Chapter 2.3 Hazard Analysis

2.3.1 Applicability of this chapter

2.3.1.1 You are required to follow this chapter if you:

a. Do job hazard analyses or hazard analyses.

b. Are a project manager, Contracting Officer, JSC’s Center Director, or the Director, Safety and Mission Assurance. Paragraph 2.3.18 lists your responsibilities.

2.3.2 Description of Sub-element 2.3

JSC shall routinely examine and analyze safety and health hazards associated with individual jobs, processes, or project phases and include results in training and hazard control programs described in Chapter 3.2. This may include job hazard analysis, hardware or facility hazard analysis, or process hazard review. A list of various hazard analysis techniques with advantages and disadvantages of each type is available at URL: https://jsc-smamissp.jsc.nasa.gov/sites/safety/Hazards/Home.aspx.

2.3.3 What this chapter covers

This chapter provides requirements for doing job hazard analyses and other hazard analyses and for managing risk for ground-based jobs and systems. See Multi Purpose Crew Vehicle, Commercial Crew Program, or Space Station requirements for more information on space systems hazard analysis. For information on system safety, system safety plans, and safety reviews, see NPR 8715.3, chapter 2.

NOTE: Hazard analysis may include the required environmental impact assessment to make sure all environmental aspects have been considered and the impacts are controlled. The assessment is required by JSC’s Environmental Management System to assess JSC’s activities, products, or services that have effects on the environment – both positive and negative. It shall follow JPR 8553.1, “JSC Environmental Management System Manual.”

2.3.4 Job hazard analysis (JHA)

a. You shall do a JHA for any job you believe to be hazardous. In this chapter, “job” means a task that someone does, not his or her position or job title.

b. The JHA shall follow OSHA pamphlet 3071, Job Hazard Analysis. You can find the current version of the pamphlet at https://www.osha.gov/Publications/osha3071.pdf. Acceptable formats include:

1) The JHA Form at URL: https://jsc-smamissp.jsc.nasa.gov/sites/safety/SH%20%20Hazards/Recommended_JHA_Form.docx.


3) An alternative format meeting the intent of the JHA with the concurrence of Safety and Test Operations Division (NS)
c. Before each hazardous operation, you shall assess any unique hazards and controls, affirm the appropriateness of the work-authorizing document, and ensure hazard controls identified in the JHA are incorporated. If the existing work-authorizing document is insufficient to adequately control the hazards, you shall:

1. Assess the hazards and update the JHA using any appropriate risk assessment tool.
2. Include any necessary controls in the work effort. The JHA will be available to all affected personnel.
3. Return a copy of the completed assessment to the work authorizing document’s originator to determine whether the document should be updated.

d. You shall review your JHA yearly or when the job changes, and update it as needed.

### 2.3.5 When a hazard analysis is required

2.3.5.1 A hazard analysis is an organized method for identifying and documenting hazards personnel, other systems, equipment, facilities, and the environment and hazard controls in a system at any point in its life cycle. Hazard analysis training is available in SATERN. Hazard analysis activities and environmental impact assessments shall begin in the early design phases for any of the following systems and operations:

a. Aircraft systems.

b. New facilities, modifications to facilities that affect previously approved hazard controls or introduce new hazards, and hazardous facility systems, such as test or oxygen systems.

c. Hazardous operations, such as:
   1. Explosives
   2. Extreme temperatures
   3. Lasers
   4. Cryogenic materials
   5. Reduced pressure chambers
   6. Lifting devices
   7. Radiation

d. Support equipment such as test, maintenance, or training equipment.

e. Software for any of the above systems.

f. Prototypes of any of the above systems.

g. Other systems or operations when required by other chapters of this Handbook.

h. Operations and support activities, such as:
   1. Constructing facilities and making hardware
   2. Experimenting on and testing systems
   3. Storing, packing, or transporting systems
   4. Checking out and using systems
(5) Maintaining or modifying systems
(6) Retrieving, disassembling, or disposing of systems
(7) Hazardous testing and human research
   i. Others as determined by the Safety and Test Operations Division or the Space and
      Occupational Medicine Branch and in consultation with the affected organization if additional
      hazard analysis is required.

2.3.6 What hazard analyses contain

2.3.6.1 Hazard analysis shall contain at least the following information:
   a. The system’s name and location.
   b. The hazards of the system and their causes. This include hazards from human factors,
      interfaces between systems, and interfaces between the equipment and the facility.
   c. The consequence of each hazard if it were to cause a mishap. For example, death, major
      injury, minor injury, or estimated property damage and dollar amount, or delay or loss of
      mission or objective.
   d. Any existing engineering or administrative controls for each hazard.
   e. Proposed engineering or administrative controls for each hazard, if the existing controls are
      inadequate.
   f. Verification methods for each control to explain how the presence of each control will be
      confirmed. This shall also include a traceable reference to the specific document(s) where
      completion of the verification will be recorded. (Examples include test procedure, facility
      checklist, operator certification documentation, document or drawing number). Completion of
      each verification shall be independently documented outside of the hazard analysis.
   g. What would happen if the engineering or administrative controls were to fail.
   h. A qualitative evaluation of the possible safety and health effects before and after the controls
      are in place.
   i. Who was on the team that did the hazard analysis?
   j. When was the last time the system was analyzed?
   k. A qualitative evaluation of the risk before and after the hazard controls are in place. This is the
      risk management will determine whether to accept.
   l. Documented risk acceptance by the appropriate level of management per paragraph 2.3.9.

