Comparative Evaluation of Hazard Analysis Requirements

PRELIMINARY DRAFT

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Comparative Evaluation of Hazard Analysis Requirements

OVERVIEW

DOE contractors implement multiple hazard analysis activities in accordance with various DOE orders, rules and federal regulations. Many of these requirements share the same basic intent: identify and analyze potential dangers to employees, the public and environment so that effective controls can be established to minimize or prevent adverse impacts.

This similarity raises the question of whether hazard analysis activities can be integrated, thus streamlining the process and saving Departmental resources. There are also other advantages to integration. Conducting hazard analysis activities independently at a given site can lead to inconsistencies or errors among hazard assumptions. Integration of personnel and resources improves teamwork and communication among safety disciplines involved.

Consequently, the body of current hazards analysis requirements were identified and reviewed to support an objective evaluation of the opportunities of integrating hazard analysis activities. The results of this review are presented in this paper, as well as the attached supplemental materials.

COMPARISON OF HAZARD ANALYSIS REQUIREMENTS

Requirements were identified that provide a "direct" reference to hazard identification, hazard analysis, hazard assessment, accident analysis, risk analysis or risk assessment. The following sources became the primary focus of the review:

- 10 CFR 830, "Nuclear Safety Management"
- 10 CFR 835, "Occupational Radiation Protection"
- 10 CFR 850, "Chronic Beryllium Disease Prevention Program"
- 10 CFR 1021, "National Environmental Policy Act Implementing Procedures"
- 29 CFR 1910.119, "Process Safety Management"
- 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response"
- 40 CFR 68, "Chemical Accident Prevention Provisions"
- 40 CFR Parts 1500-1508, "Chapter V-Council on Environmental Quality"
- DOE O 151.1, "Comprehensive Emergency Management System"
- DOE 420.1, "Facility Safety"
- DOE O 440.1A, "Worker Protection Management"
- Various other OSHA regulations

A summary comparison of hazard analysis characteristics associated with these requirement sources is shown in Attachment 1. A detailed listing of actual requirements is presented in Attachment 2.

Facility-Oriented Hazard Analysis

As seen in Attachment 1, several directives involve evaluation of consequences associated with potential releases of hazardous or radiological materials from a facility. This "facility-level" emphasis is found in the following sources:

- Nuclear facility safety analysis (10 CFR 830)
- Chemical Process Hazard Analysis (29 CFR 1910.119, and 40 CFR 68)
- Emergency Preparedness Hazard Assessment (DOE O 151.1A), and
- Environmental Impact Statements (NEPA)

There are several common features found in this group. Most obvious are the similarities between chemical process hazard analysis (PrHA) required by OSHA and EPA and nuclear facility safety analysis required in 10 CFR 830. Both activities require identification of hazardous material or radionuclide inventories; implementation of formal hazard analysis techniques that are commensurate with facility complexity; identification of systems and equipment vital to safety; formal documentation of findings; and periodic updates of hazard analysis information. **Because of these overlaps, it is reasonable to conduct one integrated analysis for nuclear and chemical process operations.** In fact, this practice is discussed and encouraged in the following DOE standards: DOE-STD-1027-92, DOE-STD-3009-94, EM-STD-5502, DOE-STD 1120-98, and DOE-HDBK-1100-96.

Similarly, an Emergency Preparedness Hazard Assessment (EPHA) requires that a hazard assessment and accident analysis be conducted for facilities exceeding certain chemical or radiological hazard thresholds. DOE G 151.1-1 acknowledges the similarity between EPHA and nuclear safety analysis. **In many cases the safety analysis, or PrHA for non-nuclear hazardous facilities, can be used to satisfy the needs of the EPHA**. At a minimum, hazard assumptions of the safety analysis or PrHA should be used as the basis for further accident evaluation needed to determine emergency management needs and establish emergency planning zones.

