GLOBAL DISSEMINATION OF PERFORMANCE DATA AND INFORMATION

by

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INTRODUCTION

The transition to performance-based methods in the design, construction, and regulatory review of buildings is bringing with it new flexibility and new complexity. The freedom to use innovative designs, materials, and methods is resulting in inore functional buildings at lower cost. The price to be paid for this freedom is increased documentation and records and close regulatory scrutiny for the life of the building.

Clearly building owners are willing to pay the price and performance-based regulatory systems are heralded in most countries as regulatory reform. Designers also praise the artistic freedom and the enhanced ability to deliver a highly functional building. While regulators ai-e pleased with more rational regulations, they express concerns about the validity of performance evaluation methods and the resources necessary to conduct and evaluate performance designs. **A** key issue in these concerns is the availability of appropriate measures of performance and the accessibility of data, especially on the innovative materials that are most likely to be used in these applications.

MEASURES OF PERFORMANCE

One of the major factors affecting the accessibility of performance-related data is the sheer quantity of data needed to characterize performance adequately. Under prescriptive regulatory systems, many materials were evaluated under prescribed conditions and rated as universally acceptable (pass/fail systems) or classified into a small number of categories. Neither approach provides any extensible measure of performance, so neither is suitable for use in a performance-based regulatory system. Some regulatory specifications were based on successful historical performance. For example, masonry walls of a certain thickness were known to perforin well unless the building was too tall or located in a seismic area, and the physical specifications for electrical conduit are identical to gas pipe because in early electrification of light fixtures the wires were pulled through the existing gas pipes, In any case, the acceptability for use could be indicated to regulatory authorities by a mark or label on the product or package.

As the ability was gained to assess performance in the actual context 01 use, there was an associated need for data that reflected the actual performance of inaterials and products under arbitrary conditions. For homogeneous structural and thermal insulating materials, this was reasonably straightforward, and lest methods that support the calculations for limit state structural design and thermal performance of the building envelope were developed. The highly complex physical and chemical processes of fire limited the ability to make accurate measurements of the fire performance of materials until the development of oxygen consumption calorimetry in the 1970's [Huggett 1978]. A common aspect of each of these performance descriptors is the much larger amount of data needed to characterize the materials and products over a range of conditions.

Traditional methods of marking ratings on the product or package did not work for the newer performance descriptors. Handbooks and standards developed by materials associations, and manufacturers' literature became the primary methods for the dissemination of performance data. But these had drawbacks with regard to their accessibility, especially in international markets, and in their ability to keep up with innovative products.

HAZARD I AND THE FIREDATA DATABASE

In 1989 NIST released the first, comprehensive fire hazard assessment methodology and PC software package, HAZARD I. Done as a "proof of concept" that the engineering tools to perform a detailed analysis of the iinpact of a fire in a building were ready for general use, it was recognized that HAZARD I needed to be a complete package, containing or referencing all of the resources needed io perform such an analysis. **A** significant issue was the availability of data needed to estimate the perforinance of common materials under arbitrary conditions related to specific scenarios of interest. Thus, part of the package was a (dBASE 111) database, called FIREdata, that contained burning rate and species yields for coininon materials and products. These data were included in the units required lor input into the fire model FAST, and included the literature relcrenccs from which the data were extracted. While all of the data was from published sources, the easy accessibility in an indexed data base, and publication in the needed units made the engineer's task easy. The positive experience with FIREdata was a lesson that has not been forgotten.

THE EMERGENCE OF THE INTERNET

Particularly in the past decade, the Internet has emerged as a simple means for the instantaneous, global dissemination of information. The Internet is especially well suited to providing access to data and applications information on innovative materials and products as soon as the data is available. NIST's Building and Fire Research Laboratory (BFRL) has been experimenting with the use of the Internet to make available research reports and data of use to the fire safety engineering community through the BFRL web site. This process began with the provision of access to FIREDOC, the bibliographic database to BFRL's library, on the Internet in about 1995. However, the utilization of FIREDOC by the global engineering, academic, and scientific communities has been greatly enhanced by the ability to search the database directly from browsers and from the provision of full-text copies of approximately 1000 BFRL staff and grantee/contractor reports on the BFRL web site. This is also true of FIRE ON THE WEB that contains a well indexed database of fire performance data on materials and products, still and video images of tests from which the data were derived, and input files for BFRL developed models that extend the data to real configurations of interest.

The resulting Web site is unique in the world in that it contains data integrated with models, iinagcs integrated with data, and reports that document everything. This *was* recognized in 1998 when the BFRL site was named the Department of Commerce "web site of the week," the first at NIST to be so honored. Feedback from the community of users has been highly complimentary and BFKL is now widely known as the definitive source of quality data and information needed to apply modern fire safety engineering to the cost effective mitigation of fire losses. Industries such as Industrial Risk Insurers (a major HPR insurance carrier) provided fire test data to post on the site. NIST's Office of Standard Reference Data has funded the world's first fire data CD developed by BFRL and for which the site serves as a means of peer review of the data. This CD, called FASTDATA, contains both NIST developed data and data from worldwide sources (with permission) in FDMS format. For example, the EURIFIC upholstered furniture data set is available on the CD.

