

MWI 8715.6

REVISION A

EFFECTIVE DATE: June 25, 2001

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# **MARSHALL WORK INSTRUCTION**

**QS01**

## **HAZARDOUS OPERATIONS**

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**DOCUMENT HISTORY LOG**

Status (Baseline/ Revision/ Canceled)	Document Revision	Effective Date	Description
Baseline		2/2/00	
Revision	A	6/25/01	Updated paragraph 1 "Purpose" to reference MWI 8715.15. Updated paragraph 2 "Applicability." Alphabetized paragraphs 3 & 4. Added MPG 1840.1 and MWI 8715.4 to paragraph 4, "References." Added definitions to paragraph 5. Changed paragraph-numbering system to be consistent with other 8715 series documentation. Added paragraph 6.1. Updated paragraph 6.2 to better define the process. Added paragraph 6.3. Added paragraph 6.5.1. Added paragraphs 6.5.6 and 6.5.7. Updated paragraph 6.5.8. Added paragraph 9.2 to include hazard analysis as a quality record. Added record disposition to paragraph 9.3. Added paragraphs 9.4, 9.5, and 9.6. Added paragraph 10.3 to provide recommended training. Revised paragraph 12 to provide the proper cancellation. Added Appendix A.

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## **1. PURPOSE**

To establish the safety guidelines for any operation that has been determined to be hazardous in accordance with MWI 8715.15, "MSFC Safety Assessment Program."

## **2. APPLICABILITY**

These safety requirements and instructions apply to all facilities, equipment, jobs, tasks, operations, and processes controlled by Marshall Space Flight Center (MSFC).

## **3. APPLICABLE DOCUMENTS**

3.1 29 CFR 1910, "Occupational Safety and Health Standards"

3.2 29 CFR 1926, "Safety and Health Regulations for Construction"

3.3 MPG 1440.2, "MSFC Records Management Program"

3.4 MPG 1840.2, "MSFC Hazard Communication Program"

3.5 MWI 3410.1, "Personnel Certification Program"

3.6 MWI 8621.1, "Close Call and Mishap Reporting and Investigation Program"

3.7 MWI 8715.8, "Operational Readiness Program"

3.8 MWI 8715.15, "MSFC Safety Assessment Program"

3.9 NASA-STD-8719.7, "Facility System Safety Guidebook"

3.10 National Fire Protection Association (NFPA), NFPA 1, "National Fire Codes"

## **4. REFERENCES**

4.1 MPG 1840.1, "Confined Space Entries"

4.2 MPG 8715.1, "Marshall Safety, Health, and Environmental (SHE) Program"

4.3 MWI 8715.4, "Personal Protective Equipment (PPE)"

4.4 NASA-STD 8719.11, "Safety Standard for Fire Protection"

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4.5 NASA-STD 8719.12, "Safety Standard for Explosives, Propellants and Pyrotechnics"

4.6 NASA-STD 8719.13, "Software Safety Standard"

4.7 NASA-STD 8719.15, "Safety Standard for Oxygen and Oxygen Systems"

4.8 NASA-STD 8719.16, "Safety Standard for Hydrogen and Hydrogen Systems"

4.9 NPG 8715.1, "NASA Safety and Health Handbook Occupational Safety and Health Programs"

4.10 NPG 8715.3, "NASA Safety Manual"

4.11 NSS 8719.9, "Safety Standard for Lifting Devices and Equipment"

## 5. DEFINITIONS

5.1 Baseline Assessment. The initial safety assessment performed for the work area including facilities, equipment, and/or jobs/tasks/operations/processes to identify all potential hazards.

5.2 Facility Risk Indicator (FRI). An indicator used to help determine the level of system safety effort required to meet NASA safety requirements (reference NASA-STD-8719.7).

5.2.1 FRI 1 (HIGH RISK). There is a high probability that the hazards can cause loss of life. Hazards may result in loss of life, permanent disability, or serious occupational illnesses to one or more persons, three or more lost-time injuries, loss of facility operational capability for 1 month or greater, or damage to equipment or property in excess of \$500,000.

