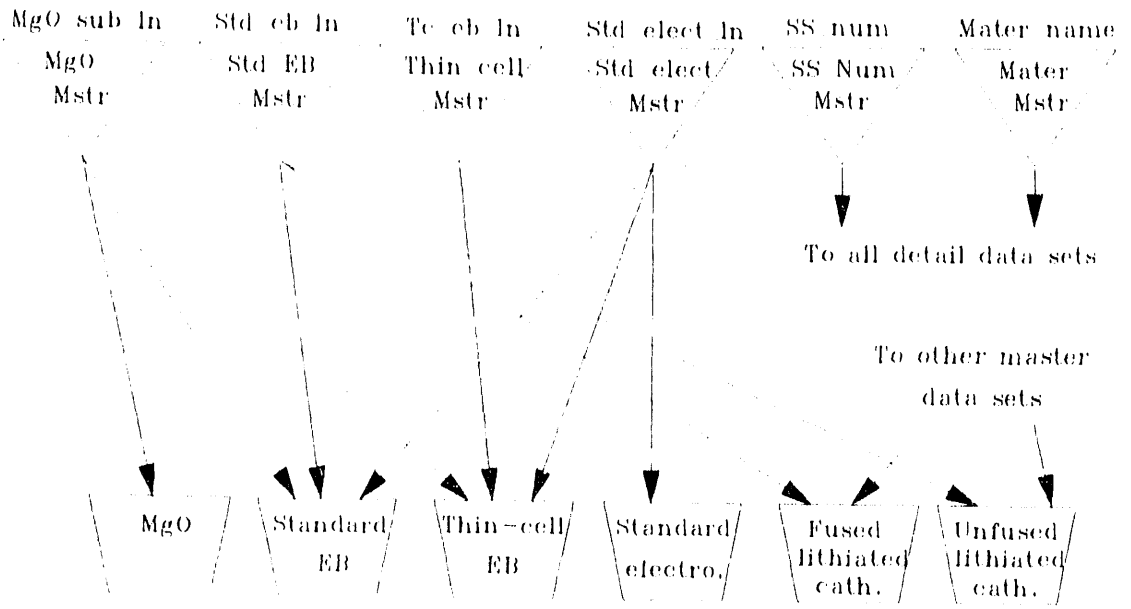

Figure A4. EB Portion of Database Structure

APPENDIX B

Paper Data Forms for Materials Used in Li(Si)/FeS_2 Thermal Batteries

Dwg. Classification Level
UNCLASSIFIED

Item	Form Completion Date (MO - DAY - YR)	Source Code	Dwg. System	Type
H, IDbSS379481,	TDb | | | - | | | - | | |,	DSb|S|,	TIE/SC/GE	A
Part Number PNbSS379481	Suf. | | | - Issue | | |,	Mfr. Code MFb | | |,		

Test Code

Lithiated Catholyte Mix (Fused) (73.5/25/1.5): Batch Data TCb|L|C|,|

Item	Batch No., Cath.
T, IDbSS379481,	LNb | | | | | |, SNb|0|0|0|0|0|0|0|0|,

	Units	I|D	Value
Batch Size, Cath.	KG	S|I|Z|E|b|b	| | | . | | | / |
Batch Disposition (A or R)		D|I|S|P|b|b	//////////
Process lot number for Iron Disulfide, Sized and Purified (from DF383017 or DF370698)		P|P|b|b|b|b	| | | | | |
Lot Number of Electrolyte-Binder Mix (65/35) (from DF343183)		E|B|b|b|b|b	| | | | | |
Lot Number of Lithium Oxide (from DF344940)		L|O|b|b|b|b	| | | | | |

NOTES:

1. Batches shall be numbered consecutively within a calendar year.
   Example: YYXXX

   YY = last two digits of calendar year
   XXX = sequential batch number manufactured within a calendar year (see note 2 below).

2. Batch numbers from 001 thru 499 are assigned for exclusive use by GEND and from 500 thru 999 are assigned for exclusive use by Eagle-Picher Ind., Inc., Joplin, Mo. Entries in the manufacturer's code field (MFb) shall be GBV for GEND or EAY for Eagle-Picher, Ind., Inc., Joplin, Mo.

3. Master lot numbers (see pg. 2) shall use the same numbering convention as for batch mixes except an "M" suffix shall be used.
   Example: YYXXXM

4. Comment information that is entered into the SNLA, Dep. 2520 HP3000 system shall be transferred to the SNLA PTD system in GEISHA format using non-standard ID's starting with COM1bb, COM2bb, COM3bb, etc., upto COM8bb. The contents of each ID shall be 8 characters maximum. The requirements of SC-M-72 0742A are applicable. (b = blank space)

5. In part number field suffix use a -200 suffix if the iron disulfide in this batch was processed using SS383017 and -201 if SS370698 was used.

