SYSTEMATIC REVIEW OF ISO-11221

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ABSTRACT

ISO-11221, “Space systems — Space solar panels — Spacecraft charging induced electrostatic discharge test methods” was published in August 1st, 2011. According to ISO rule, a systematic review is required in five years, which means August 1st, 2016. ISO-11221 is a result of efforts made by the spacecraft charging community throughout the world. The first discussion was made at 8th SCTC, 2003, followed by the round-table discussion in 9th SCTC, 2005. Since 2006, five workshops were held to discuss the standard drafts and the related technical issues. At 12th SCTC, 2012 and 13th SCTC, 2014, short discussions were done regarding ISO-11221. The participants were asked to give feed-back to ISO-11221. Generally, the response was positive and little need of heavy revision was identified. In the session of 14th SCTC, a short discussion is again planned among the participants to review the usage of ISO-11221. The aim of discussion is to decide the overall course of systematic review of ISO-11221.

1. INTRODUCTION

ISO-11221, “Space systems — Space solar panels — Spacecraft charging induced electrostatic discharge test methods” was published in August 1st, 2011. The standard is a result of international collaborative efforts to improve the reliability of satellite solar panel and power system that suffered many anomalies since introduction of high voltage (100 [V]) bus system in late 1990s. The fact that methods of ESD testing were different among countries was found at 7th SCTC, 2001. Making an ISO standard was first mentioned at 8th SCTC, 2003. At 9th SCTC 2005, a resolution to establish an ISO standard was passed unanimously. A research project to establish the ISO standard was funded by the Japanese government. Round-robin experiments, mutual visits of laboratories and workshops were held from 2005 to 2009.

Thanks to these efforts, understanding of ESD phenomena improved dramatically as reflected by numerous papers on ESD testing published through the past 10 years. Table 1 lists the on-orbit anomalies associated with solar panel or power system since 1995. It is clear that satellites launched after 2005 have not suffered the anomalies as much as earlier satellites. This fact tells that the effort by the spacecraft charging community was effective improving the reliability of satellite power system.

Several reports in 12th SCTC indicated that Japan, US, China and India used the standard (Ref.[1-4]). Therefore, the standard is really a useable standard. At 12th SCTC, the audience was asked whether they were satisfied with the current version and the response was all in favor.

In the first version, several points were left for future revision, such as how far the flashover current flow, flashover simulator, solar cell degradation, testing of solar panel backside.

At 13th SCTC, other standard activities related to spacecraft charging were presented. They are ISO/CD/19923, “Space environment (natural and artificial) -- Spacecraft potential estimation in worst case environment: and ISO/WD/20584, “Space environment (natural and artificial) -- Spacecraft charging -- Earth orbit”. Research efforts related to solar array ESD testing are underway and the latest result will be presented at this 14th SCTC. An on-orbit experiment is underway to characterize ESD current in orbit[5]. The preliminary result of the experiment will be available at 14th SCTC.

2. REVISION PROCESS

According to the ISO rule, every standard must by reviewed regularly. The systematic review of ISO-11221 takes place in 5 years after publication, i.e., August 2016. Around August 2016, a ballot sheet and a comment sheet will be circulated to P-member countries of ISO/TC20/SC14. There are three options to choose, “Confirm”, “Revise” and “Withdrawal”. The confirm option means to keep the current version of the standard as it is for the next five years.

The voting result will be notified to SC14/WG1 and the project lead. According to ISO/IEC directives[6], the criteria for confirmation is the following (2.9.3.2 Option 1),

- the standard has been adopted with or without change or is used in at least five countries (when this criteria is not met, the standard should be withdrawn); and
- a simple majority of the P members of the committee voting propose confirmation.

The ISO directives give the criteria for withdrawal as the following (2.9.3.2. Option 3),

- when the standard has not been adopted with or without change or is not used in at least five countries, the standard should be withdrawn

If the voting is not obvious about “Confirm” nor “Withdrawal”, SC14/WG1 will decide on the revision process. The revision can start either from CD or DIS. Either way, the revision must be finished within three years. During the revision process, the current version will stay effective.

