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The Stockpile Monitor Program

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by

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ABSTRACT

Recent political changes have led to drastic reductions in the number of nuclear warheads in stockpile, as well as increased expectations for warhead-service lives. In order to support and maintain a shrinking and aging nuclear stockpile, weapon scientists and engineers need detailed information describing the environments experienced by weapons in the field. Hence, the Stockpile Monitor Program was initiated in 1991 to develop a comprehensive and accurate database of temperature and humidity conditions experienced by nuclear warheads both in storage and on-alert.

INTRODUCTION

The end of the Cold War and concomitant political changes have initiated a drastic decrease in the number of warheads (WHs) constituting our nuclear stockpile. In addition, the role of the Department of Energy's (DOE's) Weapon Complex is evolving from one of nuclear weapon manufacturing to one of maintaining nuclear competence in the absence of any war reserve (WR) manufacturing. A corollary of these changes is that WHs are expected to last more than 50 years, far beyond their intended design life. Because of these changing expectations for weapon service life, scientists need detailed information about the environments WHs experience during storage. When weapon scientists examine WR surveillance units, they need to know what storage conditions the weapon has experienced throughout its life and use that information to evaluate surveillance data and predict remaining service life. Environmental information is also needed for establishing and modifying stockpile-to-target sequence (STS) requirements. Unfortunately, this type of environmental information is essentially nonexistent.

In an effort to fill this informational void, Los Alamos National Laboratory (LANL) Group M-1, now Group DX-16, initiated the Stockpile Monitor Program (SMP) in 1991. The purpose of the SMP is to develop a comprehensive database of WH storage conditions by monitoring temperature and humidity at representative locations around the world. These locations include facilities capable of storing and/or handling nuclear weapons presently, in the past, or in the future. The information gleaned from this effort is being incorporated into a comprehensive surveillance database (Excel and Oracle™) that allows detailed correlation of weapon-surveillance data with weapon pedigree and associated lifetime-environmental conditions. The data and knowledge gained from the SMP will be shared with qualified Department of Defense (DoD) and DOE agencies upon request.

We are now roughly 3 years into the Program and are still expanding our data-collection effort. Dataloggers are installed at the following locations in the United States (Fig. 1): Barksdale AFB, Louisiana; Dyess AFB, Texas; Grand Forks AFB, North Dakota; Kirtland AFB, New Mexico (three locations); K.I. Sawyer AFB, Michigan; Nellis AFB, Nevada; Sierra Army Depot, California; Mason & Hanger's Pantex Plant, Texas (four locations); Fairchild AFB, Washington; Griffiss AFB, New York; and at a North Atlantic Treaty Organization (NATO) base in the Federal Republic of Germany. Dataloggers will be installed in Minute Man III (MMIII) silos at the 341st Missile Wing in Malmstrom, Montana, during the spring of 1994. This report is intended to be a broad overview of the SMP program. Detailed reports on specific locations are being developed and will be available upon request.

HARDWARE

Equipment for the SMP is purchased from Campbell Scientific™ and is used without modification. Components required for datalogger installations have been tested for Electromagnetic Interference (EMI) in MMIII silos and have been approved for use by the Air Force.* Furthermore, SMP hardware has been reviewed and approved for installation at Pantex Plant staging areas by the Pantex Nuclear Explosive Safety Group. All hardware and personal computer (PC) software for the SMP are provided by LANL and consist of the following components:

- CR10 *Programmable Datalogger/Controller.* This unit can collect up to 12 single-ended channels of environmental information and store data in 64k of permanent memory. Simple algorithms to massage data, i.e., average, maximum/minimum values, etc., are easily programmed into the CR10.

*Electromagnetic Interference Test Report for a Campbell Scientific, Inc., Datalogger System," 00-ALC MME-89007, Contract F42600-87-C-3166 OPT-I [Disk TR3.2], Feb. 1989. Prepared by: C. V. Reid (OO-ALC/MMGRAH/BAC. Approved by V. J. Alder (OO-ALC/MMGRAH/BAC).

