

## The Revitalization of MIL-HDBK-217

Lou Gullo

Email: louis.gullo@ieee.org

### **Introduction to MIL-HDBK-217**

MIL-HDBK-217 is the military handbook for the reliability prediction of electronic equipment. This handbook was developed in 1961. The purpose of MIL-HDBK-217 is to establish and maintain consistent and uniform methods for estimating the inherent reliability (i.e., the reliability of a mature design) of military electronic equipment and systems. It provides a common basis for reliability predictions during acquisition programs for military electronic systems and equipment. It also establishes a common basis for comparing and evaluating reliability predictions of related or competitive designs. The handbook is intended to be used as a tool to increase the reliability of the equipment being designed. This handbook has not been modified since 1995.

This handbook contains two methods of reliability prediction – Parts Stress and Parts Count. These methods vary by degree of information required as inputs to component failure rate models. The Parts Stress Method requires the greatest degree of detailed information. Parts Stress Method is applied in the later phases of design when actual hardware and circuits are being designed. The Parts Stress Method requires actual and rated parametric values for assessing the stresses and stress percentages of components within an application.

### **Initiation of the Revision Project**

Defense Standardization Program Office (DSPO), OUSD (AT&L), under Mr Greg Saunders created ASSIST Project # SESS-2008-001, to initiate the effort to revise MIL-HDBK-217. ASSIST is the Acquisition Streamlining and Standardization Information System which is a web-based online database. More than 100 government activities may prepare and submit documents to the ASSIST database using the electronic document submission tool.

DSPO is funding Naval Surface Warfare Center (NSWC) Crane Division to release MIL-HBDBK-217 Rev G by the end of 2009. DSPO is driving the revision of MIL-HBDBK-217 based on the results of a survey conducted throughout government and industry. This survey was initiated in 2004. It was conducted by NSWC Crane and completed in 2007. The purpose of this survey was to determine what tools are being used by industry to generate MTBF data. NSWC Crane determined from the survey results that although this handbook has not been updated in over a decade, it remains the most widely used reliability prediction method for electronic equipment. Under the leadership of NSWC Crane, a working group of individuals representing the government, DoD, and industry has been established to conduct this revision. The members of this working group, the MIL-HDBK-217 Revision Working Group (217WG), responded to the NSWC Crane call for volunteers and were down selected from the overwhelming list of respondents.

### **Other Related Activity**

Besides this 217WG, DSPO has sponsored aerospace industry collaborative research through the Aerospace Vehicle Systems Institute (AVSI). AVSI is working to develop new reliability prediction models for new component technologies that are not covered in MIL-HDBK-217. AVSI is focused on commercializing Physics of Failure (PoF) models considering semiconductor wearout, and developing a new software tool for reliability predictions. Several members of the 217WG and AVSI are also members of VMEbus International Trade Association (VITA). VITA's mission includes not only promoting VMEbus, but promoting open technology as

embodied in the many standards currently under development within the VITA Standards Organization (VSO). VSO is accredited as an American National Standards developer and a submitter of Industry Trade Agreements to the IEC. VITA formed a Community of Practice for reliability engineering professionals called VITA51, which is focused on providing practitioners of MIL-HDBK-217F with an industry consensus-based approach to MTBF calculation. The efforts of AVSI and VITA51 should have a benefit and direct effect on MIL-HDBK-217 revisions in the future.

IEEE Reliability Society (IEEE-RS) assisted the 217WG with a virtual private on-line community. The purpose of this on-line community is to provide a repository to upload and download files to share information between the members of the 217WG. A few members of 217WG, AVSI and VITA51 are also members of the IEEE 1413 working group, revising the IEEE standard for reliability predictions.

### **217WG Kick-Off Meeting**

On May 8, 2008, the initial 217WG face-to-face meeting was held in Indianapolis, IN, sponsored by the NSWC Crane Division. Jeff Harms, NSWC Crane and Chairman of the 217WG, presented a meeting agenda, which outlined the topics and schedule for the meeting. The meeting was productive, with a considerable amount of discussion on various subject areas. During this meeting, it was decided that the project would be split into 2 phases.

Phase 1 is the release of MIL-HDBK-217 Rev G by December 2009. Phase 1 includes modification to existing models and adopting models that are used by other entities or standards, such as 217Plus, PRISM, AVSI and VITA51. Phase 2 is the reinvention of the handbook to be a more holistic approach and include all causes of system and product failures. Phase 2 includes analysis of raw test and field data to derive new failure rate models. Also, the working group is considering a proposal from Lou Gullo to reference IEEE 1413 and IEEE 1413.1 standards in the new revision of the 217 handbook to provide alternative options for performing reliability predictions using holistic approaches.

### **Most Recent 217WG Meeting**

The last working group meeting was held between November 13-14, 2008. 17 of the 25 working group members attended. A complete list of the 217WG members who attended this meeting is shown in Table 1.