Environmental Impact Statements (EIS), required by NEPA for certain classes of activities, has considerable overlap with hazard and accident analysis information found in nuclear facility safety analysis, as well as chemical PrHAs. Common features include hazard assumptions such as source term estimates, accident initiators, and release scenarios. However, an EIS is somewhat different in the methods and targets chosen to evaluate potential consequences. For example, an EIS has a broad focus on impacts to the "human environment," which may involve calculations of latent effects to populations (i.e., potential cancer fatality risks) from sources such as groundwater contamination, or impacts to other natural resources. **In spite of these differences, many of the basic assumptions supporting EIS-related hazard identification, hazard analysis, and accident analysis activities are consistent with nuclear safety analysis or chemical PrHA activities and should therefore be integrated.**

Hazard Analyses Focused on Specific Hazards

A second group of hazard analysis activities can be characterized as having in common a focus on specific hazards. Hazard analyses that fall into this category include the following:

- Fire Hazards Analysis (DOE O 420.1)
- Criticality Safety Evaluation (DOE O 420.1)
- Natural Phenomena Hazards Assessment (DOE O 420.1)
- Beryllium Hazards Assessment (10 CFR 850)

Since each of these analyses is focused on a different hazard, there is not overlap among this group. However, there are opportunities for integrating each activity with nuclear safety analysis or PrHA activities.

Fire hazards analysis, which is required for all nuclear or significant new facilities or facilities that present unique or significant fire risks, provides a comprehensive evaluation of fire hazards. This involves activities such as postulation of fire accident scenarios and estimates of potential consequences (i.e., maximum credible and possible fire loss). The Defense Nuclear Facilities Safety Board has noted several instances at DOE sites where these activities are inconsistent with accident assumptions found in nuclear safety analysis. **DOE O 420.1 requires that conclusions of the FHA be integrated into the safety analysis. This practice should also apply to chemical operations within the scope of DOE O 420.1. FHA and safety analysis, or PrHA, activities should be coordinated and integrated through means such as teaming of fire safety personnel with hazard/accident analysts.** A white paper on this topic, which was prepared by members of the DOE fire safety community, is provided in Attachment 3.

DOE O 420.1 also requires a Criticality Safety Evaluation (CSE) and Natural Phenomena Hazard Assessment. A CSE is a focused evaluation on facility piping, vessels and design features to identify unfavorable geometry or other conditions favorable to a nuclear criticality. NPH assessments are focused on response of facility systems, structures and components to a design basis earthquake and other natural phenomena events. Both of these activities are very specialized and therefore not amenable to direct integration with nuclear safety analysis or PrHA activities. **However, results and conclusions from CSEs and NPH assessments must be integrated into the safety analysis (not directly applicable to PrHA), since they may provide a basis for certain accident scenarios and assumptions. Also, CSE and NPH assessments should be coordinated through teaming efforts with hazard/accident analysts.**

A hazards assessment is an integral part of a Chronic Beryllium Disease Prevention Program Plan as required by 10 CFR 850. This activity requires identification of the quantity and form beryllium materials and their locations, as well as an assessment of possible beryllium exposures from planned activities. **Much of the hazards information needed to support this assessment may be available in existing safety analysis, PrHA documents, airborne monitoring data, or other previous hazard assessments conducted at a facility.**

Worker Activity-Level Hazard Analysis

A third group of hazard analysis activities can be characterized as focusing on worker related hazards associated with specific job tasks. These include the following sources:

- Hazard and Risk Analysis of Hazardous Waste Cleanup Activities (29 CFR 1910.120),
- Job Safety and Hazard Analyses (DOE O 440.1A and other OSHA regulations).
- Analysis of Occupational Radiation Hazards (10 CFR 835)

These activities are an integral part of work planning and feed into work packages, hazardous and radiation work permits, Health and Safety Plans and Industrial Hygiene Plans. **Analyses from this group have a different emphasis than facility-level analyses. Integration opportunities are "vertical," meaning that hazards information should flow between facility and activity levels.** For example, facility-level information and assumptions on hazardous material inventory (e.g., quantity, form and location) should be an input into job hazards analysis conducted on tasks within a specified facility area. Conversely, assessment of work-related hazards may yield insights into hazards that aren't adequately covered in nuclear safety analyses or PrHAs.