5.2.2 FRI 2 (MEDIUM RISK). There is a medium probability that the hazards can cause loss of life. Hazards may result in permanent disability to one or more persons, hospitalization (associated with illness or injury) of three or more persons, up to two lost time injuries, loss of facility operational capability from 2 to 4 weeks, or damage to equipment or property from \$250,000 to \$500,000.

5.2.3 FRI 3 (LOW RISK). There is a low probability that the hazards can cause loss of life. Hazards may result in hospitalization to one or two persons, occupational injury or

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illness resulting in a lost workday or restricted duty case, loss of facility operational capability from 1 day to 2 weeks, or damage to equipment or property from \$25,000 to \$250,000.

5.2.4 FRI 4 (ACCEPTABLE RISK). Loss of life as a result of the hazards is unlikely. Hazards may result in no lost workday injuries or no restricted duty cases, loss of facility operational capability of less than 1 day, or damage to equipment or property less than \$25,000.

5.3 Hazard. A potential condition that can result in or contribute to a mishap (injury, illness, death, or damage to systems, equipment, or facilities).

5.4 Hazard Analysis. A method of identification and evaluation of existing and potential hazards and the recommended mitigation for the hazard sources found.

5.5 Hazardous Operation. Any operation involving material or equipment that has a high potential to result in loss of life, serious injury to personnel, or damage to systems, equipment, or facilities.

Examples are operations that involve explosives, propellants, high pressure, oxidizers, corrosives, high elevations, cryogenics, hostile atmosphere, flammables, high electrical energy, radiation, noise, hyperbaric or hypobaric environment, toxic material, and critical hardware.

5.6 Operating Procedures (OP). A detailed plan listing step-by-step instructions to ensure safe and efficient operations.

5.7 Inventory of Hazardous Operations (IHOP). A listing of all identified hazardous operations on property controlled by MSFC.

5.8 Operational Readiness Inspection Committee (ORIC). An ORIC is established to review new or significantly altered equipment, facilities, or test activities/operations where there is a significant degree of risk of an accident which might cause personal injury or death, or where there is a high risk of serious damage to equipment, test articles, buildings, or adjoining areas. An ORIC may also be established to review high visibility or value projects, facilities, or operations.

5.9 Risk Assessment Classification (RAC). The RAC indicates the risk associated with each individual hazard. It is derived by considering both the severity and probability of a hazard.

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5.9.1 Hazard Severity. An assessment of the worst-case potential injury or system damage if an identified hazard were to result in an accident. Severity categories are listed below.

HAZARD SEVERITY		
Class	Hazard Category	Definition
I	Catastrophic	May cause a permanent disabling or fatal injury to personnel, and/or loss of facilities, major systems, or associated hardware.
II	Critical	May cause severe injury or occupational illness, and/or major damage to facilities, systems, or hardware.
III	Marginal	May cause minor injury or occupational illness, and/or minor damage to facilities, systems, or hardware.
IV	Negligible	May cause first aid injuries or occupational illness, an/or minimal damage to facilities, systems, or equipment.

5.9.2 Hazard Probability. The likelihood that an identified hazard will result in a mishap.

HAZARD PROBABILITY		
Level	Frequency of Occurrence	Definition
A	Frequent	Likely to occur immediately
B	Probable	Probably will occur in time
C	Occasional	May occur in time
D	Unlikely	Unlikely to occur
E	Improbable	Extremely unlikely

#### Risk Assessment Classification

Probability	Hazard Categories			
	I Catastrophic	II Critical	III Marginal	IV Negligible
A-Frequent	1A	2A	3A	4A
B-Probable	1B	2B	3B	4B
C-Occasional	1C	2C	3C	4C
D-Remote	1D	2D	3D	4D
E-Improbable	1E	2E	3E	4E

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	Severity-Probability	Criteria
	1A, 1B, 1C, 2A, 2B, 3A	Unacceptable
	1D, 2C, 2D, 3B, 3C	Undesirable, documented acceptance from Director of responsible organization required
	1E, 2E, 3D, 3E, 4A, 4B	Acceptable with documented approval from responsible department/program/project/facility manager
	4C, 4D, 4E	Acceptable without review

5.10 Safety Review Team (SRT). An SRT is established to review and inspect equipment, facilities, or test activities/operations of a less hazardous nature, to review and inspect facility additions or modifications that result in a change in existing hazard levels, or to ensure that all hazards are identified and either eliminated, controlled, or the risk has been accepted.

