SMPTE ENGINEERING GUIDELINE

EG 8-1993
Revision of EG 8-1984

Specifications for Motion-Picture Camera Equipment Used in Space Environment

1 Scope

This guideline specifies the technical and operational requirements for the use of documentary and theatrical motion-picture cameras aboard a space shuttle.

2 Objective

The objective of this guideline is to specify the conceptual design and associated technical specifications for an onboard camera system that will enable NASA to offer motion-picture producers access to the space shuttle. These specifications cover the hardware that would be required for using the space shuttle as a universal camera platform and an earth orbit location for depicting man's presence in space. (Detailed specifications are listed in annex A.3.)

2.1 Concept

Figure 1 provides a generic description of payload integration above the shuttle to familiarize users with a typical scenario of the integration process. New design, redesign, and/or new utilization of payload hardware must take into account requirements of the integration process in the early stages of the project for cost effectiveness and efficiency. The extent and complexity of each integration step will depend largely upon the specific payload and its planned utilization. Requalification of previously flown equipment for reflights is a relatively easy process. Introduction of new equipment and new utilization may involve the full integration process. Sufficient and adequate planning is highly advisable in the initial stages of the project to meet the overall objectives for the payload and make a specific flight of the shuttle, if desirable.

2.2 Basic references

NASA has established a methodological approach for the shuttle documentation system and is providing a Customer Service Center for customer liaison and interface with the STS program. The "document tree" approach to the documentation structure has been implemented to facilitate easy access. (See figure 1.)

3 Basic technical requirements

3.1 Electrical characteristics and specifications

3.1.1 Power

DC or ac power may be made available through the shuttle orbiter (see reference 7 of annex A.3).

DC power –	voltage:	28 V ± 4 V
	power:	TBD watts depending upon location
AC power –	voltage:	115 V ± 5 V rms
	power:	TBD watts
	frequency:	400 Hz ± 7 Hz

3.1.2 Fusing criteria

The payload element is required to provide circuit protection in the form of fuses, resistors, or other current limiting devices on its side of the interface in order to protect payload element/orbiter wiring.

3.1.3 Electromagnetic compatibility (EMC)

The payload shall comply with the radiated and conducted electromagnetic interference requirements of ICD 2-19001, paragraphs 10.7.3, 10.7.3.1, and 10.7.3.2 (see reference 2 of annex A.3). As a design goal, cargo wiring on the payload side of the interface shall meet the requirements of Table 10.7.1-2 (see reference 2 of annex A.3) or utilize equivalent shielding.

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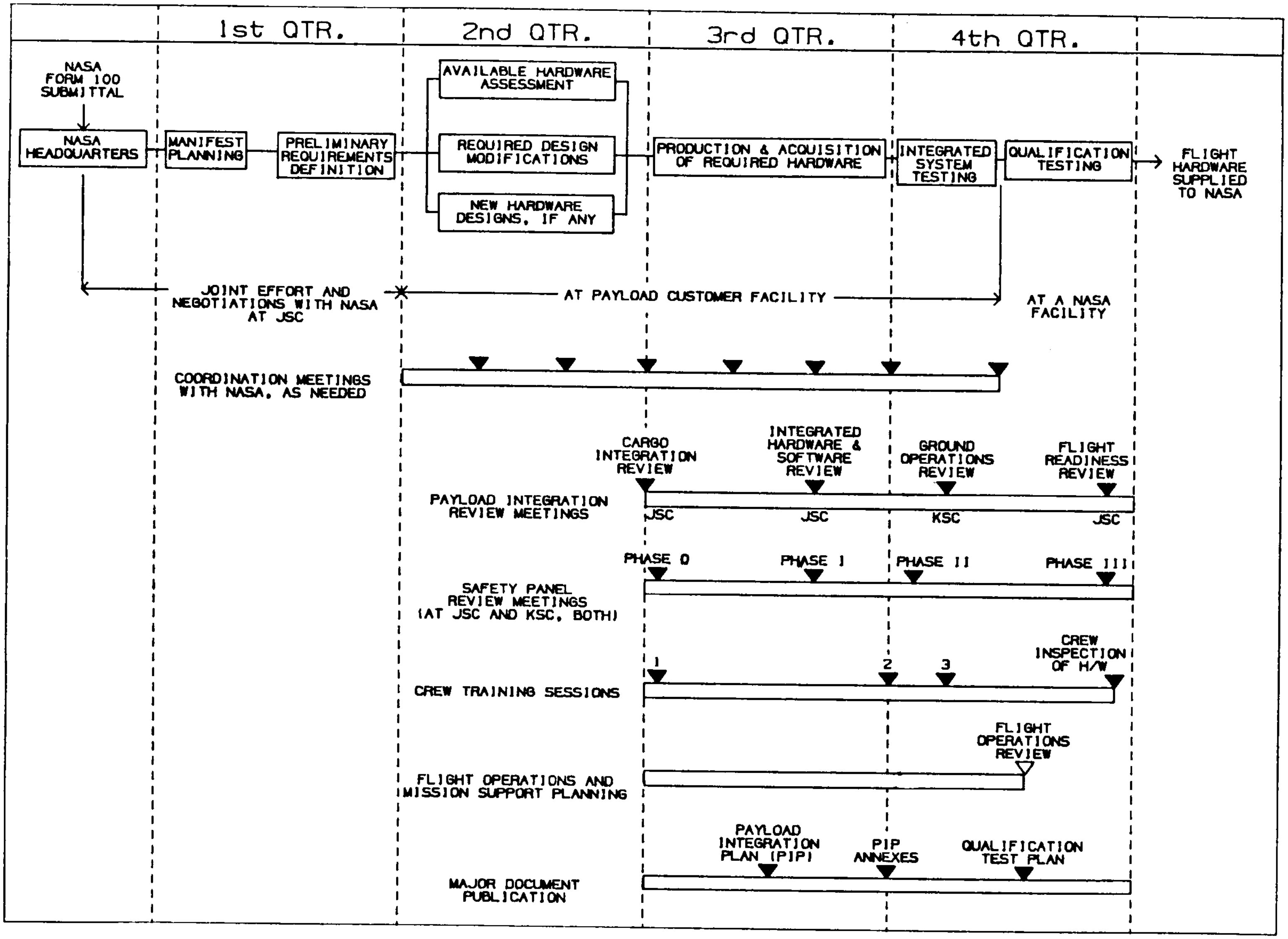

