614668

LESSONS LEARNED AND TECHNICAL STANDARDS: A LOGICAL MARRIAGE FOR FUTURE SPACE SYSTEMS DESIGN

Paul S. Gill and Danny Garcia
NASA Technical Standards Program Office
National Aeronautics and Space Administration
Huntsville, Alabama
paul.gill@msfc.nasa.gov, danny.garcia@msfc.nasa.gov

William W. Vaughan
University of Alabama in Huntsville
Huntsville, Alabama
Vaughan@nsstc.uah.edu

ABSTRACT

A comprehensive database of engineering lessons learned that corresponds with relevant technical standards will be a valuable asset to those engaged in studies on future space vehicle developments, especially for structures, materials, propulsion, control, operations and associated elements. In addition, this will enable the capturing of technology developments applicable to the design, development, and operation of future space vehicles as planned in the Space Launch Initiative. Using the time-honored tradition of passing on lessons learned while utilizing the newest information technology, NASA has launched an intensive effort to link lessons learned acquired through various Internet databases with applicable technical standards. This paper will discuss the importance of lessons learned, the difficulty in finding relevant lessons learned while engaged in a space vehicle development, and the new NASA effort to relate them to technical standards that can help alleviate this difficulty.

INTRODUCTION

NASA, DOD, and organizations in the domestic and international aerospace industry are either planning or are currently engaged in actions relative to the development of new or improved manned and un-manned space vehicles (launch vehicles, space craft, and satellites). For example, NASA is currently involved in a Second Generation Recoverable Launch Vehicle Development Program. All of these developments will benefit from the lessons learned on previous space vehicle designs, developments, and operations. The key to the success of the new or improved space vehicles will depend on the applicable lessons learned that are identified and applied. All of the new or improved space vehicle developments have one thing in common---the application of technical standards developed by NASA, DOD, ESA, NASDA, or space agencies of other governments in addition to the technical standards produced by other Standards Developing Organizations such as ASTM, SAE, ASME, IEEE, JSA, IEC, ISO, etc., plus those prepared internally by companies within the aerospace industry. The active identification and application of lessons learned is a principal component of an organizational culture committed to continuous improvement.

The NASA Technical Standards Program (http://standards.nasa.gov) was formally established in 1997 as an Agency wide effort by direction of the Administrator. It has the following principal elements:

** Increase NASA Use of Voluntary Consensus (non-Government) Technical Standards.
** Selective Development of NASA-Unique Technical Standards.
** Develop and Promote the Use of an Integrated Technical Standards System (Full-text Standards Access, Standards Update Notification, and Lessons Learned—Standards Integration)
** Exploit the Potential of Web-based Standardization Information

The Program's Website is a key mechanism for the accomplishment of these efforts. Figure 1 is the Homepage for the Program's Website. Its content provides users, both within the nasa.gov Domain and otherwise, with information on technical standards and related material

LESSON LEARNED PROBLEM

Lessons learned are a powerful method of sharing ideas for improving work processes, facility or component design and operation, quality, safety, and cost effectiveness. Properly implemented lessons learned should improve management decision-making during every phase of project activity.

Information on lessons learned may be found in a number of different locations, including organizational technical reports, professional engineering journals, and databases specifically focused on lessons learned. Locating a lessons learned applicable to one's specific interest has not been a very "user friendly" experience. Thus, the motivation for developing a "marriage" with technical standards.

With the "explosion" in technical accomplishments during the past century, especially during the last few decades, the ability to rapidly communicate lessons learned, and the knowledge gained there from, has become critical. This is very true for activities associated with producing more advanced products within the "faster, better, cheaper" philosophy. The dependence upon "word-of-mouth" and textbooks to communicate lessons learned, while still important, is no longer adequate or realistic. Expecting engineers and scientists to search through the ever-increasing number and contents of lessons learned databases has proven to be less than productive. It is difficult and time consuming for most engineers to search for and use such lessons learned databases. However, there is a potential solution to this problem.

POTENTIAL SOLUTION

All Programs/Projects are based on the application of technical standards, whether produced by government organizations, or by non-government standards developing organizations. The development of these technical standards have gone through an extensive review process. Given this database of technical standards, along with the existence of a screened lessons learned database, a productive "marriage" is now readily possible.

Over 130 national and international aerospace related lessons learned databases, can readily be located by addressing the NASA Technical Standards Program Web-site at http://standards.nasa.gov and then click the NASA ACCESS or PUBLIC ACCESS sites on the menu page. Once registered, then click on the Lessons Learned/Best Practices—Technical Standards site for direct access to the listing of lessons learned databases related to aerospace engineering.