The statistics on FIREDOC/Fire on the Web bear out the tremendous growth in global use. In 1997 we averaged about 10,000 hits per month for FIREDOC alone. With the 1998 addition of Fire on the Web those numbers grew 10-fold to 100,000 hits per month by mid-ycai-, and for March 1999 were about 175,000.

The dissemination of data by an independent, third party like NIST has significant benefits to the regulatory community in providing credibility that may be missing when the data source is a manufacturer of the material or product. But this brings to NIST a responsibility to document the quality of the data. Thus BFRL developed a system of quality indicators to apply to the data to provide such documentation and allow users to make informed decisions on data quality.

DATA QUALITY

Clearly, the integrity of data in any database is of paramount importance to the utility of the database. In the NJST implementation of FDMS 2.0, FASTData. we have provided a collection of available fire test data from NIST and elsewhere to provide a basis for evaluating the utility of the database and the effort involved in implementing future, more inclusive databases. In general, we have adapted the ASTM guide for database quality indicators for use in FDMS [ASTM 19921. The ASTM guide provides nine indicators to assess the utility of data for the intended purpose. One of the indicators in the ASTM guide pertains only to the database in its entirety (a "database supported" field used to indicate the level of active support available to keep the database current). This indicator is not included for individual tests in a FDMS database. Recognizing that the original intent of the ASTM document was to apply to scalar values of chemical property data, the field for "Statistical basis of data" has been simplified to include few qualifiers more representative of the current state-of-the-art in fire testing. Statistical methods to compare fire test measurements are an active research area [Peacock, et al 1993, 1999]. **As** appropriate techniques are better understood. this field can be expanded to include more explicit statistical methods.

Data supplied to NIST for inclusion into the FASTData database must include an assessment by the testing organization of each of these quality indicators. The following is considered the minimum values of indicators for data that is acceptable for inclusion into the database:

- *Source of data* – at least a report must be available describing the test
- *Statistical basis of data* – replicate tests are desirable, but not required for standard bench-scale test methods. Single tests are acceptable for larger than bench-scale tests.
- *Material development **or** production status* – any category (from the ASTM guide) is acceptable
- *Evaluation status* – any category (froin the ASTM guide) is acceptable
- *Certification status* – any category (from the ASTM guide) is acceptable
- *Completeness oj material(s) information* – at least partial inforination on material. See section on *Product Description,* below, for details.
- *Completeness of test procedure description* – any category (from the ASTM guide) is acceptable

Table 1 shows details of the indicators used within the NIST implementations of the FDMS format to qualify each data set included in the database:

1. *Source of datu* – Identifies the type of publication that documents the test. Further inforination on the associated documents is included with entries in the TESTDOC file by entries associated to the test by its unique TESTID.

2. *Statistical basis of data* – indicates to the user a measure of the degree to which data can be directly compared to other data, if the data can be used for design, or if their principal value is for rough comparison. For example, single-point test values are of the lowest reliability for most purposes, but may be of interest for developmental inaterials or if replicate or other data are not available.

3. *Material development or production statiis* – Is the inaterial currently available, in the research or development stage, or an obsolete inaterial'!

4. *Evaluation status* – Were the test data generated according to a standard test procedure and was the data validated by a recognized and competent method'? Were the lest data evaluated by an expert body or individual to determine reasonableness, fit with theory, or expectations'!

5. *Certification status* – Were the test data certified by an expert body or individual to determine their applicability or appropriateness for a specific application'!

6. *Completeness of materials description* – The usefulness of any particular data set is critically related to the ability of the user of the data to precisely identify the material which was tested. In addition to identification of the product, manufacturer, or supplier of the material(s) which were tested, information on the form or condition of the material(s), processing history, or precise history of the material(s) may be appropriate. These descriptors indicate to the potential user the nature of the listed properties and their applicability to a particular purpose.

7. *Completeness of test procedure description* – This descriptor does not indicate the actual test procedure used, but will indicate whether or not a standard test procedure was used to generate the data. Further information on a test procedure is included with entries in the METHDOC file associated to the test by its unique TESTID.