Figure 1 – Payload integration scenario overview — 12-month typical "accelerated" schedule

3.2 Basic mechanical characteristics and specifications

3.2.1 Approved lubricants shall be as shown below:

(a) Crew cabin — JSC-approved (Johnson Space Center) lubricants (see annex A.4);

(b) Payload bay — lubricants meeting MIL L-8937 or L-46010 (see annex A.4).

3.2.2 Finish shall be anodized or painted as per Mil-spec MIL C-83286, unless titanium is used as the structural material.

3.2.3 Controls and adjustments shall be activated with minimal force and shall achieve positive positioning (see annex A.1).

3.2.4 Mounting points shall be provided for locking attachment on three sides of camera housing.

3.2.5 All material used shall meet JSC Spec. SE-R-006B.

3.3 Camera/ location

3.3.1 Cabin location

3.3.2 External location

3.3.2.1 Payload bay gas can

3.3.2.2 Payload bay pallet and brackets

3.3.2.3 EVA location

3.4 Camera operating systems

3.4.1 Manual control

3.4.2 Remote control

3.5 Basic physical characteristics of cameras

3.5.1 External dimensions to permit camera to be placed in storage locker:

	Single locker	Double locker
Height:	9.5 in	20.5 in
Width:	16.8 in	16.8 in
Depth:	19.7 in	19.7 in

These dimensions allow for ½-in clearance all the way around for the isolation/suspension foam.

3.5.2 Magazines or film canisters should be quick-release type.

3.5.3 Self-threading film path is preferred.

3.5.4 Weight not to exceed 150 lbs (68 kg) with full film load.

3.6 Categories of locations and requirements

The categories range from a completely self-contained system that requires activation only at certain times to an elaborate multi-camera operation including directed camera movement from both on-board and remote locations outside the shuttle while in space.

3.6.1 Cabin environment conditions

(a) Temperature: Nominal 65°F–75°F (18°C–24°C);

(b) Relative humidity: Nominal 50%;

(c) Gravity: 0 g;

(d) Acceleration/vibration/shock: Up to 9 g's @ 25 Hz minimum;

(e) Lighting: 10 footcandles average;

(f) Power: 28 V dc;

(g) Mechanical: Mounting points for equipment storage areas below deck;

(h) Weight: 150 lbs maximum (68 kg);

(i) Finish and components: No outgassing.

3.6.1.1 Photographic equipment to be used in this environment is subject to certification by

NASA. (A listing of previously certified cameras used for instruments or documentary purposes can be obtained from the NASA Customer Service Center.)

3.6.2 Payload bay gas can

The Get-Away Special (Gas Can) and self-contained power supply with remote control would not require special NASA certification. This camera would be in a fixed position with the field of view predetermined by the mounting.