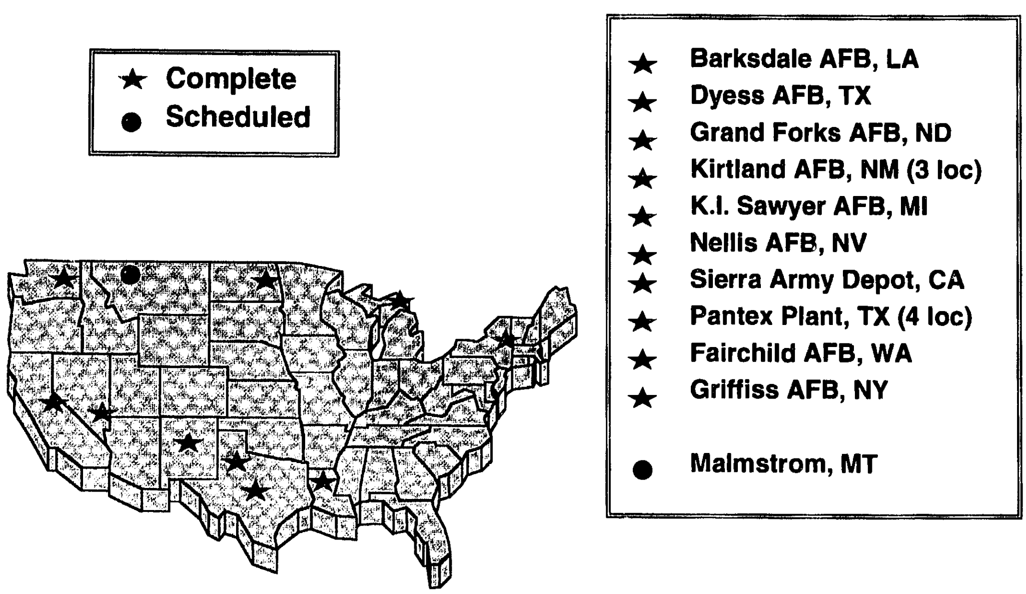

Fig. 1. SMP installation sites in the United States.

Communication with the CR10 is accomplished via a CR10KD keypad/display or PC.

- *PS12-ALK or PS12-LA Power Supplies.* The CR10 requires a 12-V power source for operation. This source can utilize alkaline D-cell batteries (PS12-ALK) or a rechargeable lead/acid battery (PS12-LA). Depending on the number of channels used and the frequency of data collection, power supplies last between 3 months and 1 year.

- ENC 12/14 *Or ENC 10/12 Modules.* These sturdy fiberglass enclosures house the CR10 and PS12. They are classified NEMA 4X and are designed to protect the CR10 and power supply from extreme environmental conditions.

- *XN218 Temperature/Relative Humidity Probe and Thermistor Probe 010-44019A.* The YSI 44019A thermistor measures temperature between -55°C and +85°C with a worst-case accuracy of ±2.1°C (typical case is better than ±1°C). The 44019 thermistor requires a 2.5-V excitation signal from the CR10 for measurement. The XN218 is a combination temperature and relative humidity/temperature (RHT) probe. Temperature is obtained from a YSI 44019A thermistor (described above). Relative humidity (RH) is obtained with a Hygrometrix humidity transducer with a linear range from 0 to 100% and a maximum error of ±4%.

- *SM192 Storage Module.* The SM192 is a small, portable, peripheral storage device used to retrieve data from the CR10 datalogger. The SM192 stores data in battery-backed random access memory (RAM).

- *PC208 Datalogger Support Software, SC32A and SC532 Interfaces.* Programs and data can be transferred between the CR10 and any DOS-compatible computer, loaded with PC208 support software, through the SC32A optical interface. PC208 capabilities include local/remote programming and data collection, CR10 programming, data manipulation, etc.