8. *Completeness of material(s) information* – at least partial information on material

9. *Completeness of test procedure description* – any category is acceptable

Table 1 – Fixed Input Choices in FDMS

Indicator	Description	Available Values
1	Source of data set	J – Journal publication H – Handbook publication G – Government report P – Producer brochure U – Unpublished report X – Source unknown
2	Statistical basis of data set	S – Statistical representation of multiple data sets R – Replicate tests associated with this test are included in the database I – Individual test X – Unknown
3	Material developinent or production status	P – Production inaterial R – Experimental material O – Obsolete, no longer in production
4	Evaluation status	E – Evaluated independently S – Evaluated at testing organization X – Not evaluated
5	Certi I'ication status	C – Certified independently S – Certified by testing organization X – Not certified
6	Completeness of material(s) inforination	F – Full inforination on inaterial form, condition, and processing history P – Partial information on material form, condition, and processing history X – No information on material form, condition, or processing history
7	Completeness of test procedure description	S – Standard tests: documented N – Non-standard tests: documented X – Test procedure(s) not documented

INFORMATION IN FDMS FORMAT

To make available test data as complete as possible, this section provides guidelines for the information which can be included for a test to be imported into an FDMS format database.

Test Description: Each test is identified by the test conducted, persons responsible for the test, the test conditions, product or products tested, and comments or observations about the test. These are each related to fields in physical database files. Applicable documents related to the test method or test documentation can also be identified in the description.

Test Conditions: Test conditions describe setup aspects for each test and thus allow the user to more completely specify the testing conditions. The information which should be included depends upon the specific test method to which the data set applies. For the Cone Calorimeter, for example, the orientation, incident flux, pilot ignition, or mounting frame specification could be included.

Product Description: At least one product must be included. For the initial data included in the Internet version of the FIREDATA database, this information is the least complete and perhaps most important to the future utility of the database. **A** completely identified product (for FDMS product descriptions) includes: Product naine (a text description of the product), Product ID, Manufacturer, Catalog number, Main use of the product (from a controlled choice list within FDMS), Density, Length, Height, Thickness, Mass, Thermal Conductivity, Specific Heat, and Emissivity. For layered products, each individual sub-product is described as above with an additional field to indicate the structure in the final product.

Personnel and Organizations: Description of personnel and organizations related to test data within the database provide contact points for additional inforination about the test or product details which may have been omitted in the database: Full name, Organization naine, Address, and Phone, fax, telex, e-mail.

Organizations are described by: Organization type (from a controlled choice list within FDMS), Organization naine, Division, Address, and Phone, fax, telex, e-mail

Fire Test Measurements: Vector and scalar data imported into a universally exchangeable database should be in consistent units, most typically SI. Within FDMS, the following base units are used:

temperature	Kelvin
absolute temperature	Kelvin
pressure	Pascal
length	meter
energy	Joule
energy release rate	Watt
energy absorbtion rate	Watt
mass	kilograin
time	Second

NEEDS OF THE USER COMMUNITY

The positive experiences with the fire data resources have led to an interest in expanding into building data in support of the design, engineering, and regulatory communities. To determine their needs a workshop was held at NIST in June 2000 to which a broad representation of potential users was invited. It was apparent from the coininents of the participants that such a resource was greatly needed and we were encouraged to continue. There was interest expressed in data on innovative materials such as high perforinance concrete and steel, appropriate performance metrics for structural and fire performance, and associated applications inforination to assure that the desired perforinance could be achieved. The need for a method of indexing the data to allow for easy retrieval and the application of the data quality indicators were all cited as important to the acceptance of the resource in the regulatory environment.

NIST is inoving ahead with this effort as a cooperative venture among the Fire Safety Engineering and Building Materials Divisions of BFRL, and the NIST Office of Standard Reference Data. The goal is to develop a pilot database available on the BFRL Web Site by the summer of 2001. This site will provide data on the performance of advanced materials, and inforination on appropriate applications for these materials, in a way that should be useful to the design and regulatory communities. The hope is that this pilot will create a demand for expansion of the site and to help identify priorities for the data to be included.

CONCLUSIONS

The accessibility of a wide range of quality experimental data is important to the application of perforinance design methods in determining compliance with building regulations. The use of the Internet has einerged as a convenient means for the global dissemination of information. The FDMS format has demonstrated the ability to provide a consistent systein for the exchange of such data from both bench-scale and real-scale fire experiments. Extension of this format to provide compatibility with other types of data on building materials, products and systems is straightforward. By establishing a protocol for storing and inaintaining data and by providing an extensible database. the design, engineering, and regulatory coininunities will be encouraged to utilize the data.

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WEB SITES

Fire on the Web http://fire.nist.gov/

BFRL Publications Online http://fire.nist.gov/bfrlpubs/

FASTdata http://fire.nist.gov/fastdata/

FAST and CFAST models http://fast.nist.gov/

Fire Dynamics Simulator and Smoke View (cfd) http://fire.nist.gov/fds/

Fire Walk Project http://www.cs.berkeley.edu/~bukowski/wkfire/index.html

Generul Information http://www.bfrl.nist.gov/