

DEFINITION OF SPACECRAFT STANDARD INTERFACES BY THE NASA SPACE ASSEMBLY AND SERVICING WORKING GROUP (SASWG)

Robert Radtke
Tracor Applied Sciences, Inc., Kingwood, Texas

Charles Woolley
NASA JSC, Houston, Texas

Lana Arnold
Lockheed / ESC, Houston, Texas

Abstract

The purpose of the NASA Space Assembly and Servicing Working Group is to study enabling technologies for on-orbit spacecraft maintenance and servicing. One key technology required for effective space logistics activity is the development of standard spacecraft interfaces, including the "Basic Set" defined by NASA, U.S. Space Command, and industry panelists to be (1) navigation aids, (2) grasping, berthing, and docking, and (3) utility connections for power, data, and fluids. Draft standards have been prepared and referred to professional standards organizations, including the AIAA, EIA, and SAE space standards committees. The objective of the SASWG is to support these committees with the technical expertise required to prepare standards, guideline, and recommended practices which will be accepted by the ANSI and international standards organizations, including the ISO, IEC, and PASC.

1. INTRODUCTION

The Space Assembly and Servicing Working Group (SASWG) is a NASA organization with over 700 individual members from government, industry, and academia dedicated to the study of enabling technologies for spacecraft maintenance and servicing. Currently, an Interface Standards Committee (ISC) is composed of 60 voluntary members who are preparing and reviewing draft documents which have been referred to professional standards organizations to become standards, guidelines, or recommended practices. After thorough review by the professional standards organization, with the assistance of SASWG ISC members, the document is adopted by the standards organization, and referred to the American National Standards Institute (ANSI) for referral to international standards organizations.

Three organizations have accepted SASWG interface standard projects. They are (1) the American Institute of Astronautics and Astrophysics (AIAA), (2) the Electrical Industry Association (EIA), and (3) the Society of Automotive Engineers (SAE). Each organization is accredited by ANSI to develop the American National Standards. Only ANSI serves as the U.S. member of international standards organizations such as the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC), and the Pacific Standards Congress (PASC).

The SASWG ISC is composed of NASA, U.S. Space Command, U.S. Air Force, U.S. Navy, and industry personnel organized into five functional areas (mechanical, electrical, fluid, thermal, and optical). Functional chairmen, elected for their areas of expertise, lead 10 draft standards projects.

While the SASWG has set an objective to create international spacecraft standards to support space maintenance and servicing, it should be noted that there are other compelling reasons to support international spacecraft standards. Joint U.S. Government and industry activity is needed to support both private sector interests in government-to-government standards negotiations. Firstly, it is unlikely that industry alone will provide the necessary financial support for U.S. representation. Secondly, industry cannot perform an adequate role of negotiator to assure a means for U.S. manufacturers to meet international standards and continue to have access to international markets.

Recently SASWG spacecraft standards panel discussions have described the need for a "Basic Set" of interface hardware standards for satellites and platforms. The set is to include (1) Navigation Aids, (2) Grasping, Berthing, and Docking Interfaces, and (3) Utility Connectors (electrical power, data, and fluid connectors, as required by spacecraft for on-orbit maintenance). It is the objective of the SASWG to develop international standards for these critical interfaces.

2. DISCUSSION

2.1 Current SASWG Interface Standards Projects

Documents have been referred to professional standards organizations for review and approval.

American Institute of Aeronautics and Astronautics

- (1) Grasping / Berthing / Docking - AIAA Guideline, Serviceable Spacecraft Committee on Standards (SS COS)
- (2) Flight Releasable Grapple Fixture (FRGF) - AIAA Standard, Committee SS COS
- (3) Magnetic End Effector - AIAA Guideline, Committee SS COS
- (4) Utility Connector - AIAA Guideline, Committee SS COS

Electrical Industry Association

- (5) Electrical Connector - Sub-Miniature - EIA Standard, Committee CE 2.0
- (6) Electrical Connector - Large - EIA Standard, Committee CE 2.0
- (7) Fiber Optic Connector - EIA Guideline, Committee F-06

Society of Automotive Engineers

- (8) Fluid Connector - SAE Recommended Practice, Committee G-3
- (9) Hex Head Bolt and Socket - SAE Standard, Committee E-25
- (10) Replaceable Thermal Insulation - SAE Technical Project, Committee EAAATA-3 (planned for 1992)

2.2 SASWG INTERFACE STANDARDS PREPARATION METHODOLOGY

The SASWG ISC standardization process is performed in six steps:

- 1) Identify and discuss key standards issues during face-to-face meetings and report in SASWG ISC Minutes.
- 2) Prioritize candidate hardware interfaces projects by consensus vote.
- 3) Identify committee members from industry and government and elect a project leader.
- 4) Prepare draft standards, guidelines, and recommended practices (mostly performed with communication by facsimile and telecon).
- 5) Refer draft documents to professional standards organizations for review and approval.
- 6) Attend professional standards organizations committee meetings and provide consultation, especially for technical requirements unique to spacecraft design and operations.