CONCLUSIONS

It is not feasible or practical to conduct one integrated hazard analysis that meets ALL user needs. However, there are many common activities and interfaces among safety/hazard analysis personnel that offer opportunities for integrating or coordinating efforts. Highlights of these areas identified in this review are as follows:

- Facility-oriented hazard analyses provide the most obvious and immediate opportunity for integrating activities. Nuclear safety analysis and PrHA activities can and should be conducted by one analysis. EPHA and EIS activities should not duplicate safety analysis or PrHA information, but rather use it to meet specific needs of emergency management and NEPA.

- Hazard analyses that are focused on various specific hazards offer integration points because of common hazard assumptions and information that either feed into or from nuclear safety analysis and PrHA. These activities can best benefit by strong coordination and teaming between various safety disciplines and hazard/accident analysts. Teaming between these individuals will provide insights into streamlining activities and minimize inconsistencies or errors between hazard analysis activities.

- Emphasis on the information flow between facility and activity level analyses is critical to worker protection. This vertical integration is particularly import in decommissioning hazardous or nuclear facilities, since facility information is vital to planning hazardous work tasks. This practice can be fostered by integrating workers and job planners into facility-level hazard analysis activities.

Attachment 1. Summary Comparison of Primary Hazard Analysis Characteristics

Hazard Analysis Requirements	Purpose	Expectations	Thresholds for Applicability	Safety Documentation	Integration with Other HA Requirements
29 CFR 1910.119, *Process Safety Management of Highly Hazardous Chemicals; and* **40CFR68.67**, *Chemical Accident Prevention Provisions-Process Hazards Analysis*	Establish process safety management programs for facilities with hazardous chemicals exceeding established thresholds	**$** Review previous incidents with potential for catastrophic consequences **$** Identify/analyze chemical process hazards using hazard evaluation technique appropriate for facility complexity (What-If, Checklist, What-If/Checklist, HAZOP, FMEA, or equivalent) **$** Identify engineering and administrative controls applicable to hazards **$** Document findings and recommendations and prepare a written schedule for corrective actions **$** Update PrHA every 5 years	Chemical inventories that exceed OSHA PSM Threshold Quantities and EPA RPM Threshold Quantities	**$** Process Hazard Analysis Document **$** Corrective Action Plan **$** Risk Management Plan	Integration between process hazard analysis and nuclear facility safety analysis is discussed and encouraged in DOE-STD-1027-92, DOE-STD-3009-94, EM-STD-5502, DOE-STD1120-98 and DOE-HDBK-1100-96. Much similarity in EPA, OSHA and nuclear safety analysis requirements. One hazard analysis could satisfy all three requirements
10 CFR 830, *Nuclear Safety Management* *(Note: Also covers DOE Order 5480.23)*	**$** Prevent or mitigate potential consequences from hazardous/radiological material releases **$** Ensure defense in depth and worker protection measures **$** Provide a technical basis for authorizing safe operation of nuclear facilities	**$** Identify inventory of facility hazardous/radiological materials **$** Perform hazard analysis and classification **$** Analyze potential accidents and establish engineering and administrative controls **$** Identify safety-class and safety-significant SSCs **$** Prepare a Documented Safety Analysis **$** Update annually	Radiological inventories that exceed Hazard Category 1, 2, or 3 thresholds of DOE-STD-1027-92	**$** Documented Safety Analysis, or **$** Basis for Interim Operation, or **$** Health and Safety Plan, **$** Technical Safety Requirements	See comments above. Other potential integration points: **$** Assumptions and findings from fire hazard analysis **$** Safety analysis provides sound basis for EIS and emergency management hazard analysis accident assumptions
29 CFR 1910.120, *Hazardous Waste Operations and Emergency Response*	Ensure worker risks associated with hazardous materials are evaluated and communicated to employees at hazardous waste cleanup sites	**$** Identify any suspected condition that may be immediately dangerous to life and health of workers **$** Calculate worker risks associated with hazardous substances and inform employees **$** Determine appropriate site controls and PPE **$** Prepare health and safety plan	Applies to facility/site cleanup activities that are regulated (e.g., CERCLA) and pose a "reasonable possibility for exposure" to workers	Health and Safety Plan	The *DOE Handbook for Occupational Health and Safety During Hazardous Waste Activities*, June 1996, encourages analysts to review safety analysis and process hazard analyses and use data as input to preparing Health and Safety Plans.