Table 1. Meeting Attendees

	<b>Name</b>	<b>Company</b>
1	Lori Bechtold	Boeing
2	Jim Garten	SDA
3	Louis Gullo	Raytheon
4	Jeffrey Harms	NSWC Crane
5	David H Johnson	AFRL/RXSA
6	Douglas Loescher	Sandia National Lab
7	Jim McLeish	DfR Solutions
8	Larry Mosher	Eaton Areospace
9	David Nicholls	RiAC
10	Dan Quearry	NSWC Crane
11	Joe Rodenbeck	DLA
12	Gerry Thomas	NSWC Crane

13	Jack Thompson	WPAFB
14	Bahig Tawfellos	Honeywell Aerospace
15	Bill Allen	LMSI
16	Dan Jacob	RELEX
17	Bob Ricco	Northrop Grumman

Dave Johnson stated new microcircuit (commercial) types with life limited/wear-out data needs to be added. The group discussed the current wear-out model usage and methodology. It was stated that Jim McLeish would address wear-out issue in the Phase 2 and Phase 3 proposals. Mention was made of making the handbook a dynamic/web-based tool. This suggestion is not possible given the scope of the current MIL-HDBK-217 Phase 1 requirements. Change control could be an issue. NSWC Crane took an action to discuss possibilities with DSPO for future phases.

Discussion became rather lengthy on the verification and source of component data. Concerns were expressed by several members on the source sensitivity. For Phase I of the MIL-HDBK-217 update, the RiAC is handling all submitted data using the structure and taxonomy of the existing RiAC databases. RiAC is responsible to ensure data is sanitized and that there is no data pedigree retained in the data warehouse and outputs from this data warehouse. Dave Nicholls reminded the 217WG that RiAC will accept individual company Non-Disclosure Agreements (NDAs).

Engineering Judgment vs. Component Data became a source of debate at the meeting. First priority for section updates is to utilize data. Guidance was provided that stated, when necessary, each section lead can use engineering judgment as their section revision basis and would document engineering judgment rationale and submit to WG for review and approval. Section leads could decide when to stop collecting data and use engineering judgment for section updates in lieu of data. NSWC Crane to indoctrinate guidelines for documenting engineering judgment. A suggestion was made to add working group review and feedback loop to '217 Revision Process' flow chart.

Doug Loescher had conducted a comparison of inductor models between Telecordia, 217 and RiAC prediction models. He found 3 orders of magnitude difference, and expressed concern with reflecting this in the Rev. G update.

Lou Gullo discussed his interaction with NSWC Corona to gain access to the Navy's Material Readiness Database (MRDB) to leverage fleet performance historical data for component model refresh and handbook updates. Lou provided his NSWC Corona points of contact (POCs) to NSWC Crane. Lou also discussed gaining access to the Navy's Open Architectural Retrieval System (OARS) database. OARS is another repository for the Navy's fleet performance data, known as 3M data. Dave Nichols, RiAC, was helpful in providing website link and Navy POCs for OARS access.

The list below shows persons who volunteered to lead most of the sections. Since there are several sections that do not have leads assigned, a discussion occurred on how to best handle unassigned sections. There was also discussion on new part sections, currently not covered in 217.

**MIL-HDBK-217 Sections and Leads**

- Sections 1-4 NSWC Crane
- Section 5 (Microcircuits) Tyrone Jackson
- Section 6 (Discretetes) Chandru Michandani

■Section 9 (Resistors)	Jim Garten	
■Section 10 (Capacitors)	Bahig Tawfellos	
■Section 11 (Inductors)	Doug Loescher	
■Section 13 (Relays)	Rich Yannitti	
■Section 14 (Switches)	Rich Yannitti	
■Section 15 (Connectors)	Bill Allen	
■Section 16 (Interconnection Assy)	Larry	Mosher
■Section 17 (Connections)	Larry Mosher	
■Section 21 (Filters)	Jack Thompson	
■Appendix B	Jim McLeish	

#### **MIL-HDBK-217 Sections that do not have a Lead**

- Section 7 (Tubes)
- Section 8 (Lasers)
- Section 12 (Rotating Devices)
- Section 18 (Meters)
- Section 19 (Quartz Crystals)
- Section 20 (Lamps)
- Section 22 (Fuses)
- Section 23 (Misc. Parts)

A new Fiber Optics/Photonic section was planned to be added to the handbook. Preliminary data for this new section was received and placed in the IEEE on-line community 217WG share area.

Interconnection Assemblies & Connections model updates was discussed by Larry Mosher. He has over 1 million hours of data with failure analysis of solder joints performed. Disclosure of this data to the 217WG is pending legal approval. He will most likely update pi-factors. There was discussion of leveraging the Engelmeier models. There was also discussion about the prediction methodology from Boeing on lead free solders.

#### **Phases II & III Review**

Jeff Harms began the sessions with a review of the Phase II and III objectives, which included investigating current reliability approaches. This was followed by three presentations (see IEEE 217WG website for presentation material):

##### 217Plus – Bill Denson

Review of the reliability prediction methodology utilized in 217Plus from a component and system-level perspective.

##### AVSI – Lori Bechtold

Provided an update on the work being performed in current AVSI reliability initiatives. One objective of these initiatives is to provide findings to the 217 Working Group.

##### Reliability Assessment – Jim McLeish

Provided a detailed presentation of the Physics of Failure approach to design reliability practices.

**Next Meeting Discussion**

The next meeting dates are tentatively scheduled for 18,19 FEB 2009. NSWC Crane to determine next meeting location. Jeff Harms to check on potential for meeting in Dallas, TX site.

**Further Information**

Details of the project can be found at the NSWC Crane website: [www.crane.navy.mil](http://www.crane.navy.mil)

Besides details about the 217WG, there is also other pertinent information on reliability such as SD18 for parts derating, which can be found at this website. A questionnaire survey to the electronics industry is also available on this website.