Release Identification	Engr.	Org.	Date	Test Agency	Authorized Signature
	LH	2825	3/87		

Cont. Suff.	Issue ~~A~~/B/D	Dwg. Classification Level	Size	Code Id	Dwg. Number
000		UNCLASSIFIED	A	14213	DF379481 Sheet 1 of 2

Dwg. Classification Level
UNCLASSIFIED

	Item	Form Completion Date MO	DAY	YR	Source Code	Dwg. System	Type
H,	IDbSS379481, TDb				DSbS,	TIE/SC/GE	A

Part Number	Suf.	Issue	Mfr. Code
PNbSS379481-			MFb

Test Code
Lithiated Catholyte Mix (Fused) (73.5/25/1.5)

Master Lot Data TCb L C

	Item	Master Lot No.													
T,	IDbSS379481,	LNb					M	,	SNb	0	0	0	0	0	0	0	0

Chemistry % by Weight	Units	ID	Value
Total Iron	%	P C T F E b	.
Total Sulfur	%	P C T S b b	.
Acid Soluble Iron	%	P C T A S I	.
Water Soluble Sulfate	%	P C T W S S	.
Magnesium	%	P C T M G b	.
Calculated from Sublot Qualification Data or Analyzed (C or A)		P C T W T b	
Master Lot Size	Units KG	I D S I Z E b b	.
Master Lot Disposition (A or R)		D I S P b b	///////

Catholyte batch numbers contained in the master lot shown above shall be entered sequentially in the following fields starting with N01bbb (Use one batch number per field).

ID		ID		ID	
N01bbb		N15bbb		N28bbb	
N02bbb		N16bbb		N29bbb	
N03bbb		N17bbb		N30bbb	
N04bbb		N18bbb		N31bbb	
N05bbb		N19bbb		N32bbb	
N06bbb		N20bbb		N33bbb	
N07bbb		N21bbb		N34bbb	
N08bbb		N22bbb		N35bbb	
N09bbb		N23bbb		N36bbb	
N10bbb		N24bbb		N37bbb	
N11bbb		N25bbb		N38bbb	
N12bbb		N26bbb		N39bbb	
N13bbb		N27bbb		N40bbb	
N14bbb					

Distribution Instructions:
1. Original to SNLA, Product Support Division, within 10 working days of batch or master lot acceptance and a copy retained by the manufacturer.
2. One copy to SNLA, Org. 2522.
3. One copy to GEND Quality Control.

Release Identification	Engr.	Org.	Date	Test Agency	Authorized Signature
	LH	2825	3/87		

Cont.	Suff.	Issue	A	R	Dwg. Classification Level	Size	Code Id	Dwg. Number
		D						DF379481
	000				UNCLASSIFIED	A	14213	Sheet 2 of 2

Dwg. Classification Level
U N C L A S S I F I E D

	Item	Form Completion Date MO	DAY	YR	Source Code	Dwg. System	Type
H,	IDbSS343183,	TDb			DSb S,	TIE/SC/GE	A

Part Number	Suf.	Issue	Mfr. Code
PNbSS343183	2 0 0		MFb

Test Code

Separator Mixture (65/35): Batch Data TCb E B,

	Item	Batch No.		
T,	IDbSS343183,	LNb		SNb 0 0 0 0 0 0 0 0,

Lot Size	Units	ID	Value
	KG	SIZEbb	
Batch Disposition (A or R)		DISPbb	
Master Lot Number of Electrolyte Mix (45/55 Eutectic) (from DF343184)		ELbbbb	
Magnesium Oxide (from DF344954): Incoming Lot Number		MGOILN	
Sublot Number		MSbbbb	

NOTES:

1. Batches shall be numbered consecutively within a calendar year.
   Example: YYXXX

   YY = last two digits of calendar year
   XXX = sequential batch number manufactured within a calendar year (see note 2 below).

2. Batch numbers from 001 thru 499 are assigned for exclusive use by GEND and from 500 thru 999 are assigned for exclusive use by Eagle-Picher Ind., Inc., Joplin, Mo. Entries in the manufacturer's code field (MFb) shall be GBV for GEND or EAY for Eagle-Picher, Ind., Joplin, Mo.

3. Master lot numbers (see pg. 2) shall use the same numbering convention as for batch mixes except an "M" suffix shall be used.
   Example: YYXXXM

4. Comment information that is entered into the SNLA, Dep. 2520 HP3000 system shall be transferred to the SNLA PTD system in GEISHA format using non-standard ID's starting with COM1bb, COM2bb, COM3bb, etc., upto COM8bb. The contents of each ID shall be 8 characters maximum. The requirements of SC-M-72 0742A are applicable. (b = blank space)

Release Identification	Engr.	Org.	Date	Test Agency	Authorized Signature
CER/DTER 872075SC		2825	12/5/88		

Cont.	Suff.	Issue	A	Dwg. Classification Level	Size	Code Id	Dwg. Number
							DF343183
000				U N C L A S S I F I E D	A	14213	Sheet 1 of 2

Dwg. Classification Level
U N C L A S S I F I E D

	Item	Form Completion Date MO DAY YR	Source Code	Dwg. System	Type
H	IDbSS343183	TDb | | | - | | | - | | |	DSb | S |	TIE/SC/GE	A

