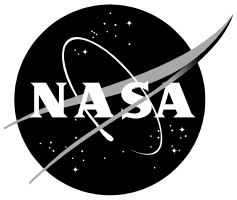
NASA/CR-2019-220447



Exploration Extravehicular Mobility Unit Outer Rendering Configuration Control Computer-Aided Design Model User's Guide

National Aeronautics and
Space Administration

Johnson Space Center
Houston, Texas 77058

September 2019

NASA STI Program Office ... in Profile

Since its founding, NASA has been dedicated to the advancement of aeronautics and space science. The NASA scientific and technical information (STI) program plays a key part in helping NASA maintain this important role.

The NASA STI program operates under the auspices of the Agency Chief Information Officer. It collects, organizes, provides for archiving, and disseminates NASA's STI. The NASA STI program provides access to the NTRS Registered and its public interface, the NASA Technical Report Server, thus providing one of the largest collections of aeronautical and space science STI in the world. Results are published in both non-NASA channels and by NASA in the NASA STI Report Series, which includes the following report types:

- TECHNICAL PUBLICATION. Reports of completed research or a major significant phase of research that present the results of NASA Programs and include extensive data or theoretical analysis. Includes compilations of significant scientific and technical data and information deemed to be of continuing reference value. NASA counter-part of peer-reviewed formal professional papers but has less stringent limitations on manuscript length and extent of graphic presentations.

- TECHNICAL MEMORANDUM. Scientific and technical findings that are preliminary or of specialized interest, e.g., quick release reports, working papers, and bibliographies that contain minimal annotation. Does not contain extensive analysis.

- CONTRACTOR REPORT. Scientific and technical findings by NASA-sponsored contractors and grantees.

- CONFERENCE PUBLICATION. Collected papers from scientific and technical conferences, symposia, seminars, or other meetings sponsored or co-sponsored by NASA.

- SPECIAL PUBLICATION. Scientific, technical, or historical information from NASA programs, projects, and missions, often concerned with subjects having substantial public interest.

- TECHNICAL TRANSLATION. English-language translations of foreign scientific and technical material pertinent to NASA's mission.

Specialized services also include organizing and publishing research results, distributing specialized research announcements and feeds, providing information desk and personal search support, and enabling data exchange services.

For more information about the NASA STI program, see the following:

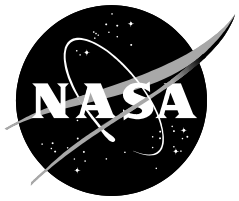
- Access the NASA STI program home page at *http://www.sti.nasa.gov*

- E-mail your question to help@sti.nasa.gov

- Phone the NASA STI Information Desk at 757-864-9658

- Write to:
  NASA STI Information Desk
  Mail Stop 148
  NASA Langley Research Center
  Hampton, VA 23681-2199

NASA/CR-2019-220447



Exploration Extravehicular Mobility Unit Outer Rendering Configuration Control Computer-Aided Design Model User's Guide

National Aeronautics and
Space Administration

Johnson Space Center
Houston, Texas 77058

September 2019

Available from:

NASA STI Program
Mail Stop 148
NASA Langley Research Center
Hampton, VA 23681-2199

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161

This report is also available in electronic form at http://www.sti.nasa.gov/ and http://ntrs.nasa.

The Exploration Extravehicular Mobility Unit (EMU) (xEMU) Computer-Aided Design (CAD) models are configuration controlled. This is a managed copy of the development xEMU system prior to Preliminary Design Review (PDR). Please do not transfer this model to others or modify it. The model may be obtained by emailing lee.coggins@nasa.gov . Please include your organization/company and designated point of contact (email and phone) along with your request. This will ensure that you are working with the most up-to-date copy while tracking those who have it. The model is not meant to be used as a volumetric simulator for any engineering work, but rather to allow for a good visual rendering of the suit.

The design and delivery of an exploration-class space suit, called the xEMU, will be demonstrated on the International Space Station (ISS) first, then upgraded with future extensibility for missions in cislunar orbit and on the lunar surface. To achieve this goal, an incremental approach has been developed that consists of two suit configurations, which are hybrid configurations encompassing elements of the current ISS EMU with enhanced mobility and complex informatics. The configuration planned for the ISS mission is referred to as the xEMU Demo. The configuration planned for microgravity cislunar and lunar surface missions is applicable to this User's Guide and referred to as simply the exploration space suit or xEMU. It allows crew members to perform autonomous extravehicular exploration, science, construction, maintenance, and contingency operations in pressure and thermal environments that exceed human capability for lunar surfaces and cislunar orbit. Views of the configuration control CAD model of the xEMU are provided in Figure 1, for reference.