Note: You can find a hazard analysis example in a preferred format at URL: https://jsc-sma-
missp.jsc.nasa.gov/sites/safety/Hazards/Home.aspx.

2.3.7 Required review and concurrence of a hazard analysis

2.3.7.1 The following shall review and concur via signature each hazard analysis, where
appropriate:
   a. Hazard Analysis author(s).
b. Facility Manager or Test Director.
c. Branch or Division Chief, depending on accepted risk, or designee (see paragraph 2.3.10 in this chapter for required approval authority).
d. Safety and Test Operations Division representative.
e. Medical Office representative for the Institutional Review Board to approve human testing or research.
f. Other technical expertise identified by any of the above approvers, such as Occupational Health or Environmental, depending on the nature of the hazard (for example, asbestos, radiation, explosive, hazardous materials, or other health issues).

2.3.8 Assessing risk

2.3.8.1 You shall use the risk assessment code (RAC) matrix below to assess the risk of each hazard. To use this matrix:

a. Find the “consequence” or the worst-case outcome of a mishap from the hazard along the left side of the matrix. The possible consequences are:
   (1) Class I – Catastrophic. A condition that may cause death or permanently disabling injury, facility destruction on the ground.
   (2) Class II – Critical. A condition that may cause severe injury or occupational illness, or major property damage to facilities, systems, equipment, or flight hardware.
   (3) Class III – Moderate. A condition that may cause minor injury or occupational illness, or minor property damage to facilities, systems, equipment, or flight hardware.
   (4) Class IV – Negligible. A condition that could cause the need for minor first-aid treatment but would not adversely affect personal safety or health; damage to facilities, equipment, or flight hardware more than normal wear and tear level.

b. Find the “likelihood” you expect the consequence to occur across the top of the matrix. The possible likelihood estimates are:
   (1) Likelihood A. Likely to occur.
   (2) Likelihood B. Probably will occur.
   (3) Likelihood C. May occur.
   (4) Likelihood D. Unlikely to occur.
   (5) Likelihood E. Improbable.

c. Find the RAC in the box where the “consequence” and “likelihood” cross.

<table>
<thead>
<tr>
<th>CONSEQUENCE CLASS</th>
<th>LIKELIHOOD ESTIMATE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>I</td>
<td>1</td>
</tr>
<tr>
<td>II</td>
<td>1</td>
</tr>
<tr>
<td>III</td>
<td>2</td>
</tr>
<tr>
<td>IV</td>
<td>3</td>
</tr>
</tbody>
</table>
Note: You can find a conversion matrix for the risk scorecard used in the JSC Risk Management Plan, JPR 8000.4A, and how it converts into the above matrix at URL: https://jsc-sma-missp.jsc.nasa.gov/sites/safety/Hazards/Home.aspx.

### 2.3.9 What each RAC means

The table below tells you what action to take for each RAC. For systems in design, you shall eliminate or control the hazard before the system goes into operation. For existing systems, investigate and abate the hazard as described in Chapters 3.2 and 3.5.

<table>
<thead>
<tr>
<th>If the RAC is . . .</th>
<th>Then the risk is . . .</th>
</tr>
</thead>
</table>
| 1                 | Unacceptable – All operations shall cease immediately until the hazard is corrected, or until temporary controls are in place and permanent controls are in work.  
A safety or health professional shall stay at the scene at least until temporary controls are in place.  
RAC 1 hazards have the highest priority for hazard controls.  
Center Director is authorized to accept the risk with adequate justification in rare cases where critical tests must be done and the risk cannot be reduced. |
| 2                 | Undesirable – All operations shall cease immediately until the hazard is corrected or until temporary controls are in place and permanent controls are in work.  
RAC 2 hazards are next in priority after RAC 1 hazards for control.  
Program Manager (directorate level), Organizational Director, or equivalent management is authorized to accept the risk with adequate justification. |
| 3                 | Acceptable with controls – Division Chief or equivalent management is authorized to accept the risk with adequate justification. |
| 4–7               | Acceptable with controls – Branch Chief or equivalent management is authorized to accept the risk with adequate justification. |

*Never accept the risk of violating JSC, NASA, local, state, or federal requirements. If you think you can’t follow any NASA or JSC requirement, request relief from the requirement as described in Chapter 1.3, “Written Safety and Health Program.”