A complete datalogger "kit" is pictured in Fig. 2. Mounted in the white fiberglass box (ENC 10/12) are the CR10 datalogger and PS12-ALK power supply. Sitting on the ENC 10/12 lid are the CR10KD keypad display, SM192 storage module, and PS12-ALK cover plate. Measurement probes (not pictured) are fed out through the port on the left side of the ENC 10/12.

EXPERIMENTAL

Installation

Storage sites at nuclear-capable facilities include earth covered "igloos," "pull-throughs," underground cells, and tunnels. Site instrumentation has gradually evolved into a "typical" configuration that is adhered to as consistently as possible, given site-specific constraints.* Typical instrumentation consists of one 010-44019A thermistor located on the outside wall of the structure and two XN218 RHT probes on the inside wall. Both RHT probes are suspended from the ceiling along the center-line of the structure, one in front and one in the rear. The CR10 datalogger (in ENC10/12) is set in an out-of-the-way location on the floor or is mounted on the structure wall. Cables are run along existing conduit with no permanent alterations made to the facility. A typical site installation involves instrumenting two representative structures with unique environmental characteristics, i.e., one "pull-through" and one "igloo." Site installation and checkout is usually completed in less than one working day. Each site is maintained for a minimum of 2 years.

*LANL is usually willing to "custom" configure installations if local organizations require specialized data for their own programs.