14th SCTC is held in April 2016. I will ask the community how each country intends to vote and if the intention is "Revise", what points need to be revised. Through that discussion, we can clarify the revision points and at which stage we should start depending on the degree of revision expected.

3. References

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TABLE I. ANOMALIES OF SATELLITE SOLAR PANEL OR POWER SYSTEM

Satellite name	Manufacture	Launch date	Anomaly date	Description
Telstar 4	Lockheed Martin	1995.9.24	2003/9/19	Short circuit of power bus, Total loss
Echostar II	Lockheed Martin	1996.9.10	2008 July	Power system, Total loss
IS-804	Lockheed Martin	1997,12,22	2005/1/14	Power system, Total loss
Sirius 2	Aerospatial	1997.11.12	1998/9/1	Decrease of generated power
Tempo-2	Space Systems/Loral	1997.3.8	1997/4/11	Decrease of generated power by 15%
Thaicom 3	Alcatel	1997.4.16	2003/2/6	Short-circuit of solar array driver system
PAS-6	Space Systems/Loral	1997.8.8	1997/8/30	Loss of generation power
Eurobird 4	Astrium	1997.9.2	2006 Oct.	Solar array circuit, partial loss of power
PAS-7	Space Systems/Loral	1998.9.16	2001/9/6	Sudden decrease of 25% power
AMC-4	Lockheed Martin	1999.11.13	2008 Aug.	Solar array circuit, partial loss of power
Glaaxy XI	Boeing	1999.12.22	2001 Sept.	Decrease of solar array output
Galaxy 26	Space Systems/Loral	1999.2.15	2008 Jan.	Power system, partial loss of power
Arabsat 3A	Alcatel	1999.2.26	2001/12/7	Short-circuit of solar array driver system, total loss
Echostar V	Space Systems/Loral	1999.9.23	2002 Jul.	Solar array drive system
Galaxy 27	Space Systems/Loral	1999.9.25	2004/11/28	Power system, 50% power loss
Launched after 2000				
Thuraya	Boeing	2000.10.21	2001 Sept.	Decrease of solar array output
AMC-6	Lockheed Martin	2000.10.21	2008 Aug.	Solar array circuit, partial loss of power
PAS 1R	Boeing	2000.11.16	2001 Sept.	Decrease of solar array output
Anik F1	Boeing	2000.11.21	2001 Sept.	Decrease of solar array output
Echostar VI	Space Systems/Loral	2000.7.14	2002 Aug.	Short-circuit of solar array circuit
XM-2	Boeing	2001.3.18	2001 Sept.	Decrease of solar array output
XM-1	Boeing	2001.5.8	2001 Sept.	Decrease of solar array output
Eutelsat W5	Thales Alenia Space	2002.11.20	2008 June	Short-circuit of solar array driver system, 50% power loss
Midori II	Mitsubishi Electric Corp.	2002.12.4	2003/10/24	Sudden loss of 80% power, total loss
Nimiq 2	Lockheed Martin	2002.12.29	2003/2/20	Decrease of power
IGS Radar 1	Mitsubishi Electric Corp.	2003.3.28	2007 March	Power system, Total loss
AMC-16	Lockheed Martin	2004.12.17	2010 March	Solar array circuit, partial loss of power
Launched after 2005				
IGS 4A	Mitsubishi Electric Corp.	2007.2.24	2010 Aug.	Power system, Total loss
INSAT 4B	ISRO/Antrix	2007.3.11	2010 July	Solar panel, 50% power loss
NigComSat 1	CAST	2007.5.13	2008 April	Solar panel, Total loss
Echostar XI	Space Systems/Loral	2008.7.16	2012 Spring	Solar array circuit, partial loss of power
Echostart XIV	Space Systems/Loral	2010.3.20	2011 Fall	Solar array circuit, partial loss of power