### 2.3.10 Controlling hazards

2.3.10.1 You shall use these steps to decide what corrective action to take for any hazard found during your analysis. Take the following actions in the order below to control a hazard. Go to the next step only if the present step or previous steps aren’t feasible or are too costly:

a. Change the design to eliminate or reduce the hazard. For example, use a less hazardous material or lower voltage if you can.

b. Install safety devices or guards. For example, use safety interlocks, machine guards, or relief valves if you can.
c. Install caution and warning devices. For example, use oxygen monitors or alarms if you can.

d. Use administrative controls, such as special work procedures, training, administrative barriers, and signs.

e. Use personal protective equipment.

f. Document risk acceptance and make sure employees at risk are informed of the risk acceptance.

g. Make sure all hazards are controlled. Track each hazard and keep it “open” until one of the above actions has occurred and reduced the post-control RAC to an acceptable level.

### 2.3.11 Maintaining a hazard analysis or job hazard analysis

2.3.11.1 You shall:

a. Keep the analysis and review it at least every 5 years while the project is active or before making any changes to the hardware, software, or operation. This will allow you to see how valid your analysis was after you have had some experience with the system. Include the findings of the hazard analysis in the operational procedures to ensure personnel performing the procedures are aware of the hazards and take appropriate actions.

b. Review job hazard analyses every year or when the job changes.

c. Review hazard analyses submitted to the Committee for the Protection of Human Subjects for human research each year.

### 2.3.12 Changes to the job, system, or operation

2.3.15.1 If you intend to change your job, system, or operation, including changes to process or chemicals used in a process, you shall:

a. Hold a safety review, update the existing hazard analysis, or do a new hazard analysis to make sure the change doesn’t create a hazard.

b. Analyze any change proposed to correct a hazard to see whether it will effectively control the hazard.

c. Include in the hazard analysis a listing of chemicals used in the process. Update the hazard analysis whenever maximum expected quantities increase or the process changes.
2.3.13 Other requirements for hazard analyses and job hazard analyses

In addition to this chapter, you shall follow the requirements in these documents.

<table>
<thead>
<tr>
<th>For . . .</th>
<th>Follow this standard . . .</th>
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</table>
| Job hazard and hazard analyses on JSC ground-based systems | NPR 8715.3, Chapter 2
| | NASA STD 8719.7, “Facility System Safety Guidebook” |
| Failure tolerance requirements for safety-critical functions | Paragraph 1.7 of NPR 8715.3 |
| Product safety | 29 CFR 1960.34(b) & paragraph 2.5 of NPR 8715.1 |
| Ground-based chemical processes | 29 CFR 1910.119 |
| Environmental impact assessments of new or different activities, products, or services | JPR 8553.1, “JSC Environmental Management System Manual” |

2.3.14 For more information on job hazard and hazard analyses


e. JSC 17773, “Preparing Hazard Analyses for JSC Ground Operations,” current version

2.3.15 Responsibilities for hazard analysis

a. The Center Director has the final authority for all system safety products and risk management decisions for systems and facilities at JSC and JSC field sites. He or she is responsible for appointing a senior manager at JSC and each field site to serve as the site manager for risk management decisions involving JSC personnel, property, and operations.

b. A project manager for any new or modified system, facility, or operation at JSC or a JSC field site is responsible for:

   (1) Reporting hazards that could result in death, major injury, or major property damage to anyone or anything outside the project, and other hazards, as required, to higher management.

   (2) Fulfilling the responsibilities in paragraphs 1.5, 2.5, 2.6, 2.7, and 2.8 of NPR 8715.3.

c. The Director, Safety and Mission Assurance Directorate, is responsible for providing personnel to:
(1) Provide guidance to JSC organizations on system safety programs, job hazards, and hazard analyses.

(2) Review analyses.

(3) Make sure system safety products are complete and accurate and management is properly accepting risk and documenting its decisions.

(4) Support project and safety reviews to make sure hazards are being identified and addressed.

(5) Fulfill the responsibilities in paragraphs 2.5, 2.6, 2.7, and 2.8 of NPR 8715.3.

d. The Space and Occupational Medicine Branch is responsible for helping JSC organizations conduct job hazard or hazard analyses for potential occupational health hazards in the workplace.

2.3.16 Safety and health records and documentation for hazard analysis

a. Organizational-level documentation:

   (1) Line managers and employees shall keep current copies of job hazard analyses.

   (2) Ground programs shall keep copies of hazard analyses.

b. Center-level records – Records on environmental impact assessments are maintained in the Environmental Management System Control plan as described in JPR 8553.1, “JSC Environmental Management System Manual.”

NOTE: See Appendix F, Attachment 1.1A for details on records and documentation required by this Chapter.