Hazard Analysis Requirements	Purpose	Expectations	Thresholds for Applicability	Safety Documentation	Integration with Other HA Requirements
DOE O 151.1, *Comprehensive Emergency Management System*	Obtain hazards information in order to identify resources, personnel and equipment for emergency hazardous materials program and define a facility's emergency management plan and Emergency Planning Zones	**$** Identify and screen hazardous chemicals and radiological materials **$** Analyze potential accident events **$** Estimate consequences **$** Update annually	**Chemicals**: Lowest of threshold quantities in 29 1910.119, 40 CFR 68.130, or TPQ in 40 CFR 355 (Use 40CFR302.4 for chemicals not found in stated regulations) **Radiological**: Thresholds given in 10 CFR 30.72, Schedule C	Emergency Management Hazard Assessment	DOE G 151.1-1 encourages the hazard assessment to make use of facility description and accident scenarios from safety analysis, as well as hazardous material estimates used for other purposes
DOE O 420.1, Facility Safety *(Note: Requires a fire hazards analysis, natural phenomena assessment, and a criticality safety evaluation)*	*Fire Hazards Analysis*. Identify the potential for fire loss (life, monetary and mission) and justify the appropriate fire protection programs and systems to meet the DOE fire protection goals established in DOE Order 420.1.	**$** Identify fire hazards (e.g., energy sources, building construction, combustibles) **$** Postulate possible fire accident scenarios **$** Estimate potential consequences (e.g., maximum credible and possible fire loss) and assess adequacy of controls **$** Provide recommendations related to any deficiencies	Required for all nuclear facilities, significant new facilities and facilities that present unique or significant fire safety risks	FHA Document	DOE O 420.1 requires that conclusions of the FHA be integrated into the safety analysis. This practice should also apply to chemical operations with the scope of Doe O 420.1
	Natural Phenomena Assessment. Ensure that NPH impacts on facility safety are assessed and adequately controlled	**$** Conduct NPH site investigation using DOE-STD-1022 **$** Conduct Probabilistic Seismic Hazard Analysis (PSHA) to produce a seismic hazard curve to be used in selecting the design basis earthquake (DBE) for PC-3 and PC-4 SSCs. **$** Choose DBE and analyze SSC response and necessary controls	Applied on a graded approach depending on facility and system, structure or component Performance Category (see DOE -STD-1021-93)	NPH Document	NPH assessment results must be integrated into safety analysis and evaluated as an accident initiator
	Criticality Safety Program Evaluation. Document the parameters, limits, and controls needed to prevent inadvertent nuclear criticality	Perform nuclear criticality safety evaluations for normal and abnormal credible accident conditions	Applies when a facility has fissionable nuclides of concern as addressed in Table 4.3-1 of DOE 420.1	CSE document	Integration is only at issue with nuclear safety analysis activities
DOE 440.1A, *Worker Protection Management*	Ensure that workplace hazards and risk of associated worker injury	**$** Analyze designs for new facilities and modifications to existing ones, operations and procedures, and	None. Applies to all DOE and contractor activities	**$** Job Hazards Analysis **$** Health and Safety Plan **$** Work Permits	Oriented primarily at the task or activity level. Facility-level analysis such as process hazard