3.6.2.1 Gas can environment operating conditions

(a) Temperature: Depending upon the use of insulation and heaters, nominal 50°F–80°F (10°C–27°C);

(b) Relative humidity: Use of dry nitrogen could maintain humidity at less than 10%. Moisture problem on glass surfaces;

(c) Gravity: 0 g;

(d) Acceleration/vibration/shock: Up to 9 g's @ 25 Hz minimum;

(e) Lighting: Ambient — bright sunlight to space black;

(f) Power: Battery or orbiter power;

(g) Mechanical: Mounting points in canister (suspension in solamide foam is advisable);

(h) Weight: 200 lbs maximum (91 kg);

(i) Size: 20" I.D. × 28" height, cylinder (MDA configuration).

3.6.2.2 Photographic equipment

Camera equipment is at the discretion of the user. The equipment must withstand launch and re-entry shock and vibration.

3.6.3 Payload bay (environmental and operational conditions)

3.6.3.1 Structure using existing mounting points

3.6.3.2 Pallet mounting fixed — remote operation

3.6.3.3 Pallet-mounted remote pan and tilt

3.6.3.4 Payload bay environment operating conditions

(a) Temperature: –273°F to 212°F;

(b) Relative humidity: 0% to 100%;

(c) Gravity: 0 g;

(d) Acceleration/vibration/shock: Up to 9 g's @ 25 Hz minimum;

(e) Lighting: Ambient bright sunlight to space black;

(f) Power: 28 VDC;

(g) Mechanical: Mounting points compatibility;

(h) Weight: TBD lbs maximum;

(i) Size: TDB cube;

(j) Finish and components: No outgassing.

The cameras and lenses to be exposed to the space environment shall require protective enclosures, heating and cooling provisions, and special shock and vibration mountings. If the cameras utilize shuttle power, they will be certified by NASA for compliance with RFI/EMI and other electrical specifications. The same requirement will also apply to all remote-control equipment.

3.6.4 Remote manipulator systems (RMS arm)

The mast that is used for moving and placing payloads may be used for photographic purposes. However, this mast has limited travel capability and cannot handle any heavy weight until the shuttle is in orbit.

3.6.5 Free flyer

This type of operation requires the photographic system to be capable of being ejected or placed in space and remotely controlled. The remote control may come from either the shuttle or a ground-based control center. It is also possible to utilize the free flyer as a type of satellite system with complex movements for pan, tilt, and scan. The system may be combined with a television observation system to permit operators to choose their fields of view. Alterations in the orbit of the photographic platform are also possible.

3.6.6 Extravehicular activity (EVA)/extravehicular mobility unit (EMU)

A description of EVA/EMU and their requirements are shown in annexes A.1 and A.2, and refer to Sec. 9.0 of Vol. XIV, Revision H, JSC 07700, Space Shuttle System Payload Accommodations.

Any user who plans on employing the EVA/EMU for photographic purposes must be aware of the constraints and extensive planning required to utilize this option.

The categories that have been described are a method for providing the potential user with a choice of shuttle capabilities. As the user decides on the needs for the photographic coverage, the lead time, cost, and coordination are progressively more complex and expensive. The user shall determine from these categories what equipment is required and plan accordingly.

4 Illumination sources

Illumination, including incandescent, arc, xenon or other gas-filled tube, fluorescent, and reflective, shall meet safety and environmental specifications for photographic equipment.

5 Motion-picture film stock

5.1 Types of film

5.2 Optical filter requirements

5.3 Film storage in space

5.3.1 Unexposed stock

5.3.2 Exposed stock

5.4 Film storage prior to and after mission

6 Basic operational requirements

6.1 Equipment certification

All equipment shall be available for initial certification tests at least 120 days prior to date of scheduled mission. If the equipment has not been certified previously for shuttle use, it shall be initially certified 18 months prior to the mission on which it is planned to be used.

6.2 Storage, handling, and transportation

All equipment shall be in an approved container which is capable of withstanding environmental requirements as per annex A.3. The equipment in its container shall be identified to indicate its type, ownership, mission number, special handling instructions, weight, and volume. Expiration dates for any components, supplies, parts, critical sensors, and material shall be provided.

6.3 Personnel certification

All personnel involved with the equipment who will be interfacing with NASA personnel shall be identified by name and social security number. People requiring access to NASA installations, facilities, and areas shall be certified at least ten days in advance of their first visit.

6.4 Camera documentation equipment

Requests for inclusion on shuttle flights shall be submitted 24 months prior to desired date on NASA Form 100. Reports of operations and projected time-lines shall be submitted 60 days after approval.

6.5 Change requests

Final change requests shall be submitted 180 days prior to mission launch date. No changes will be accepted after that date. A penalty will be imposed on any contractor who cancels his request less than 18 months before a scheduled launch.