Part Number	Suf.	Issue	Mfr. Code
PNbSS343183-	2 | 0 | 0	- | | |	MFb | | | |

Test Code
Separator Mixture (65/35) : Master Lot Data TCb | E | B

	Item	Master Lot No.	
T	IDbSS343183	LNb | | | | | M |	SNb | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Chemistry % by Weight	Units	ID	Value
Magnesium Oxide	%	P | C | T | M | G | 0	| | . | |
Calculated from Sublot Qualification Data or Analyzed (C or A)		P | C | T | W | T | b	

Master Lot Size	Units	ID	Value
	KG	S | I | Z | E | b | b	| | . | |
Master Lot Disposition (A or R)		D | I | S | P | b | b	

EB mix batch numbers contained in the master lot shown above shall be entered sequentially in the following fields starting with N01bbb (Use one batch number per field):

ID		ID		ID	
N01bbb		N15bbb		N28bbb	
N02bbb		N16bbb		N29bbb	
N03bbb		N17bbb		N30bbb	
N04bbb		N18bbb		N31bbb	
N05bbb		N19bbb		N32bbb	
N06bbb		N20bbb		N33bbb	
N07bbb		N21bbb		N34bbb	
N08bbb		N22bbb		N35bbb	
N09bbb		N23bbb		N36bbb	
N10bbb		N24bbb		N37bbb	
N11bbb		N25bbb		N38bbb	
N12bbb		N26bbb		N39bbb	
N13bbb		N27bbb		N40bbb	
N14bbb					

Distribution Instructions:
1. Original to SNLA, Product Support Division, within 10 working days of lot acceptance and a copy retained by the manufacturer.
2. One copy to SNLA, Org. 2522.
3. One copy to GEND Quality Control.

Release Identification	Engr.	Org.	Date	Test Agency	Authorized Signature
CER/DTER 872075SC		2825	12/5/88		

Cont.	Suff.	Issue	A	Dwg. Classification Level	Size	Code Id	Dwg. Number
							DF343183
	000			U N C L A S S I F I E D	A	14213	Sheet 2 of 2

Dwg. Classification Level
U N C L A S S I F I E D

Item	Form Completion Date MO DAY YR	Source Code	Dwg. System	Type
IDbSS343184,	TDb | | | - | | | - | | |,	DSb|S|,	TIE/SC/GE	A

Part Number	Suf.	Issue	Mfr. Code
NbSS343184-	2|0|0	- | | |,	MFb| | | |,

Test Code

Electrolyte Mix (45/55 Eutectic) : Batch Data	TCb|E|U|,

Item	"E" Batch No.		
IDbSS343184,	LNb| | | | | |,	SNb|0|0|0|0|0|0|0|0|,	

	Units	ID	Value
Lot Size	KG	S|I|Z|E|b|b	| | . | | |
"E" Sublot Disposition (A or R)		D|I|S|P|b|b	
LiCl Vendor Lot Number		L|I|C|L|b|b	| | | | |
LiCl Vendor Lot Number Suffix		L|I|C|L|S|U	| | |
KCl Vendor Lot Number		K|C|L|b|b|b	| | | | |
KCL Vendor Lot Number Suffix		K|C|L|S|U|F	| | |

NOTES:

1. Sublots shall be numbered consecutively within a calendar year. Example: YYXXX

   YY = last two digits of calendar year
   XXX = sequential sublot number manufactured within a calendar year (see note 2 below).

2. Sublot numbers from 001 thru 499 are assigned for exclusive use by GEND and from 500 thru 999 are assigned for exclusive use by Eagle-Picher Ind., Inc., Joplin, Mo. Entries in the manufacturer's code field (MFb) shall be GBV for GEND and EAY for Eagle-Picher Ind., Inc., Joplin, Mo.

3. Master lot numbers (see pg. 2) shall use the same numbering convention as for sublots except an "M" suffix shall be used. Example: YYXXXM

4. Comment information that is entered into the SNLA, Dep. 2520 HP3000 system shall be transferred to the SNLA PTD system in GEISHA format using non-standard ID's starting with COM1bb, COM2bb, COM3bb, etc., upto COM8bb. The contents of each ID shall be 8 characters maximum. The requirements of SC-M-72 0742A are applicable. (b = blank space)

5. Instructions for entering data in vendor lot no. suffix fields above are contained in SS dwg.

Release Identification	Engr.	Org.	Date	Test Agency	Authorized Signature
CER/DTER 872075SC	JKF	2825	12/5/88		

Cont. Suff.	Issue	A	Dwg. Classification Level	Size	Code Id	Dwg. Number
000	| | | | |		U N C L A S S I F I E D	A	14213	DF343184 Sheet 1 of 2

| Dwg. Classification Level |
| U N C L A S S I F I E D |

Item | Form Completion Date MO DAY YR | Source Code | Dwg. System | Type

H, | IDbSS343184, | TDb | | | - | | | - | | | , | DSb | S | , | TIE/SC/GE | A

Part Number Suf. Issue | Mfr. Code

PNbSS343184- | 2 | 0 | 0 | - | | | | , | MFb | | | | | , |

Test Code

Electrolyte Mix (45/55 Eutectic): Master Lot Data Form TCb | E | U |

| Item | Master Lot No. |

T, | IDbSS343184, | LNb | | | | | | | M | , | SNb | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ,