5.11 Test/Operational Readiness Review (TRR/ORR). A pre-operation review of all risks associated with a specific hazardous test/operation to ensure test/operational objectives are met without property damage or personnel injury and to determine test/operation system and test article readiness. A TRR/ORR does not take the place of an ORI/SRT but is used in conjunction with these reviews, if they are required.

## **6. INSTRUCTIONS**

### **6.1 Baseline Assessment**

6.1.1 Supervisors shall ensure a baseline assessment is performed for all new or existing/modified equipment, facilities, or operations/processes under their control or jurisdiction and establish an FRI.

6.1.2 The supervisor will use the baseline assessment and the FRI to help determine the level of system safety effort required to meet NASA, OSHA, and national consensus standards throughout the life of the facility, equipment, or operation/process.

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6.1.3 Compliance with this document is required for any facility, equipment, job, task, operation, and process with an FRI 1 or 2.

6.1.4 Supervisors shall ensure that any facility, equipment, job, task, operation or process determined to be an FRI 1, FRI 2, or FRI 3, is listed in the IHOPS data base located on "Inside Marshall."

**NOTE:** No entries into IHOPS is required until IHOPS is fully operational, estimated date is September 2001.

## 6.2 Safety Analysis and Reviews

6.2.1 Responsible organizations and program/project managers assisted by S&MA identify safety requirements for a hazardous operation for each stage of study, design, construction, and test/operation.

6.2.2 Supervisors shall ensure an HA is performed for all hazardous operations with an FRI 1 or 2. The HA is conducted in coordination with the responsible organization or technician, program/project manager, facility user, and S&MA. HAs shall be approved by the responsible manager, in accordance with the Risk Assessment Classification chart section 5.9 and S&MA prior to performing the hazardous operation.

6.2.3 Supervisors shall ensure OPs are developed and utilized during the conduct of hazardous operations. Operating procedures for hazardous operations will be reviewed and approved by the responsible manager and S&MA prior to performance of the operation.

6.2.4 Managers/supervisors, with assistance from S&MA, shall ensure appropriate readiness reviews are performed for hazardous operations. MWI 8715.8, "Operational Readiness Program," provides guidelines to assist in determining the appropriate level of review.

## 6.3 Hazard Analysis

6.3.1 Gather Data. Identify information and data resources pertinent to the system design, configuration, operation, and safety requirements. This activity includes identifying cognizant personnel through whom data and information may be obtained, as well as collecting the actual documentation that details the design, configuration, and operations. Information may be contained in design documents, performance specifications,

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operation documents, engineering drawings, schematics, and presentation materials.

6.3.2 Learn the System. Read and study the data gathered. Ask questions of key technical personnel to aid in understanding the system. In addition, the safety requirements of the system need to be understood.

6.3.3 Define the Scope of the Analysis. Defining the scope of the analysis includes: (a) deciding what needs to be analyzed, (b) determining the level of analysis detail, and (c) ensuring the analysis is focused at a manageable level.

6.3.4 Perform the Analysis. The analysis should be performed utilizing hazard identification guideline listings (e.g., Energy Source Checklist, NASA-STD-8719.7, "Facility System Safety Guidebook," Appendix A) to provide a methodology for recognizing hazards, recommending controls, specifying technical requirements, and good safety design practices. This is the application of the analytical technique to methodically review the system.