7 General responsibility

The organization supplying the equipment and recording material is responsible for its proper performance. NASA personnel will assist the supplier with the installation, checkout, storage, and removal but should a failure occur, the supplier accepts total responsibility. Operation of the equipment by shuttle personnel shall be performed in as professional a manner as possible; however, should there be operational variations from the requested time-lines, the supplier shall accept those variations due to operational problems.

8 Safety guidelines

References 8 and 9 of annex A.3 establish the safety requirements and guidelines applicable to all STS payloads and their GSE.

It is the responsibility of each payload organization to assure the safety of its payload and to implement all the applicable requirements outlined in the above references.

The Safety Panel review meetings (Phase 0, I, II, and III) are being arranged and scheduled with NASA in order to assist the payload organization in identifying potential safety hazards and provide cost-effective methods for their elimination. A typical time plan for scheduling the safety review meetings is shown in figure 1.

Annex A (informative)
Additional data

A.1 Extravehicular activity (EVA)

A.1.1 Shuttle orbiter EVA definition and provisions

The term EVA, as applied to the space shuttle, includes all activities for which crew members don their space suits and life-support systems and then exit the orbiter cabin into a vacuum space environment to perform operations internal to or external to the cargo bay volume.

All EVA equipment and payload interfaces for EVA must be designed to be compatible with shuttle and EVA operations such as those mentioned below.

A.1.2 EVA capabilities

Given adequate restraints, working volume, and compatible man-machine interfaces, the EVA crew members can duplicate almost any task designed for manned operation on the ground.

The following typical EVA tasks demonstrate the range of EVA opportunities available to the payload designer:

(a) Inspection, photography, and possible manual override of vehicle and payload systems, mechanisms, and components;

(b) Installation, removal, or transfer of film cassettes, material samples, protective covers, instrumentation, and launch or entry tie-downs;

(c) Operation of equipment, including tools, cameras, and cleaning devices;

(d) Cleaning of optical surfaces;

(e) Connection, disconnection, and storage of fluid and electrical umbilicals.

These EVA applications can demechanize the operational task and thereby reduce design complexity (automation), simplify testing and quality-assurance programs, lower manufacturing costs, and improve the probability of task success.

A.1.3 EVA guidelines and constraints

The following general EVA guidelines and constraints shall apply to payload EVA design.

EVA operations will be developed using the capabilities, requirements, definitions, and specifications set forth in JSC 10615, Shuttle EVA Description and Design Criteria.

A.1.4 Airlock specifications

The size of the airlock, tunnel adapter, and associated hatches limits the external dimensions of packages that can be transferred to or from payloads to $22 \times 22 \times 50$ in ($559 \times 559 \times 1270$ mm) for unsuited operations and to $18 \times 18 \times 50$ in ($457 \times 457 \times 1270$ mm) for pressure-suit operations. Package sizes exceeding these dimensions shall be evaluated on an individual basis.

A.2 Extravehicular mobility unit (EMU)

The extravehicular mobility unit consists of a self-contained (no umbilicals) life-support system and an anthropomorphic pressure garment with thermal and mircometeoroid protection.

A.3 Reference documents

Integration related

1 Space Shuttle System Payload Accommodations (JSC 07700, Vol. XIV, latest revision)

2 Shuttle Orbiter/Cargo Standard Interfaces (Attachment 1 of JSC 07700, ICD 2-19001)

3 STS Space Shuttle Payload Flight Assignments (published monthly by NASA Headquarters)

4 Orbiter Middeck Payload Provisions Handbook (JSC 16536, Revision C)

5 Shuttle/Payload Standard Integration Plan for Middeck-Type Payloads (JSC 14084)

6 Standard Middeck Interface Control Document (ICD-2-1M001)

7 EVA Description and Design Criteria Document (JSC 10615, Revision A)

Safety related

8 Interpretations of STS Payload Safety Requirements (JSC 18798)

9 Space Transportation System Payload Safety Guidelines Handbook (JSC 11123)

A.4 Typical lubricants

Typical lubricants used in the crew cabin are Brayco 601 and Kryptox 240. Typical lubricants used in the payload bay are Brayco 601 or other dryfilm lubricants.

NOTES

1 The NASA Customer Service Center can be reached at 713/483-2337 (525-2337 on the FTS) or visited at JSC Building 1, Room 765, in Houston, Texas. Annex A.3 of this document provides a summary of the basic references currently available through the JSC Center which covers the applicable material for the integration process of payloads aboard the shuttle.

2 The payload designer is encouraged to purchase and use standard, NASA-specified "universal" or "multi-mission" EVA support hardware, whenever possible, in order to minimize flight-specific EVA training, operational requirements, and cost.