Chemistry % by Weight	Units	I D	Value
Lithium Chloride	%	P | C | L | I | C | L	| | . | |
Calculated from Sublot Qualification Data or Analyzed (C or A)		P | C | T | W | T | b	|
Master Lot Size	Units	I D	Value
	KG	S | I | Z | E | b | b	| | . | |
Master Lot Disposition (A or R)		D | I | S | P | b | b	| //////////

"E" Sublot numbers contained in the master lot shown above shall be entered sequentially in the following fields starting with N01bbb (Use one sublot number per field):

ID		ID		ID	
N01bbb		N15bbb		N28bbb	
N02bbb		N16bbb		N29bbb	
N03bbb		N17bbb		N30bbb	
N04bbb		N18bbb		N31bbb	
N05bbb		N19bbb		N32bbb	
N06bbb		N20bbb		N33bbb	
N07bbb		N21bbb		N34bbb	
N08bbb		N22bbb		N35bbb	
N09bbb		N23bbb		N36bbb	
N10bbb		N24bbb		N37bbb	
N11bbb		N25bbb		N38bbb	
N12bbb		N26bbb		N39bbb	
N13bbb		N27bbb		N40bbb	
N14bbb					

Distribution Instructions:

1. Original to SNLA, Product Support Division, within 10 working days of lot acceptance and a copy retained by the manufacturer.
2. One copy to SNLA, Org. 2522.
3. One copy to GEND Quality Control.

Release Identification	Engr.	Org.	Date	Test Agency	Authorized Signature
CER/DTER 872075SC	[signature]	2825	12/5/88		

Cont. Suff.	Issue	A	Dwg. Classification Level	Size	Code Id	Dwg. Number
						DF343184
000			U N C L A S S I F I E D	A	14213	Sheet 2 of 2

Dwg. Classification Level
U N C L A S S I F I E D

Item	Form Completion Date MO	DAY	YR	Source Code	Dwg. System	Type
IDbSS383017	TDb			DSb S	TIE/SC/GE	A

Part Number	Suf.	Issue	Mfr. Code
NbSS383017-			MFb

Test Code

Iron Disulfide, Sized and Purified: Process Lot Data TCb I P

Item	Process Lot No., Sized & Purified															
IDbSS383017	LNb												SNb	0	0	0	0	0	0	0	0

Lot Size	Units KG	I	D S	I	Z	E	b	b	Value													
Leach Temperature	deg. C	L	E	T	E	M	P					.		///								
Process Lot Disposition (A or R)		D	I	S	P	b	b		//////////													
Incoming Lot No. (from DF344952)		D	I	b	b	b	b															

NOTES:

1. Process lots shall be numbered per **SS383017**. Ex.: YYXXX.

   YY = last two digits of calendar year
   XXX = sequential process lot number manufactured within a calendar year (see note 2 below).

2. Batch numbers from **001** thru **499** are assigned for exclusive use by GEND and from **500** thru **999** are assigned for exclusive use by Eagle-Picher, Ind., Inc., Joplin, Mo. Entries in the manufacturer's code field (**MFb**) shall be **GBV** for GEND or **EAY** for Eagle-Picher, Ind., Inc., Joplin, Mo.

3. Master lot numbers (see pg. 2) shall use the same numbering convention as for process lots except an "**M**" suffix shall be used on this data form. Example: YYXXXM

4. Enter applicable part number suffix per SS drawing.

5. Comment information that is entered into the **SNLA, Dep. 2520 HP3000 system** shall be transferred to the **SNLA PTD system** in GEISHA format using non-standard ID's starting with **COM1**bb, **COM2**bb, **COM3**bb, etc., upto **COM8**bb. The contents of each ID shall be 8 characters maximum. The requirements of **SC-M-72 0742A** are applicable. (b = blank space)

Distribution Instructions:

1. Original to SNLA, Product Support Division, within 10 working days of batch or master lot acceptance and a copy retained by the manufacturer.
2. One copy to SNLA, Org. 2522.
3. One copy to GEND Quality Control.