3.0 AMERICAN INSTITUTE OF ASTRONAUTICS AND ASTROPHYSICS INTERFACE STANDARDS PROJECTS

3.1 AIAA GUIDELINE FOR THE SERVICEABLE SPACECRAFT GRASPING / BERTHING / DOCKING INTERFACES

This guideline provides technical information for the design of three mechanical interfaces required for spacecraft servicing -- grasping by telerobotic or visual manipulation, berthing of payloads or spacecraft, and docking of spacecraft. Achieving a degree of commonality individually and collectively for this general class of interface will simplify the servicing of a variety of orbital replaceable units (ORU's), Attached payloads, platforms, Space Station Freedom, satellites, and other passive and mobile spacecraft. The invaluable experience of past missions from Gemini to the Shuttle Orbiter provides the basis for the information contained in this document.

3.2 FLIGHT RELEASABLE GRAPPLE FIXTURE (FRGF) STANDARD

This standard establishes the interface design requirements for three standard grapple fixtures - Flight Releasable Grapple Fixture (FRGF), Rigidized Sensing Grapple Fixture (RSGF), and Electrical Flight Grapple Fixture (EFGF). Design requirements are provided for the Grapple Fixture interface and Extravehicular Activity (EVA) release interface. It should be noted that there are three new non-standard grapple fixtures models - Flight Releasable Light Weight Grapple Fixture (LWGF), Auxiliary Grapple Fixture (AGF), and Electrical Light Weight Grapple Fixture (ELWGF). The light weight grapple fixtures are a solution to the weight / budget problems of payloads.

3.3 MAGNETIC END EFFECTOR STANDARD

The Magnetic End Effector has been developed to provide a dextrous end effector for the Shuttle Remote Manipulator System (RMS). Work is progressing to perform a flight demonstration. This standard establishes the interface design requirements for the end effector to payload interface.

3.4 UTILITY CONNECTOR GUIDELINE

This guideline reviews the development of a utility connectors for spacecraft servicing systems. Utility connectors are designed for fully automated remote operation, separate from and independent of any docking mechanism, operation after a docking mechanism is rigidized, and are compatible with both single point and three point docking mechanisms. Designs are reconfigurable for monopropellant, bipropellant, and cryogenic resupply.

4.0 ELECTRONIC INDUSTRY ASSOCIATION INTERFACE STANDARDS PROJECTS

4.1 STANDARD FOR CONNECTORS, ELECTRICAL, RECTANGULAR, BLIND-MATE, SCOOP-PROOF

This standard provides terminology, description and requirements of a blind-mate, scoop-proof, rectangular shell series of electrical connectors for serviceable spacecraft for use during space and ground support activities. Aspects such as size, alignment, mating force, material requirements, reliability, durability, weight, electrical and physical characteristics, and temperature range are covered. The intent is to insure compatibility to both unmanned and robotic based servicing modes.

4.2 STANDARD FOR CONNECTORS, ELECTRICAL, RECTANGULAR, BLIND-MATE, SCOOP-PROOF, LOW-FORCE, SUBMINIATURE

This guideline is for a rectangular electrical connector similar to the connector above, except for the size and locking mechanism. This connector is smaller, and may utilize release levers designed to be compatible for Extravehicular Activity (EVA) or robotic engagement and release.

4.3 GUIDELINE FOR CONNECTORS, FIBEROPTIC

This guideline provides design requirements for fiberoptic connectors for spacecraft use. NASA Long Duration Exposure Facility (LDEF) experience has shown that conventional fiberoptic connectors survived the space environment without any degradation or loss in performance.

5.0 SOCIETY OF AUTOMOTIVE ENGINEERS INTERFACE STANDARDS PROJECTS

5.1 FLUID COUPLINGS FOR SPACECRAFT SERVICING

The objective of this recommended practice is to provide high level design, development, verification, storage, and delivery guidelines for fluid couplings and its ancillary hardware for spacecraft servicing. The couplings shall be capable of resupplying storable propellants in a variety of space environments.

5.2 HEX HEAD BOLT AND SOCKET INTERFACE

This standard provides and design and materials requirements for a 8 and 12 millimeter hex head bolt to spacecraft fastening. Dimensions and clearances were determined to assure bolt and socket compatibility over the temperature extremes of space as part of a Special Project prior to the preparation of a draft standard for spacecraft fasteners.

5.3 REPLACEABLE THERMAL INSULATION

This recommended practice provides design concepts for candidate mechanisms to attach thermal insulation to orbital replacement units (ORUs) and other spacecraft services where thermal insulation degradation is likely to occur requiring the replacement of the thermal insulation blanket.

6. CONCLUSION

The purpose of the NASA Space Assembly and Servicing Working Group Interface Standards Committee is to prioritize spacecraft mechanical, electrical, fluid, thermal, and optical interface projects selected by member consensus, prepare draft standards, guideline, and recommended practices, refer to professional standards organizations, and assist with document review, approval, and referral to international standards organizations.

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8. REFERENCE

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