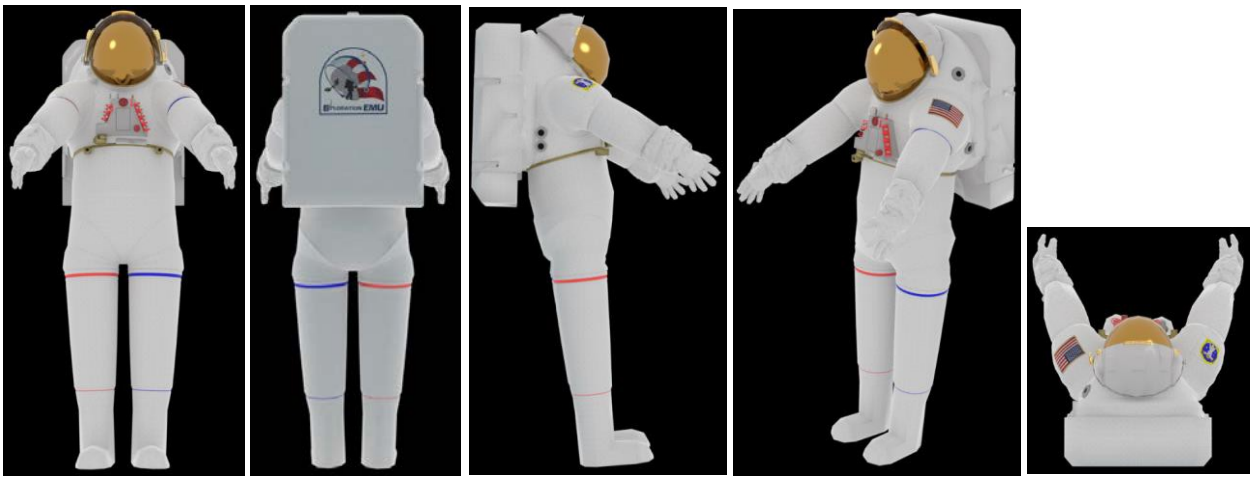


Figure 1. CAD model of the xEMU.

The xEMU is a rear entry suit in which the Portable Life Support System (PLSS) rotates away from the Pressure Garment, thereby allowing the crew member to enter and exit the suit. The rear entry suit is ingressed thru a suit hatch, as shown in Figure 2. The don/doff envelope is dimensioned, also as shown in Figure 2. Note: The images in this figure are not representative of the xEMU suit features; specifically, the green plate indicates a suit port, which is not a requirement for the xEMU suit. Regardless, the approximate dimensions are still applicable, per EVA-EXP-0031, EVA Office Extravehicular Activity (EVA) Airlocks and Alternative Ingress/Egress Methods Document.

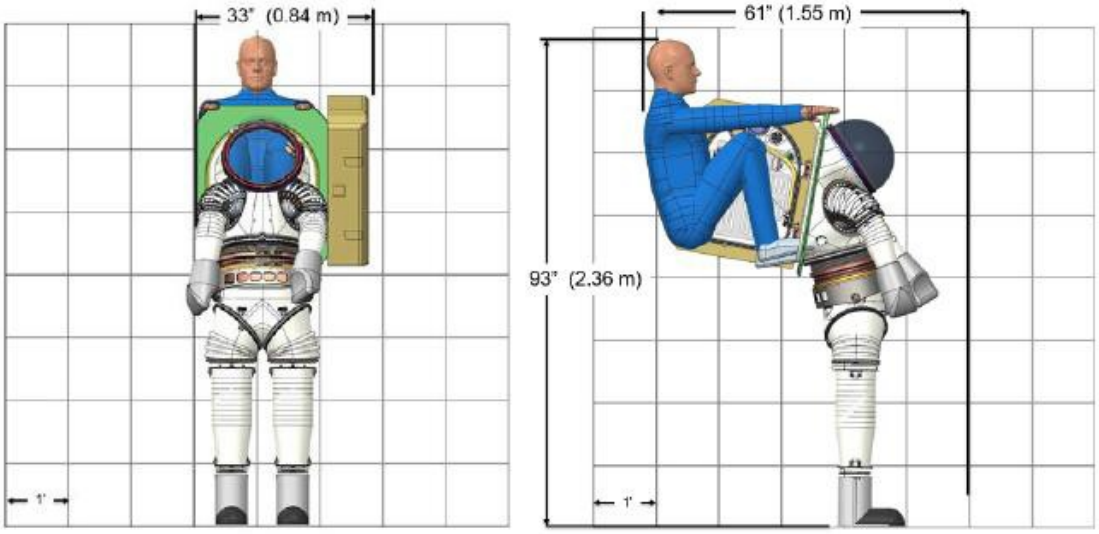


Figure 2. xEMU don/doff volume estimate.