Release Identification	Engr.	Org.	Date	Test Agency	Authorized Signature
CER/DTER 872075SC		2825	12/5/88		

Cont.	Suff.	Issue	A	Dwg. Classification Level	Size	Code Id	Dwg. Number
							DF383017
000				U N C L A S S I F I E D	A	14213	Sheet 1 of 2

Dwg. Classification Level
UNCLASSIFIED

Item	Form Completion Date MO DAY YR	Source Code	Dwg. System	Type
H, IDbSS383017,	TDb - - ,	DSb S ,	TIE/SC/GE	A

Part Number	Suf.	Issue	Mfr. Code
PNbSS383017-		- ,	MFb ,

Test Code
Iron Disulfide, Sized and Purified: Master Lot Data TCb I P ,

Item	Master Lot No.
T, IDbSS383017,	LNb M ,

SNb 0 0 0 0 0 0 0 0 ,

Chemistry % by Weight	Units	ID	Value
Total Iron	%	PCTFEb	.
Total Sulfur	%	PCTSbb	.
Acid Insoluble Residue	%	PCTAIR	.
Acid Soluble Iron	%	PCTASI	.
Chemistry % by Weight Calculated from Sublot Qualification Data or Analyzed (C or A)		PCTWTb	

Master Lot Size	Units	ID	Value
	KG	SIZEbb	.
Master Lot Disposition (A or R)		DISPbb	

Process lots of iron disulfide, sized and purified, blended to form the master lot shown above shall be entered sequentially in the following fields starting with N01bbb (Use one process lot number per field):

ID		ID		ID	
N01bbb		N15bbb		N28bbb	
N02bbb		N16bbb		N29bbb	
N03bbb		N17bbb		N30bbb	
N04bbb		N18bbb		N31bbb	
N05bbb		N19bbb		N32bbb	
N06bbb		N20bbb		N33bbb	
N07bbb		N21bbb		N34bbb	
N08bbb		N22bbb		N35bbb	
N09bbb		N23bbb		N36bbb	
N10bbb		N24bbb		N37bbb	
N11bbb		N25bbb		N38bbb	
N12bbb		N26bbb		N39bbb	
N13bbb		N27bbb		N40bbb	
N14bbb					

Release Identification	Engr.	Org.	Date	Test Agency	Authorized Signature
CER/DTER 872075SC	JG	2825	12/5/88		

Cont.	Suff.	Issue	Dwg. Classification Level	Size	Code Id	Dwg. Number
		A				DF883017
-000			UNCLASSIFIED	A	14213	Sheet 2 of 2

Dwg. Classification Level
U N C L A S S I F I E D

Item	Form Completion Date MO DAY YR	Source Code	Dwg. System	Type
IDbSS344952, TDb	- -	DSb S	TIE/SC/GE	A

Part Number	Suf.	Issue	Mfr. Code
NbSS344952		-	MFb

Test Code
Iron Disulfide TCb I D

Item	Incoming Lot No.	
IDbSS344952,	LNb	SNb 0 0 0 0 0 0 0 0

*Chemistry % by Weight	Units	ID	Value
Total Iron	%	PCTFEb	.
Total Sulfur	%	PCTSbb	.
Acid Insoluble Residue	%	PCTAIR	.
Total Metallic Impurities	%	PCTTMI	.
Total Iron and Sulfur	%	PURITY	.
Amount Greater than Coarse Limit on Particle Size	%	PCT50b	.

Lot Size	Units	ID	Value
	KG	SIZEbb	. ///
Lot Disposition (A or R)		DISPbb	///////////////
Vendor's Lot Number		MANFbb	

NOTES:

1. Incoming lots shall be numbered consecutively within a calendar year. Example: YYXX

   YY = last two digits of calendar year
   XX = sequential number (see note 2 below)

2. Incoming lot numbers from **01** thru **49** are assigned for exclusive use by GEND and from **50** thru **99** are assigned for exclusive use by Eagle-Picher Ind., Inc., Joplin, Mo. Entries in the manufacturer's code field (**MFb**) shall be **AVH** for MC/B Manufacturing Chemists, **BJO** for American Minerals, Camden, NJ., or **BKD** for Climax Molybdenum Co., Golden, Co.

3. Enter applicable part number suffix per SS drawing.

4. Comment information that is entered into the **SNLA, Dep. 2520 HP3000 system** shall be transferred to the **SNLA PTD system** in GEISHA format using non-standard ID s starting with **COM1bb, COM2bb, COM3bb**, etc., upto **COM8bb**. The contents of each ID shall be 8 characters maximum. The requirements of **SC-M-72 0742A** are applicable. (b = blank space)

Distribution Instructions:

1. Original to SNLA, Product Support Division, within 10 working days of lot acceptance and a copy retained by the manufacturer
2. One copy to SNLA, Org. 2522
3. One copy to GEND Quality Control.

Release Identification Engr Org Date Test Agency Authorized Signature

CRB 2426 10 81

Cust	Suff	Issue A B C D	Dwg. Classification Level	Size	Code Id	Dwg Number
000			U N C L A S S I F I E D	A	14213	DF344952 Sheet 1 of 1

Dwg. Classification Level
U N C L A S S I F I E D

	Item	Form Completion Date MO DAY YR	Source Code	Dwg. System	Type
H,	IDbSS344954, TDb		DSb S,	TIE/SC/GE	A

Part Number	Suf.	Issue	Mfr. Code
PNbSS344954-	2 0 0		MFb A V D,

Test Code
Magnesium Oxide TCb M 0,

	Item	Incoming Lot No.	Sublot No.
T,	IDbSS344954,	LNb	SNb

Impurities by Weight	Units	ID	Value
Total Metallic Impurities	%	PCTTMI	.
Water	%	PCTH2O	.
Carbon Dioxide	%	PCTC02	.
Loss on Ignition	%	PCTL0I	.
BET Surface Area in Units of Sq. Meters per Gram		BETSAb	.
Sublot Size	Units	ID	Value
	KG	SIZEbb	. /
Lot Disposition (A or R)		DISPbb	//////////////
Vendor's Lot Number		MANFbb	

NOTES:

1. Incoming lots shall be numbered consecutively within a calendar year. Example: YYXX

   YY = last two digits of calendar year
   XX = sequential lot number (see note 2 below).

