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## THE DOE/DOD ENVIRONMENTAL DATA BANK<sup>1</sup>

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The DOE/DOD Environmental Data Bank was established in 1959 as a central location for storing weapons and equipment environments information from a variety of DOE, DoD, and industrial sources and continues to be maintained by Sandia National Laboratories. The Data Bank contains approximately 3,000 documents regarding normal and abnormal environments that describe the handling, storage, transportation, use, and general phases, which occur during the life of a system. This paper describes the DOE/DOD Environmental Data Bank system, its structure, data sources, usage, and progress in converting it from a microfilm database to an electronic database.

### INTRODUCTION

The Environmental Data Bank is used by Sandia engineers as a source of information to determine the environments to which a system or a component could be subjected.

For the purpose of indexing and data retrieval, the data is cataloged under two major headings, normal and abnormal environments. Normal environments are those environments that will be encountered regularly. They are characterized by a high frequency of occurrence but relatively low consequence. Conversely, abnormal environments are not encountered often, and they are characterized by a low frequency of occurrence but possible high consequence.

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All of the environments are also identified as either *input*, "the environment to which a system is exposed" or *response*, "the reaction of components of that system to an input." Whether the environment can be termed input or response is often dependent on the system being considered; however, the distinction is necessary to assess the occurrence.

## ENVIRONMENTAL DATA BANK OPERATION

When new test reports and published documents are acquired by the Environmental Data Bank, they are reviewed for engineering data content. Pertinent information is extracted, assigned a numerical index number, and is then archived as electronic media. Prior to 1996, documents were archived on microfilm aperture cards or microfiche. The data bank index is maintained in an electronic database format. Additionally, the microfilm documents are in the process of being converted to electronic media and will be archived in the DOE/DOD Environmental Data Bank database located on Sandia's Image Management System. Because it is estimated that the conversion will require two to three years, the Environmental Data Bank will operate as both a microfilm and electronic database until the conversion is completed.

## STRUCTURE OF THE ENVIRONMENTAL DATA BANK

Environmental data can be defined as numerical or digitized descriptions of the aggregate of all external conditions and influences affecting the development and survival of systems, subsystems, and components. For efficient collection and evaluation of these data, the following 14 environment categories were established and the electronic storage and retrieval system is based upon them.

| Environmental Categories      |               |
|-------------------------------|---------------|
| - Acceleration/time histories | - Pressure    |
| - Acoustic noise              | - Radiation   |
| - Atmospheric contents        | - Shock       |
| - Biotic                      | - Temperature |
| - Fragmentation               | - Trajectory  |
| - Humidity                    | - Vibration   |
| - Precipitation               | - Wind        |

Not all environments lend themselves to normal/abnormal division. Three factors limit the number of abnormal environmental levels that require consideration:

- Some environments reach an absolute limit. Because humidity is limited by ambient temperature, for example, relative humidity cannot exceed 100 percent.
- The abnormal aspects of some environments are encountered so infrequently that they are of little interest, for example, acoustic noise of an intensity to cause structural damage.
- Protection against normal environments includes protection against abnormal environments; for example, protection against entry of liquid water is effective in a cloudburst as well as during a drizzle.

For these reasons, the abnormal levels of environment are considered only for the following categories:

## Environmental Categories – Abnormal Manifestation Examples

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|                              |   |
|------------------------------|---|
| Acceleration/time histories: | <i>Earthquake, vehicle collision</i>              |
| Fragmentation:               | <i>Projectile impalement, explosion, puncture</i> |
| Pressure:                    | <i>Explosion, immersion depth, crush</i>          |
| Radiation:                   | <i>Lighting (direct strike)</i>                   |
| Shock:                       | <i>Impact (vehicle collision)</i>                 |
| Temperature:                 | <i>Fire</i>                                       |
| Wind:                        | <i>Wind storm (tornado, hurricane, etc.)</i>      |

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All of the environments are divided into individual use phases that occur during the life of a weapon system:

- Handling
- Storage
- Transport
- Utilization
- General

The transport and utilization phases are further subdivided into the type of carrier involved, for example, aircraft, automobile, railroad, etc.

## ELECTRONIC INDEX STRUCTURE

The electronic Environmental Data Bank uses a customized Microsoft FoxPro index database called SPEEDI II. SPEEDI II uses one, or a combination of two, of eleven search categories - Program, Phase, Condition, Environment, Method, Carrier, Subcarrier, Model, Event, Subevent, and Keywords - to perform a global document search and provide a search query that contains the following document information: index number, title, classification, publication date, number of pages, an electronic-media/microfilm storage format flag, and an abstract of the information contained in the document. This query information is used to determine whether documents must be retrieved from the electronic database or printed from microfilm. Each item's index number is then used to locate the corresponding document in the electronic database at the Image Management System, where it can be viewed or transmitted to a local personal computer. If the document has not been converted to electronic media, the index number is used to locate the microfilm aperture cards or microfiche. The information in the Environmental Data Bank is available to qualified requesters.