The work envelope for early CAD visualization purposes can be considered equal to the existing EMU requirement. Design and early testing of the xEMU engineering units indicates that it will be able to exceed the EMU work envelopes shown. However, these data are preliminary only, and are not sufficient to update the requirements. Please use the envelopes shown as they are within both EMU and xEMU work envelopes. One- and two-handed work envelopes are illustrated in Figure 3.

Additionally, the approximate distance from the xEMU work envelope to an ISS-style worksite interface used to secure an Articulating Portable Foot Restraint (APFR) is shown in Figure 4. An additional requirements box is able to locate APFR ingress/egress handrails and local restraints to be used while reacting loads during EVA.

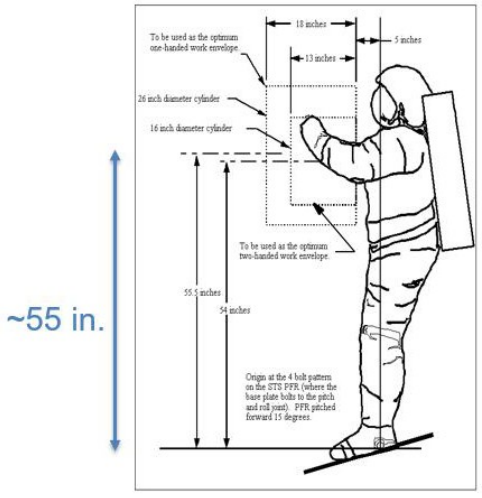


Figure 3. Optimum EVA work envelope.

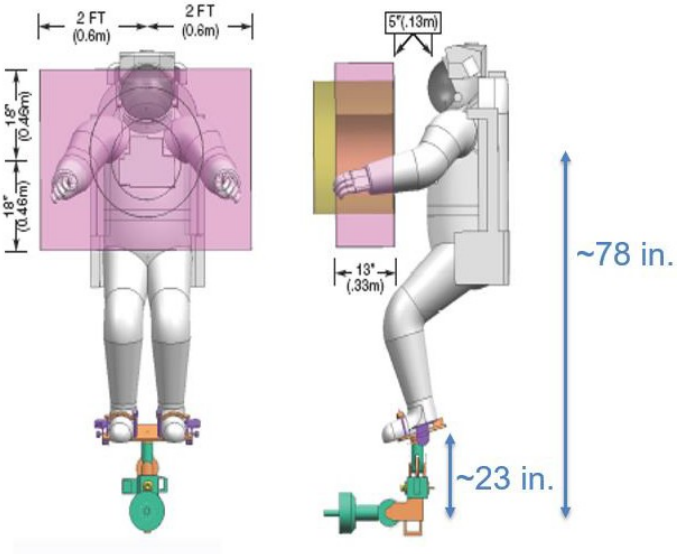


Figure 4. Crew aids for stability, foot restraint ingress, egress, and local force reaction.

The volume required for the suit, either for translation purposes or working volume, is shown in Figure 5. A 43-inch cylinder may be shown around the suit to analyze the amount of room required for 5th%-95th% EVA crew. It is recommended to use the 43-inch diameter work and translation envelope for reference and show the xEMU within it for clarity, per EVA-EXP-0035, EVA Office Exploration EVA System Compatibility.

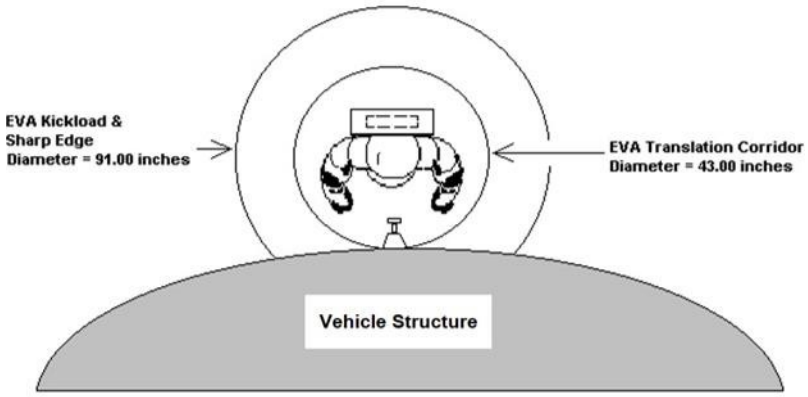


Figure 5. Translation and work volume.

The xEMU model is intended primarily for visualization and reference use. It should not be used to program reach and range parameters, as it is for static use only. It is approximately a 99th% range size. Do not rely on the physical volume of the xEMU CAD model alone because the xEMU is currently in development.

The models are available in two file formats: .fbx or .obj/.mtl files. These were chosen as being the most current and acceptable formats that many CAD applications can read. The .png files provide the texture maps and color data for the model and need to accompany the fbx or obj/mtl files.