2. Sequential incoming lot numbers from 01 thru 49 are assigned for exclusive use by GEND and from 50 thru 99 are assigned for exclusive use by Eagle-Picher Ind., Inc., Joplin, Mo.

3. Sublots (or bags) shall be numbered consecutively within an incoming lot. A can identification letter is required only if the analysis results are being reported for a can sample. Example: BBC

   BB = bag number C = can identification letter (A thru E)

4. Comment information that is entered into the SNLA, Dep. 2520 HP3000 system shall be transferred to the SNLA PTD system in GEISHA format using non standard ID's starting with COM1bb, COM2bb, COM3bb, etc., upto COM8bb. The contents of each ID shall be 8 characters maximum. The requirements of SC-M-72 0742A are applicable. (b = blank space)

Distribution Instructions:

1. Original to SNLA, Product Support Division, within 10 working days of lot acceptance and a copy retained by the manufacturer.
2. One copy to SNLA, Org. 2522.
3. One copy to GEND Quality Control.

Release Identification	Engr. Org.	Date	Test Agency	Authorized Signature
	CRB 2426	10/81		

Cont.	Suff.	Issue	A/R	Dwg. Classification Level	Size	Code Id	Dwg. Number
		C					DF344954
000				U N C L A S S I F I E D	A	14213	Sheet 1 of 1

Dwg. Classification Level
UNCLASSIFIED

Item	Form Completion Date MO	DAY	YR	Source Code	Dwg. System	Type
IDbSS344940	TDb	-	-	DSb S	TIE/SC/GE	A

art Number	Suf.	Issue	Mfr. Code
NbSS344940-	2 0 0	-	MFb

est Code	
Lithium Oxide	TCb L 0

Item	Incoming Lot No.	Sublot No.
IDbSS344940	LNb	SNb 0 0 0 0 0 0 0 0

Chemistry % by Weight	Units	ID	Value
Li_2O (by titration)	%	P C T L I 0	.
Total Metallic Impurities	%	P C T T M I	.
Does material match JCPDS 12-254 (A or R)		X R A Y b b	
Lot Size	Units	ID	Value
	KG	S I Z E b b	.
Lot Disposition (A or R)		D I S P b b	//////////
Vendor's Lot Number		M A N F b b	

NOTES:

1. Incoming lots shall be numbered consecutively within a calendar year. Example: YYXX

   YY = last two digits of calendar year
   XX = sequential lot number (see note 2 below).

2. Incoming lot numbers from **01** thru **49** are assigned for exclusive use by GEND and from **50** thru **99** are assigned for exclusive use by Eagle-Picher Ind., Inc., Joplin, Mo. Entries in the manufacturer's code field (**MFb**) shall be **AVG** for Cerac, Inc. or **BJN** for ALFA Products.

3. Comment information that is entered into the **SNLA, Dep. 2520 HP3000** system shall be transferred to the **SNLA PTD** system in GEISHA format using non-standard ID's starting with **COM1bb, COM2bb, COM3bb**, etc., upto **COM8bb**. The contents of each ID shall be 8 characters maximum. The requirements of **SC-M-72 0742A** are applicable. (b = blank space)

Distribution Instructions:

1 Original to SNLA, Product Support Division, within 10 working days of lot acceptance and a copy retained by the manufacturer.
2 One copy to SNLA, Org. 2522.
3 One copy to GEND Quality Control.

Release Identification	Engr.	Org.	Date	Test Agency	Authorized Signature
	CRB	2426	10/81		

Cont.	Suff.	Issue A B C	Dwg. Classification Level	Size	Code Id	Dwg. Number
						DF344940
000			UNCLASSIFIED	A	14213	Sheet 1 of 1

Dwg. Classification Level
UNCLASSIFIED

Item	Form Completion Date MO DAY YR	Source Code	Dwg. System	Type
IDbSS344953	TDb | | | - | | | - | | |	DSb | S	TIE/SC/GE	A

Part Number	Suf.	Issue	Mfr. Code
PNbSS344953-	2 | 0 | 0	-	MFb

Test Code

Lithium Silicon Alloy Powder (-40 +230 mesh), Li(Si) TCb | L | S

Item	Incoming Lot No.	Sublot No.
IDbSS344953	LNb	SNb | 0 | 0 | 0 | 0 | 0 | 0 | 0

Chemistry % by Weight	Units	ID	Value
Lithium	%	PCTLIb	.
Silicon	%	PCTSIb	.
Oxygen	%	PCTOXY	.
Total Metallic Impurities	%	PCTTMI	.