6.3.5 Document the Analysis. Items to be documented include (Appendix A provides a sample hazard analysis worksheet):

- a. System/Subsystem: Identify the equipment being analyzed.
- b. Operation: Define the operation being performed when the hazard is identified.
- c. Hazard Number: An assigned designator used to reference each identified hazard.
- d. Hazard Description: Defines the potential hazard associated with a particular hazard category and describes tasks and procedures that may cause hazards or hazardous conditions.
- e. Initial Risk Assessment Classification (RAC): Defines the hazards severity and probability prior to performing mitigation actions to eliminate or control the hazard.
- f. Recommendations/Existing Controls: Identify recommended controls to eliminate the hazard or reduce the hazard severity and probability of occurrence to an acceptable level.
- g. Residual RAC: Indicate the hazard severity and probability after all the recommendations are incorporated.

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h. Resolution: Document the controls that have been implemented to control the hazard severity and probability.

i. Status: Indicates whether the identified hazard is "Open" or "Closed."

j. Revise Analysis: The analysis should be revised as changes occur in the equipment, operation, or environment.

6.3.6 Hazard Reduction. Hazard reduction strategies shall be in the order of precedence listed in Table 1.

TABLE 1

- a. Design to Eliminate Hazards
  - b. Design to Control Hazards
  - c. Provide Safety Devices
  - d. Provide Warning Devices
  - e. Provide Special Procedures or Training
  - f. Hazard Acceptance or System Disposal
- Reference NASA-STD-8719.7, "Facility System Safety Guidebook," Chapter 5.

#### 6.4 Operating Procedure

6.4.1 Operating procedures for hazardous operations will consist of the following:

- a. A cover sheet identifying the operation as hazardous
- b. Activity description
- c. Reference documents
- d. Definitions and acronyms
- e. Responsibilities
- f. Safety section
  - List of potential hazards and controls
  - Pretest requirements (i.e., weather restrictions)
  - Emergency telephone numbers

g. Detailed operating sequences include:

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- Status of switches, valves, etc., before fluid flow or energizing circuit
- Activity sequences
- Secure sequences
- Safety mandatory inspection points

h. Hazardous area access control

i. List of required equipment

j. Provide WARNING, CAUTION, and NOTE statements prior to sequences/steps in which a malfunction or error produces a reaction that causes system degradation or property damage, personnel injury, or death. See below:

**WARNING**

Maintenance or operating procedures, techniques, restrictions, etc., may result in severe personnel injury, loss of life, or major equipment damage if not followed exactly.

**CAUTION**

Maintenance or operating procedures, techniques, restrictions, etc., may result in some damage to equipment or system or minor injuries to personnel if not followed exactly.

**NOTE**

Maintenance or operating procedures, techniques, restrictions, etc., require emphasis for safe operation.

k. Emergency procedures for securing facility and operation when an anomaly occurs (i.e., equipment failure, personal injuries, and fire/explosion).

l. Schematics, drawings, setup diagrams, etc., as necessary for clarity.

m. Signature sheet. As a minimum, the signature sheet shall include the name and title of the person submitting the procedure and date signed, and the approval names and date signed of persons responsible for the test and appropriate functional areas (as determined by the program/project manager) and S&MA.

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## 6.5 Operations

6.5.1 The responsible organization will maintain configuration control for hazardous facilities, equipment, operations, and processes.

6.5.2 For each hazardous operation, a group leader, team leader, technician, or other responsible authority will be in charge of the operation.

6.5.3 Where the risk of injury is high, personnel shall use the buddy system whereby a person not directly exposed to the hazard serves as an observer to render assistance. When in doubt about when the buddy system is appropriate, the responsible authority should contact S&MA for assistance.

6.5.4 Material Safety Data Sheets (MSDS) are provided for hazardous materials in accordance with MPG 1840.2, "MSFC Hazard Communication Program." For a listing of MSFC MSDS and other MSDS links, see [http://eemo.msfc.nasa.gov/environmental/haz\\_mat/](http://eemo.msfc.nasa.gov/environmental/haz_mat/).