Some examples of lessons learned databases on the NASA Technical Standards Program Web-site are:

- NASA/Headquarters—Lessons Learned Information System
- NASA/Glenn Research Center – Frequently Asked Questions On Failures
- NASA/Kennedy Space Center - Cryogenic Transfer System Mechanical Design
- NASA/Goddard Space Flight Center – Systems Engineering Office Lessons Learned
- AIAA/Satellite Mission Operations Best Practices
- NASA/Langley Research Center - Lessons for Software Systems

On the surface this "marriage" appears to be an easily achieved action. However, such is not the case. It requires the talents of dedicated and experienced engineers who must also possess the gifts of persistence and meticulous attention to detail. The material involved must be read and interpreted and then correlated. The lessons learned database must then be integrated with the technical standards database. Both databases continue to grow at a prolific rate.

A NASA "pilot" effort to test this approach has been successful. Consideration is being given to expand the effort beyond the NASA Preferred Technical Standards database. To the degree practical, this should be done in collaboration with the Standards Developing Organizations.

The result will be an invaluable database whereby technical standards required for a Program/Project design, development, or operations process will also have identified with them any applicable lesson(s) learned. This "marriage" will without doubt significantly enhance the accomplishment of "better, faster, cheaper" products. Also, technical standards identified with associated lessons learned may be candidates for revision or updating or the development of a new technical standard.

EXAMPLES OF INITIAL RESULTS

To illustrate the results of the pilot effort regarding the integration of information on lessons learned with technical standards, two examples are presented as the products appears within the NASA Technical Standards Program Web-site. These two examples are taken from the Agencywide Full-Text Technical Standards System within the NASA ACCESS site on the menu page. Due to licensing agreements on the access to Non-government Technical Standards Products, the NASA ACCESS site is only available to those within the <nasa.gov> Domain.

Figure 2 provides an illustration of the Standards Document Summary Page for MIL-STD-1686 C, a NASA Preferred Technical Standard. The information provided for a user on this NASA Preferred Technical Standard includes two lessons learned links, plus a brief description of each, that are available on the NASA Lessons Learned Information System (LLIS) Database. The nasa.gov Domain user of this standard can then easily locate the two listed lessons learned through hyperlinks and decide whether the contents might be applicable to their use of this MIL-STD. The full-text content of this MIL-STD is readily available from both the NASA ACCESS and PUBLIC ACCESS sites.

Figure 3 provides a similar illustration of the Standards Document Summary Page for ASTM-B117. This ASTM Technical Standard is one that has been adopted (endorsed) by the Agency as a NASA Preferred Technical Standard. It is so identified on both the NASA ACCESS and PUBLIC ACCESS sites. However, its full-text content is readily available only from the NASA ACCESS site due to licensing restrictions noted above. Figure 3 has the same format as Figure 2. There is one lessons learned entry noted from the NASA LLIS Database.

VALUE OF MARRIAGE

Both Government and Industry conscientiously investigate, document, and track all of their successes and failures. Yet, much of that effort is meaningless if an Industry or Government Agency fails to incorporate these experiences into ongoing and future Programs/Projects and their operations. They need a viable mechanism to identify and incorporate lessons learned into their design, development, and operations efforts, thus reducing mission risk. The cost of achieving the "marriage" of lessons learned and technical standards will be modest compared to the significant results that will be achieved

Links should be established as soon as practical between lessons learned and, where possible, the technical standard to which they relate. This can be accomplished by a government organization such as NASA and DOD, Industry Groups, and Standards Developing Organizations. The results can then be made available and shared with all interested parties. Given the scope of many non-government technical standards, they would be an excellent database to use and benefit from this "marriage". Users of the technical standards would then have immediate links/access to lessons learned and other relevant information as they select and apply technical standards in the normal design, development, and operations process.

The longer-term goal should be to update technical standards, where appropriate, to reflect lessons learned. Normal practice in the standards community is for technical standards to be reviewed and, where necessary, updated at least once in five years. Links to related lessons learned would provide a basis for additions and updates of technical standards, thus facilitating the "marriage" process. For government and non-government developed technical standards, the addition of lessons learned can be made directly whenever prudent. To accomplish this goal, and thus reduce mission risk, it is recommended that initiatives by those developing and using technical standards products be established to integrate lessons learned with technical standards

SUMMARY

There are no guarantees that future mishaps like the recent two NASA/JPL Mar's Missions will not occur. However, the existence of an Integrated Lessons Learned and Technical Standards System will certainly contribute toward minimizing such risks. Only one Project saved, or whose performance is enhanced, will repay the cost of developing an Integrated Lessons Learned and Technical Standards System many fold. Without this "marriage" the lessons learned databases, and other similar databases, will continue to find limited and very focused utility relative to the development and operation of future industry and government aerospace Programs/Projects.