Particle Size Data	Units	ID	Value
Rel. Amt. -230 mesh after sieving	%	PCT230	.

Lot Size	Units	ID	Value
	KG	SIZEbb	.

Lot Disposition (A or R)	DISPbb
Vendor's Lot Number	MANFbb

NOTES:

1. Incoming lots shall be numbered consecutively within a calendar year. Example: YYXX

   YY = last two digits of calendar year
   XX = sequential lot number (see note 2 below).

2. Incoming lot numbers from 01 thru 49 are assigned for exclusive use by GEND and from 50 thru 99 are assigned for exclusive use by Eagle-Picher Ind., Inc., Joplin, Mo. Entries in the manufacturer's code (MFb) field shall be AVE for Foote Mineral Co., AVF for Lithium Corporation of America, or BJR for Eagle-Picher Research Laboratory, Specialty Materials Division, 209 Ninth Ave. NE, Miami, OK

3. Comment information that is entered into the SNLA, Dep. 2520 HP3000 system shall be transferred to the SNLA PTD system in GEISHA format using non-standard ID's starting with COM1bb, COM2bb, COM3bb, etc., upto COM8bb. The contents of each ID shall be 8 characters maximum. The requirements of SC-M-72 0742A are applicable. (b = blank space)

Distribution Instructions:

1. Original to SNLA, Product Support Division, within 10 working days of lot acceptance and a copy retained by the manufacturer.
2. One copy to SNLA, Org. 2522.
3. One copy to GEND Quality Control.

Release Identification	Engr.	Org.	Date	Test Agency	Authorized Signature
	CRB	2426	10/81		

Cont.	Suff.	Issue	A	B	Dwg. Classification Level	Size	Code Id	Dwg. Number
		0 | D						DF344953
000					UNCLASSIFIED	A	14213	Sheet 1 of 1

Dwg. Classification Level
U N C L A S S I F I E D

Item	Form Completion Date MO	DAY	YR	Source Code	Dwg. System	Type
IDbSS370711,	TDb			DSb S	TIE/SC/GE	A

Part Number	Suf.	Issue	Mfr. Code
NbSS370711	2 0 0		MFb

Test Code

Lithium Silicon Alloy Powder (-100 +325 mesh), Li(Si) TCb L S

Item	Incoming Lot No.	Sublot No.
IDbSS370711,	LNb	SNb 0 0 0 0 0 0 0 0

Chemistry % by Weight	Units	ID	Value
Lithium	%	P C T L I b	.
Silicon	%	P C T S I b	.
Oxygen	%	P C T O X Y	.
Total Metallic Impurities	%	P C T T M I	.
Particle Size Data	**Units**	**ID**	**Value**
Rel. Amt. -325 mesh after sieving	%	P C T 3 2 5	.
Lot Size	**Units**	**ID**	**Value**
	KG	S I Z E b b	.
Lot Disposition (A or R)		D I S P b b	
Vendor's Lot Number		M A N F b b	

NOTES:

1. Incoming lots shall be numbered consecutively within a calendar year. Example: YYXX

   YY = last two digits of calendar year
   XX = sequential lot number (see note 2 below).

2. Incoming lot numbers from 001 thru 499 are assigned for exclusive use by GEND and from 500 thru 999 are assigned for exclusive use by Eagle-Picher Ind., Inc., Joplin, Mo. Entries in the manufacturer's code field (MFb) field shall be **AVE** for Foote Mineral Co., **AVF** for Lithium Corporation of America, or **BJR** for Eagle-Picher Research Laboratory, Specialty Materials Division, 209 Ninth Ave. NE, Miami OK

3. Comment information that is entered into the SNLA, Dep. 2520 HP3000 system shall be transferred to the SNLA PTD system in GEISHA format using non-standard ID's starting with **COM1**bb, **COM2**bb, **COM3**bb, etc., upto **COM8**bb. The contents of each ID shall be 8 characters maximum. The requirements of **SC-M-72 0742A** are applicable. (b = blank space)

Distribution Instructions:

1. Original to SNLA, Product Support Division, within 10 working days of lot acceptance and a copy retained by the manufacturer.
2. One copy to SNLA, Org. 2522.
3. One copy to GEND Quality Control.

Release Identification	Engr.	Org.	Date	Test Agency	Authorized Signature
	JDS	960	2/84		

Part	Suff	Issue A B C	Dwg. Classification Level	Size	Code Id	Dwg. Number
000			U N C L A S S I F I E D	A	14213	DF370711 Sheet 1 of 1

Dwg. Classification Level
UNCLASSIFIED

	Item	Form Completion Date MO DAY YR	Source Code	Dwg. System	Type
H,	IDbSS344796,	TDb| | | - | | | - | | |,	DSb|S|,	TIE/SC/GE	A

Part Number	Suf.	Issue	Mfr. Code
PNbSS344796-	2|0|0	- | | |,	MFb| | | |,

Test Code

Iron Powder Data TCb |F|E|,

	Item	Incoming Lot No.	
T,	IDbSS344796,	LNb| | | | | |,	SNb|0|0|0|0|0|0|0|0|,

Chemistry % by Weight	Units	ID	Value
Total Iron	%	PCTFEb	.
Metallic Iron	%	PCMEFE	.
Wt. Loss on H_2 Reduction	%	PCWTLS	.