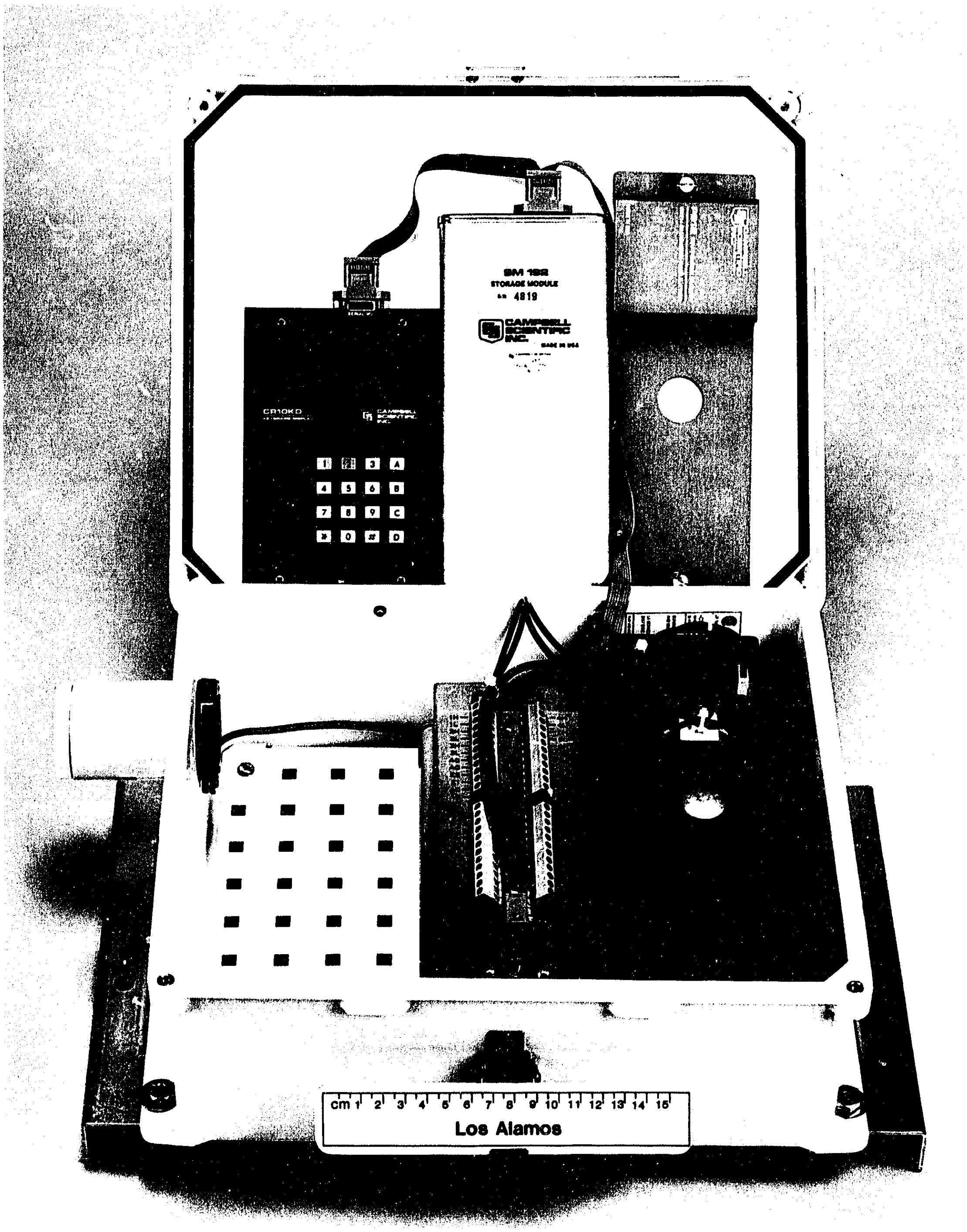

Fig. 2. Datalogger "kit."

CR10 dataloggers are programmed to measure temperatures and humidities every minute and store the data in intermediate memory. Every 4 hours data in intermediate memory are averaged and stored in permanent memory, giving six data sets per day. In addition, every 4 hours maximum/minimum temperatures and humidities are selected from intermediate memory and stored in permanent memory along with their time of acquisition.

Maintenance

Datalogger maintenance (periodic data collection and battery changing) is performed quarterly or semi-annually, depending upon site configuration. Maintenance is typically performed by weapons storage area (WSA) personnel, although LANL will perform this function if needed. Data collection involves attachment of the SM192 storage module and CR10KD keypad to the CR10 datalogger and entering nine keystrokes. Data can be transferred from the SM192 to any IBM-compatible PC as a comma-delineated ASCII file by using PC208 software. These raw data are mailed to LANL Group DX-16, either on a floppy-disk or SM192 medium, for incorporation into a surveillance database.

Part of CR10-datalogger maintenance includes changing the eight D-cell batteries providing power to the system. Changing batteries involves attaching an auxiliary 12-V battery to the CR10 while replacing the spent batteries with fresh commercial batteries. The entire CR10 maintenance operation (data collection and battery changing) requires approximately 15 minutes per datalogger. If 110-V power is available at the installation site, the CR10 can run indefinitely off a 12-V power supply with a lead/acid-gel battery backup. Solar charging panels are also possible sources of energy in some instances.

RESULTS

Examples of data obtained from the SMP are presented in the following figures. Raw data are collected as comma-delineated

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107,1993,289,1600,11.82,23.62,74.5,72.9,72.9,72.8,45.95,44.87,44.62,74.5,16
00,72.9,1500,72.9,1600,72.8,1300,46.06,1300,45.08,1300,44.77,1300,74.5,1300
,72.8,1300,72.8,1300,72.8,1300,45.79,1600,44.77,1500,44.52,1600

107,1993,289,2000,11.82,23.62,74.5,73,72.9,72.9,45.92,44.87,44.69,74.5,1700
,73,1700,73,1700,72.9,1700,46.06,2000,44.97,1900,44.77,1900,74.5,1800,72.9,
1800,72.8,1800,72.8,1800,45.79,1700,44.77,1700,44.6,1700