6.5.5 Personnel performing a hazardous operation are trained and certified for the job or task in accordance with MWI 3410.1, "Personnel Certification Program."

6.5.6 Supervisors will ensure that adequate personnel access controls are in place to prevent unauthorized personnel from entering hazardous areas.

6.5.7 Personnel requiring entry into a hazardous area will coordinate with the responsible organization to request permission to enter the area prior to entry.

6.5.8 Dry runs are conducted for highly critical or extremely hazardous operations if determined to be necessary by responsible management or S&MA.

6.5.9 Preoperation briefings are conducted by responsible authority before the start of a hazardous operation.

6.5.10 Personnel injury or equipment damage will be reported in accordance with MWI 8621.1, "Mishap/Incident Reporting and Investigation."

## 7. NOTES

None

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**8. SAFETY PRECAUTIONS AND WARNING NOTES**

None

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## **9. RECORDS**

9.1 Operating procedures for hazardous operations will be maintained by the responsible organization or program/project manager. This record will be maintained for the life of the facility/operation, then destroyed or maintained for historical purposes.

9.2 HAs will be maintained by the responsible organization or program/project manager for the life of the facility/operation then destroyed or maintained for historical purposes.

9.3 Configuration control for hazardous facilities will be maintained by the responsible organization for the facility. This record will be maintained for the life of the facility then destroyed or maintained for historical purposes.

9.4 Record of any recommended supervisor or employee safety training. This record will be maintained by the Employee & Organizational Development Department for the employees' length of employment, then destroyed or maintained for historical purposes.

9.5 Personnel certification records will be maintained in accordance with MWI 3410.1, "Personnel Certification Program."

9.6 Documented approvals of risk will be maintained by the responsible organization for the life of the facility, then destroyed or maintained for historical purposes.

## **10. PERSONNEL TRAINING AND CERTIFICATION**

10.1 Training shall be conducted in accordance with MWI 3410.1, "Personnel Certification Program."

10.2 Training shall include supervisor approved on-the-job training with experienced personnel.

10.3 Recommended training for supervisors and employees:

10.3.1 NSTC 020, "Basic System Safety Practice," or equivalent course for finding hazards and for assessing their safety risk.

10.3.2 NSTC 021, "Advanced System Safety Practice," or equivalent course aimed at ensuring safety operating risks.

10.3.3 NSTC 005, "Managers Safety," or equivalent course that provides and introduction into workplace safety requirements.

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10.3.4 NSTC 828, "Hazard and Operability Analysis (HAZOP) Methodology," or equivalent course that provide and understanding of the Hazard and Operability (HAZOP) method of safety analysis.

10.3.5 NSTC 048, "System Safety for Managers," or equivalent course that discusses typical analytical techniques.

10.3.6 NSTC 002, "System Safety Fundamentals," or equivalent course that teaches the fundamentals of system safety management and hazard analysis of hardware and operations.

10.3.7 NSTC 008, "System Safety Workshop," or equivalent course that teaches hazard recognition and analysis for hardware and operations.

## 11. FLOW DIAGRAM

None

## 12. CANCELLATION

MWI 8715.6 dated February 2, 2000

Original Signed by  
Sidney P. Saucier for

A. G. Stephenson  
Director

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**APPENDIX A  
SAMPLE HAZARD ANALYSIS WORKSHEET**

<b>TITLE</b>		<b>Date:</b>	
		<b>Control #:</b>	
<b>System/Subsystem:</b>		<b>Operation(s):</b>	
		<b>Analyst(s):</b>	
<b>Hazard #:</b>	<b>Priority:</b>	<b>Initial RAC:</b>	<b>Key Words:</b>
<b>Hazard Description:</b>			
.			
<b>Recommendations / Existing Controls:</b>			
<b>RAC After Recommendations:</b>			
<b>Resolution:</b>			<b>Status:</b>
.			
<b>Residual RAC:</b>	<b>Status:</b>	<b>Responsible Organization:</b>	