Physical Properties	Units	ID	Value
Green Strength	PSI	GRSTbb	.
Apparent Density	G/CC	APDENb	.
Fe Powder less than 325 Mesh	%	PS325b	.
Fe Powder greater than 100 Mesh	%	PS100b	.

Particle Size Analysis

Cumulative Mass %	Units	ID	Value
25.0	Microns	PS25bb	.
50.0	Microns	PS50bb	.
75.0	Microns	PS75bb	.
Average Particle Size (Fischer)	Microns	AVGPSb	.

Lot Size	Units	ID	Value
	KG	SIZEbb	.
Lot Disposition (A or R)		DISPbb	//////////
Vendor's Lot No.		MANFbb	

NOTES:

1. Incoming lots shall be numbered consecutively within a calendar year. Ex.: YYXXX.

   YY = last two digits of calendar year
   XXX = consecutive number (001 thru 999).

2. Comment information that is entered into the **SNLA, Dep. 2520 HP3000** system shall be transferred to the **SNLA PTD system** in GEISHA format using non-standard ID's starting with **COM1bb, COM2bb, COM3bb**, etc., upto **COM8bb**. The contents of each ID shall be 8 characters maximum. The requirements of **SC-M-72 0742A** are applicable. (b = blank space)

Distribution Instructions:

1. Original to SNLA, Product Support Division, within 10 working days of lot acceptance and a copy retained by the manufacturer.
2. One copy to SNLA, Org. 2522.
3. One copy to GEND Quality Control.

Release Identification	Engr.	Org.	Date	Test Agency	Authorized Signature
CER/DTER 890695SC		2825	4/3/89		

Cont. Suff.	Issue	A	Dwg. Classification Level	Size	Code Id	Dwg. Number
-000			UNCLASSIFIED	A	14213	**DF344796** Sheet 1 of 1

Dwg. Classification Level
UNCLASSIFIED

	Item	Form Completion Date (MO / DAY / YR)	Source Code	Dwg. System	Type
H,	IDbSS388378,	TDb|||-|||-|||,	DSb|S|,	TIE/SC/CE	A

Part Number	Suf.	Issue	Mfr. Code	Test Code Potassium Perchlorate Data
PNbSS388378-	20	-	MFb||||,	TCb|K|P|,

	Item	Incoming Lot No.	
T,	IDbSS388378,	LNb||||||,	SNb|0|0|0|0|0|0|0|0,

Chemistry % by Weight	Units	ID	Value
Moisture	%	PCTH2O	.|||
Chlorides, as % KCl	%	PCTKCL	.|||
Chlorates, as % $KClO_3$	%	PCKCLO	.|||
Hypochlorites	%	PCHCLO	.|||
Bromates, as % $KBrO_3$	%	PCKBRO	.|||
Sodium, as % $NaClO_4$	%	PCTNAb	.|||
Ca and Mg Salts, as % Oxides		PCCAMG	.|||
Water Insoluble Material	%	PCTWIN	.|||
$KClO_4$ Assay	%	PCTKP4	|.|||
pH of Water Solution	%	PHbbbb	.|||

Particle Size Analysis

Cumulative Mass %	Units	ID	Value
25.0	Microns	PS25bb	||.|||
50.0	Microns	PS50bb	||.|||
75.0	Microns	PS75bb	||.|||
Average Particle Size (Turbimetry)	Microns	AVGPSb	||.|||

Lot Size	Units	ID	Value
	KG	SIZEbb	|||.||
Lot Disposition (A or R)		DISPbb	//////////
Vendor's Lot No.		MANFbb	||||||||

NOTES:

1. Incoming lots shall be numbered consecutively within a calendar year. Ex.: YYXXX.

   YY = last two digits of calendar year
   XXX = consecutive number (001 thru 999).

2. Comment information that is entered into the **SNLA, Dep. 2520 HP3000 system** shall be transferred to the **SNLA PTD system** in GEISHA format using non-standard ID's starting with **COM1bb, COM2bb, COM3bb**, etc., upto COM8bb. The contents of each ID shall be 8 characters maximum. The requirements of **SC-M-72 0742A** are applicable. (b = blank space)

Distribution Instructions:

1. Original to SNLA, Product Support Division, within 10 working days of lot acceptance and a copy retained by the manufacturer.
2. One copy to SNLA, Org. 2522.
3. One copy to GEND Quality Control.

Release Identification	Engr.	Org.	Date	Test Agency	Authorized Signature
CER/DTER 890695SO		2825	4/3/89		

Cont. Suff.	Issue	A	Dwg. Classification Level	Size	Code Id	Dwg. Number
000			UNCLASSIFIED	A	14213	DF388378 Sheet 1 of 1

END

DATE FILMED

12/05/90