107;1993,289,2400,11.82,23.62,74.5,72.9,73,72.7,46.68,45.77,45.62,74.5,2200
,72.9,0,73,0,72.7,2200,47.07,0,46,2300,45.93,0,74.5,2100,72.8,2100,72.9,2100,
72.7,2100,46.33,2100,45.38,2100,45.27,2100
```

Fig. 3. Example of SMP comma-delineated ASCII file.

Array ID	Year	Julian Day	Time	Battery Volts	CR10 Temp.	TC Temp.	RHT1 (Front)	Etc...
107	1993	289	1600	11.82	23.62	74.5	72.9	.
107	1993	289	2000	11.82	23.62	74.5	73	.
107	1993	289	2400	11.82	23.62	74.5	72.9	.
107	1993	290	400	11.82	23.62	74.5	72.9	.

Fig. 4. Example of SMP spreadsheet file.

Once environmental data are in spreadsheet form, graphs of environmental conditions as a function of time can be produced. Representative graphs of environmental conditions at sites on Nellis AFB, Nevada, and Kirtland AFB, New Mexico, illustrate the environmental diversity WHs can experience (Figs. 5 and 6). Temperature and humidity at the Nellis AFB installation reflect a relatively "uncontrolled" environment, while temperature at the Kirtland installation is much more "controlled." It is possible to search environmental data at specified locations for certain conditions, such as if and when prescribed temperature and/or humidity limits were exceeded.