Credits: This paper is based on the contents of a paper entitled "Lessons Learned and Technical Standards: A Logical Marriage" produced by the authors and published in the November 2001 issue of ASTM Standardization News.

Presentation: Prepared July 17, 2002 for presentation at 53rd International Astronautical Congress, Session U.3. Systems Engineering, Tools and Processes. Houston, Texas, October 17, 2002.

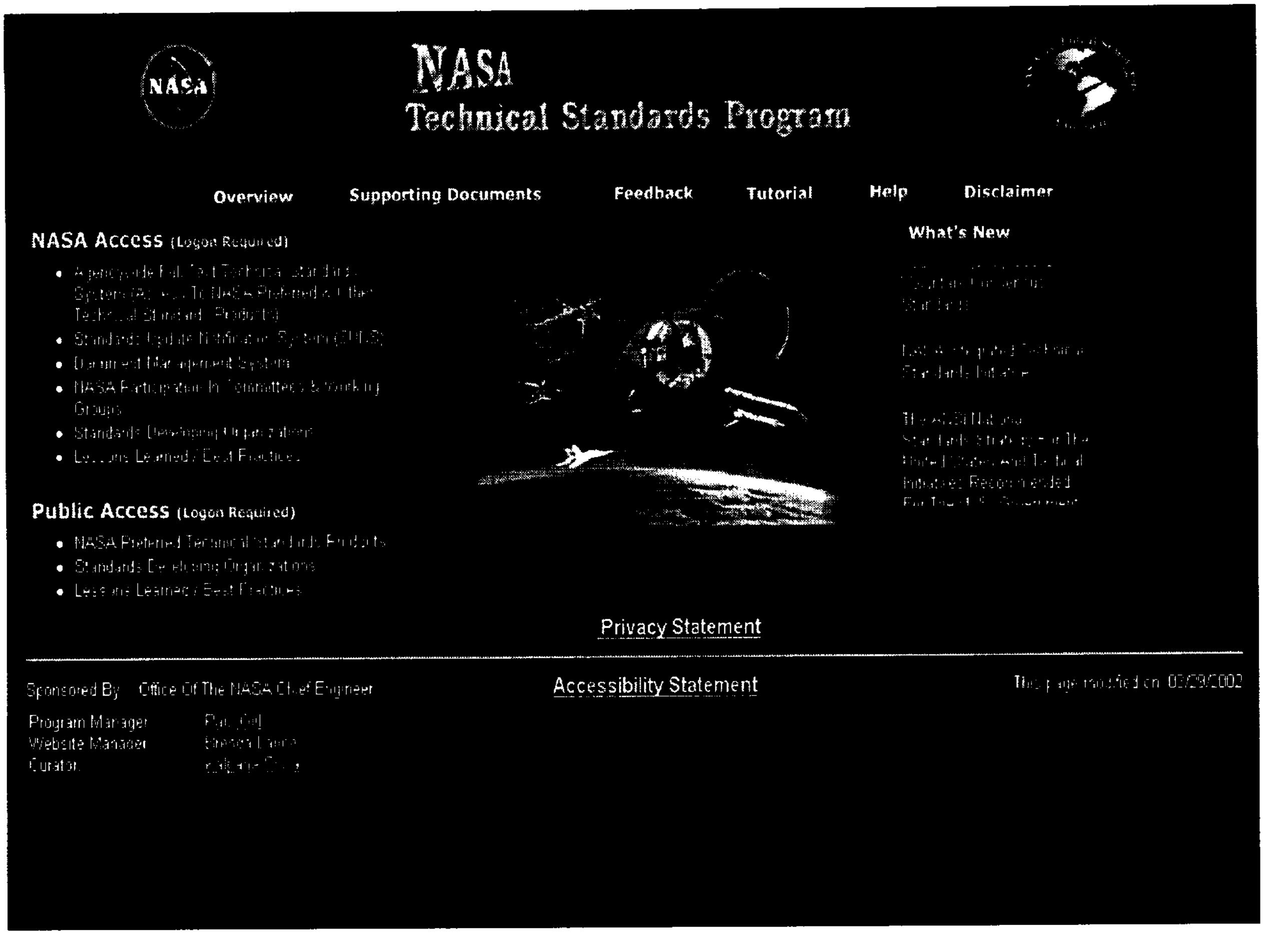

Figure 1. NASA Technical Standards Program Homepage

Summary page

MIL STD 1686	Revision: C	Status: Active	NASA Status: Preferred
DoDISS info	No. of NASA Accesses since 06/2001: 4	SDO: MIL	Year Reaffirmed

