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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:

- Do job hazard analyses or hazard analyses.
- 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 Hazard analysis at JSC

- JSC shall:
 - Routinely examine and analyze safety and health hazards associated with individual jobs and ground-based processes, hardware, facilities, or project phases,
 - Develop hazard controls
 - Include results in hardware designs, training, and hazard control programs described in Chapter 3.2.
- Hazard analysis may involve one or more techniques as appropriate to the project. A list of various [hazard analysis](#) techniques with advantages and disadvantages of each type is available at URL: <https://smasp.jsc.nasa.gov/ns/ns1/Hazards/Home.aspx>.

2.3.3 What this chapter covers

This chapter provides requirements for job hazard analyses and other hazard analyses and for managing risk for ground-based jobs and systems. For more information on space systems hazard analysis refer to specific space flight program requirements. For information on system safety programs, 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)

2.3.4.1 For JHAs in general:

- Employees and supervisors shall do a JHA for all jobs at JSC. In this chapter, "job" means a task someone does, not his or her position or job title.
- 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/osh3071.pdf>. Acceptable formats include:
 - The [JHA Form](#) at URL:
https://smasp.jsc.nasa.gov/ns/ns1/SH%20%20Hazards/Recommended_JHA_Form.docx.
 - A [Safe Plan of Action](#) (SPA) at URL:
https://smasp.jsc.nasa.gov/ns/ns1/SH%20%20Hazards/Safe_Plan_Of_Action_Forms.docx.

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(3) An alternative format meeting the intent of the JHA with the concurrence of Safety and Test Operations Division.

- c. Employees and supervisors shall review JHAs yearly or when the job changes, and update it as needed.

NOTE: A [JHA](#) for office workers is available at URL:

<https://smasp.jsc.nasa.gov/ns/ns1/SH%20%20Hazards/OfficeJHA.pdf>.

2.3.4.2 For JHAs related to hazardous operations:

- a. Before doing any hazardous operations, employees and supervisors shall:

- (1) Assess any unique hazards and controls
- (2) Affirm the appropriateness of the work-authorizing document, to ensure hazard controls identified in the JHA are incorporated.

- b. If the existing work-authorizing document is insufficient to adequately control the hazards, employees and supervisors shall:

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

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 to personnel, other systems, equipment, facilities, and the environment and corresponding hazard controls at any point in a system's 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, operations, or situations:

- a. Aircraft systems.
- b. New facilities, modifications to facilities affecting previously approved hazard controls or introducing 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.

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- 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 JPR.
- 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. As determined by the Safety and Test Operations Division or the Space and Occupational Health and in consultation with the affected organization.

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. A listing of chemicals used in the process, if applicable.
- d. 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.
- e. Any existing engineering or administrative controls for each hazard.
- f. Proposed engineering or administrative controls for each hazard, if the existing controls are inadequate.
- g. 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.
- h. What would happen if the engineering or administrative controls were to fail.
- i. A qualitative evaluation of the possible safety and health effects before and after the controls are in place.
- j. Who was on the team that did the hazard analysis?
- k. When was the last time the system was analyzed?

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l. 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.

m. Documented risk acceptance by the appropriate level of management per paragraph 2.3.9.

NOTE: You can find a [hazard analysis example](https://smasp.jsc.nasa.gov/ns/ns1/Hazards/Home.aspx) in a preferred format at URL:
<https://smasp.jsc.nasa.gov/ns/ns1/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, or higher management, depending on risk to be accepted (see paragraph 2.3.9 in this chapter for required authority for risk acceptance).
- 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 Risk assessment 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.

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(5) Likelihood E. Improbable.

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

LIKELIHOOD ESTIMATE

CONSEQUENCE CLASS	A	B	C	D	E
I	1	1	2	3	4
II	1	2	3	4	5
III	2	3	4	5	6
IV	3	4	5	6	7

2.3.9 What each RAC means

The table below describes 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.

<i>If the RAC is . . .</i>	<i>Then the risk is . . .</i>
1	<p>Unacceptable – All operations shall cease immediately until the hazard is corrected, or until temporary controls are in place and permanent controls are in work.</p> <p>A safety or health professional shall stay at the scene at least until temporary controls are in place.</p> <p>RAC 1 hazards have the highest priority for hazard controls.</p> <p>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.</p>
2	<p>Undesirable – All operations shall cease immediately until the hazard is corrected or until temporary controls are in place and permanent controls are in work.</p> <p>RAC 2 hazards are next in priority after RAC 1 hazards for control.</p> <p>Program Manager (director level), Organizational Director, or equivalent management is authorized to accept the risk with adequate justification.</p>
3	<p>Acceptable with controls – Division Chief or equivalent management is authorized to accept the risk with adequate justification.</p>
4–7	<p>Acceptable with controls – Branch Chief or equivalent management is authorized to accept the risk with adequate justification.</p>

*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.”

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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:

- Change the design to eliminate or reduce the hazard. For example, use a less hazardous material or lower voltage if possible.
- Install safety devices or guards. For example, use safety interlocks, machine guards, or relief valves if possible.
- Install caution and warning devices. For example, use oxygen monitors or alarms if possible.
- Use administrative controls, such as special work procedures, training, administrative barriers, and signs.
- Use personal protective equipment.
- Document risk acceptance and make sure employees at risk are informed of the risk acceptance.
- 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

2.3.11.1 Employees and managers with hazard analyses shall:

- Include the findings of the hazard analysis in the operational procedures to ensure personnel performing the procedures are aware of the hazards, controls, and appropriate actions to take.
- Keep the analysis and review it at least every 5 years while the system, operation, or facility is active or before making any changes to the hardware, software, or operation. This will allow you to see how valid the analysis was after you have had some experience with the system.
- Review hazard analyses for human research submitted to the Institutional Review Board each year.

2.3.12 Changes to the job, system, or operation

2.3.15.1 If you intend to change a job, system, process, quantity of hazardous chemicals, or operation, you shall:

- Hold a safety review, update the existing hazard analysis, or do a new hazard analysis to make sure the change doesn't create new hazards.
- Analyze any change proposed to correct a hazard to see whether it will effectively control the hazard.

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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.

<i>For . . .</i>	<i>Follow this standard . . .</i>
Job hazard and hazard analyses on JSC ground-based systems	NPR 8715.3, Chapter 2 NASA STD 8719.7, "Facility System Safety Guidebook"
Software safety	NASA STD-8719.13, "NASA Software Safety Standard"
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

- Chapter 2 and Appendix F of NPR 8715.3, "NASA General Safety Program Requirements," current version.
- Langley Research Center Handbook 1740.4, "Facility System Safety Analysis and Configuration Management," current version.
- NPR 8820.2, "Facility Project Requirements," current version.
- MIL-STD-882, "System Safety Program Requirements," current version.

2.3.15 Responsibilities for hazard analyses

- 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.
- 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 to higher management that could result in death, major injury, or major property damage to anyone or anything .
 - (2) Fulfilling the responsibilities in paragraphs 1.5, 2.5, 2.6, 2.7, and 2.8 of NPR 8715.3.
- 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.

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- (3) Make sure hazard analyses 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. *Occupational Health* 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.