CONCLUSION

The SMP was initiated in 1991 to develop a database of environmental conditions nuclear warheads can experience during deployment and/or storage. These data are used by Los Alamos scientists when evaluating weapon-surveillance results and predicting remaining service life. Other agencies use data obtained from the SMP to evaluate STS requirements and other military requirements. Although the Program is still in its infancy, considerable data are available from locations across the continental United States and Europe. Furthermore, as the Program matures, the amount and complexity of information available will increase.

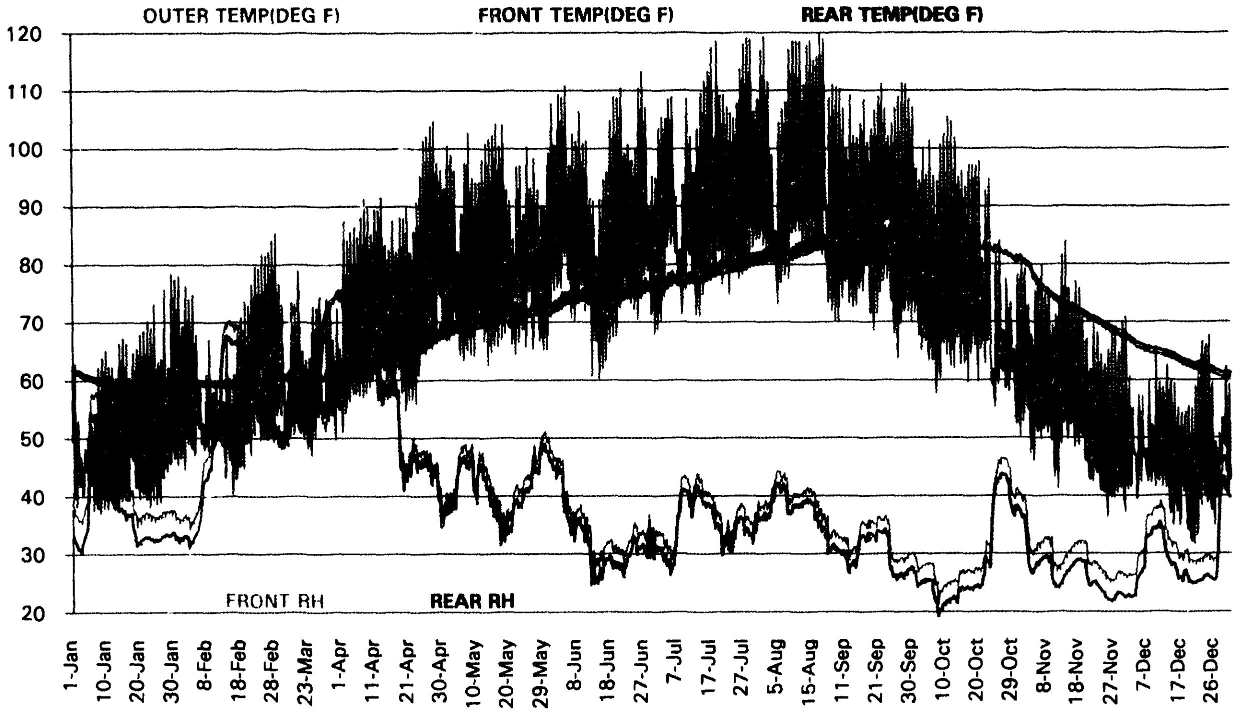

Fig. 5. Temperature and humidity data from Nellis AFB, 1992.

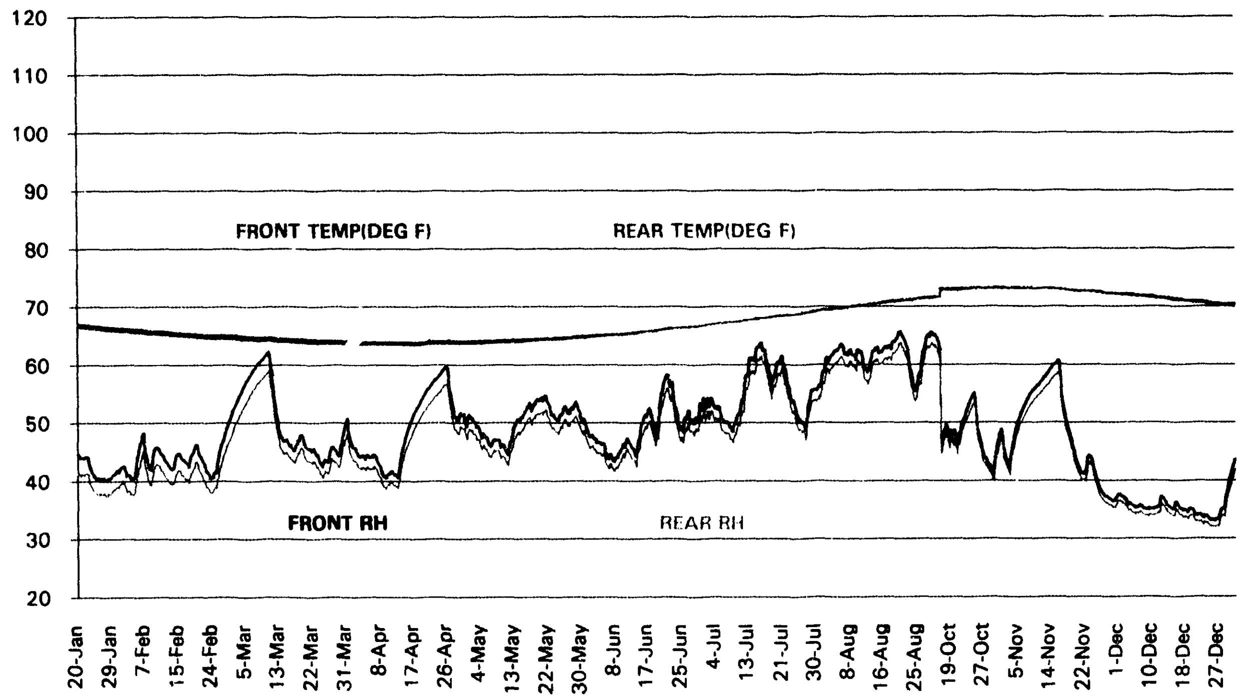

Fig. 6. Temperature and humidity data from Kirtland AFB, 1993.

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