## DOE/DOD ENVIRONMENTAL DATA BANK - DATA SOURCES AND CONTENT

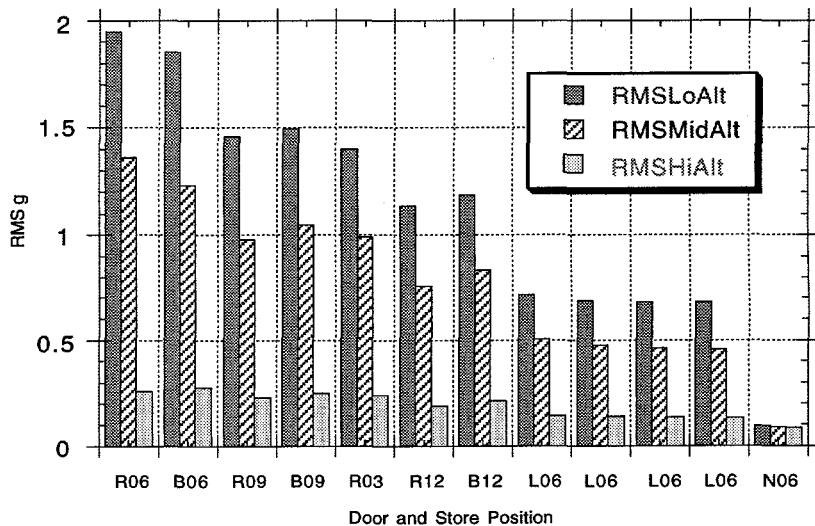
The DOE/DOD Environmental Data Bank provides engineering and experimental information concerning intensity and duration of various environments to which systems and equipment may be exposed during storage, transportation, handling, and use. The Environmental Data Bank contains documents acquired from military agencies, government organizations, industrial groups, and various project groups at Sandia National Laboratories. The development of shock and vibration specifications for system mechanical, electrical, and pyrotechnic components is one of the major responsibilities at Sandia National Laboratories. Data required to generate these specifications are obtained from archived field test data as well as from finite element analysis

and/or laboratory simulations. The Environmental Data Bank is Sandia's primary source of archived shock and vibration environments test data and analysis reports on weapons, ships, trains, truck trailers, cargo aircraft, and weapon delivery aircraft. Archival of shock and vibration environments test data and analysis reports is an ongoing process on new test data and on re-analyzed archived test data.

### SAMPLE USAGE OF THE ENVIRONMENTAL DATA BANK B-2A VIBRATION GRMS VS. ALTITUDE AND POSITION

A typical usage of the Environmental Data Bank is demonstrated by the following example. It was desired to study the effect of B-2A altitude and bomb bay status on the vibration levels of a Sandia gravity bomb. The DOE/DOD Environmental Data Bank has several reports on the B-2A vibration environment.

Figure 1 shows a plot of data obtained from an Environmental Data Bank report: the RMS g measured at an internal component of the bomb, vs. which bomb bay was opened, and position of the bomb on the rotary launcher. The x axis corresponds to which bomb bay was opened (R = Right, N = None, L = Left, B = Both), and the rotary launcher position of the bomb (03 = 3 o'clock, 06 = 6 o'clock, 09 = 9 o'clock, etc.). The bomb was in the right bomb bay. This figure shows that the vibration levels are inversely proportional to the altitude: lower altitude flight induces the highest vibration levels. The vibration levels are also strongly influenced by the rotary launcher position. Six o'clock (the lowest position) has the highest vibration levels, while nine and three o'clock are next, and 12 o'clock is, not surprisingly, the lowest. The worst vibration levels occur with the right bomb bay open. Both bomb bays open induced a slightly lower vibration level, as the dynamic pressure of the aircraft decreased more rapidly due to increased drag. Opposite bomb bay opening (left bay) induced about a third of the levels induced by same bomb bay opening (right bay). With no bays opened, the vibration level (0.1 grms) was only about 2 to 3 times the average noise channel. The highest vibration level is almost a factor of 20 higher than the bomb bays closed environment.



**Figure 1 - Bomb Internal Component GRMS vs. Bomb Bay & Rotary Launcher Position B-2A**

## **MICROFILM TO ELECTRONIC MEDIA DATABASE - PROGRESS**

The effort to computerize the DOE/DOD Environmental Data Bank was initiated eight years ago. This effort was presented in two papers at the 59th Shock and Vibration Symposium, "DOE/DOE Environmental Data Bank" [1] and "GREEDI - The Computerization of the DOE/DOD Environmental Data Bank" [2]. This computerization effort was suspended in 1990 because of budget constraints and was re-initiated in 1996 as part of Sandia's Knowledge and Information Preservation program. The current computerization of the DOE/DOD Environmental Data Bank differs from the original effort by the fact that the GREEDI (a Graphical Resources for an Engineering Database Implementation) interactive analysis database was replaced with a library type electronic database. The digitized microfilm documents and the ASCII test data are being stored electronically on Sandia's Image Management System and are accessible over Sandia's internal computing network. The SPEEDI index database has been converted from an INGRES database to a FoxPro database and is now called SPEEDI II. A library type electronic archival database, located at Sandia's Image Management System, was implemented to ensure long term data preservation and accessibility and to make the ASCII test data independent of any particular computer system.

## **SUMMARY AND CONCLUSION**

The DOE/DOD Environmental Data Bank contains approximately 3,000 documents that archive normal and abnormal environments which span almost 40 years. The data bank index is maintained in an electronic database format. Documents are in transition from microfilm aperture card and microfiche formats to digitized, electronic format to expedite searches and to facilitate data retrieval. ASCII test data are being archived in a library type archival system to make the data independent of any particular computer system. The information archived in Sandia's DOE/DOD Environmental Data Bank is invaluable in the development of shock and vibration system and component specifications and in the transportation of these systems.

### **References**

1. C. A. Davidson, "DOD/DOE Environmental Data Bank," *59th Shock and Vibration Symposium Proceedings*, October 1988, Vol. I, pp. 41-45.
2. C. R. Adams and E. M. Kephart, "GREEDI - The Computerization of the DOE/DOD Environmental Data Bank," *59th Shock and Vibration Symposium Proceedings*, October 1988, Vol. I, pp. 47-59.

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