TITLE: ELECTROSTATIC DISCHARGE CONTROL PROGRAM FOR PROTECTION OF ELECTRICAL AND ELECTRONIC PARTS, ASSEMBLIES AND EQUIPMENT (EXCLUDING ELECTRICALLY INITIATED EXPLOSIVE DEVICES) (SUPERSEDING MIL STD 1686B)

Base	Date: 10/25/1995	19 pages	View Doc / View TOC

Document Scope

[Base - 10/25/1995]
The purpose of this standard is to establish comprehensive requirements for an ESD control program to minimize the effects of ESD on parts, assemblies, and equipment. An effective ESD control program will increase reliability and decrease both maintenance actions and lifetime costs. This standard shall be tailored for various types of acquisitions.

Application Notes

Applicable Revision	Project ID	NASA Center	Creation Date	Note
-	-	JPL	4/26/2001	Requires that each facility have a document that describes how they implement ESD controls (for example, see MSFC-RQMT-2918)

Lessons Learned and Best Practices

LL/BP No.	Title	Date	Relevance to the Standard
685	Electrostatic Discharge (ESD) Control in GSE	2/1/1999	The Lesson provides technical recommendations for the control of ESD in aerospace equipment
732	Electrostatic Discharge (ESD) Control in Flight Hardware	2/1/1999	The Lesson addresses the generation of triboelectric and electrostatic charges as a common cause of damage and/ordegradation to unprotected Electrostatic Discharge Sensitive (ESDS) devices. A carefully devised and implemented ESD control programcan provide protection from this damage and/or degradation

Document History

Document No.	Rev	Date	Title	Status
MIL-STD-1686B	B	12/31/1992	ELECTROSTATIC DISCHARGE CONTROL PROGRAM FOR PROTECTION OF ELECTRICAL AND ELECTRONIC PARTS, ASSEMBLIES AND EQUIPMENT (EXCLUDING ELECTRICALLY INITIATED EXPLOSIVE DEVICES) (S/S BY MIL-STD-1686C) (SUPERSEDING MIL-STD-1686A)	Superseded
MIL-STD-1686A	A	08/08/1988	ELECTROSTATIC DISCHARGE CONTROL PROGRAM FOR PROTECTION OF ELECTRICAL AND ELECTRONIC PARTS, ASSEMBLIES AND EQUIPMENT (EXCLUDING ELECTRICALLY INITIATED EXPLOSIVE DEVICES) (METRIC) (S/S BY MIL-STD-1686C)	Superseded

Figure 2. MIL-STD-1686C Standards Document Summary Page

File Edit View Go Communicator Help

Agencywide Full-Text Technical Standards System

Summary page

ASTM B117	Revision: 1997	Status: Active	NASA Status: Preferred
DoDISS info	No. of NASA Accesses since 06/2001: 0	SDO: ASTM	Year Reaffirmed

TITLE: OPERATING SALT SPRAY (FOG) APPARATUS (SUPERSEDING ASTM-B117-1995)

Base	Date: 04/10/1997	8 pages	View Doc

Document Scope

[Base - 04/10/1997]

1. Scope

1.1 This practice describes the apparatus, procedure, and conditions required to create and maintain the salt spray (fog) test environment. Suitable apparatus which may be used is described in Appendix X1.

1.2 This practice does not prescribe the type of test specimen or exposure periods to be used for a specific product, nor the interpretation to be given to the results.

1.3 The values stated in SI units are to be regarded as standard. The inch-pound units in parentheses are provided for information and may be approximate.

1.4 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

Application Notes

Applicable Revision	Project ID	NASA Center	Creation Date	Note

Lessons Learned and Best Practices

LL/BP No.	Title	Date	Relevance to the Standard
764	Controlling Stress Corrosion Cracking in Aerospace Applications	2/1/1999	This Lesson presents considerations that should be evaluated and applied concerning stress corrosion and subsequent crack propagation in mechanical devices, structural devices, and related components used in aerospace applications

View History

Document: Done

Figure 3. ASTM B-117 Standards Document Summary Page