Hazard Analysis Requirements	Purpose	Expectations	Thresholds for Applicability	Safety Documentation	Integration with Other HA Requirements
	or illness are adequately controlled	equipment, product and services. $ Assess worker exposure to chemical, physical, biological, or ergonomic hazards. $ Evaluate workplace activities through job hazards analysis		$ Chemical Hygiene Plan	analysis or nuclear safety analysis should be used a major input to worker hazard analysis activities. Conversely, worker hazards analysis may provide insights into facility hazards not adequately analyzed in existing safety analysis or process hazard analysis.
DOE O 451.1A, *National Environmental Policy Act Compliance Program,* and **40 CFR 1502,** *Environmental Impact Statement;* **10 CFR 1021,** *DOE NEPA Procedures*	Provide the regulators and public with maximum potential environmental and health effects associated with planned work activities	Evaluate direct and indirect environmental effects and their significance from proposed DOE actions	EIS required for classes of actions as described in Appendix D to Supbart D of 10 CFR 1021	Environmental Impact Statement	An EIS should rely on analytical assumptions from DSAs or process hazard analyses
10 CFR 850, *Chronic Beryllium Disease Prevention Program*	Ensure that beryllium hazards and potential exposure pathways are identified and controlled	$ Analyze existing facility conditions, exposure data, medial surveillance trends, $ Identify quantities and forms of beryllium $ Identify locations of beryllium materials $ Assess exposure potential of planned activities	Presence of beryllium materials or residues	• Chronic Beryllium Disease Prevention Plan • Hazard Assessment Report	Existing hazard analysis documents such as safety analysis should be used as input in surveying beryllium hazard potential
Various Hazard or Activity Specific OHSA Regulations: **29 CFR 1910.146,** *Permit-required Confined Spaces;* **29 CFR 1910.132,** *Personal Protective Equipment;* **29 CFR 1910.94**, *Ventilation;* **29 CFR 1910.1450**,	Ensure that worker hazards are controlled and appropriate personal protective equipment used when appropriate	$ Analyze health hazards associated with specific job activities $ Measure worker exposures to chemical substances $ Identify hazards that should be controlled by personal protective equipment	Regulation specific such as: • Work performed in confined spaces, • Laboratory operations, • Blasting operations	• Chemical Hygiene Plan • Job safety analysis • Work permits • Work packages	OSHA regulations are required by DOE O 440.1A. Activities prescribed by the order are consistent and should not be duplicative of OSHA requirements

Hazard Analysis Requirements	Purpose	Expectations	Thresholds for Applicability	Safety Documentation	Integration with Other HA Requirements
Occupational Exposure to Hazardous Chemicals in Laboratories					

Attachment 2. Hazard Analysis Requirements Applicable to DOE Facilities

Requirement Source	Section	Requirement Text	Applicability to DOE or Contractor	Area of Coverage
29 CFR 1910.120, *Hazardous Waste Operations and Emergency Response*	(b)(4)(ii)	The site safety and health plan, as a minimum, shall address the following: (b)(4)(ii)(A) A safety and health risk or hazard analysis for each site task and operation found in the workplan	Both	DOE facility cleanup operations
29 CFR 1910.120, *Hazardous Waste Operations and Emergency Response*	(c)(1)	General. Hazardous waste sites shall be evaluated in accordance with this paragraph to identify specific site hazards and to determine the appropriate safety and health control procedures needed to protect employees from the identified hazards.	Both	DOE facility cleanup operations
29 CFR 1910.120, *Hazardous Waste Operations and Emergency Response*	(c) (3)	Hazard identification. All suspected conditions that may pose inhalation or skin absorption hazards that are immediately dangerous to life or health (IDLH) or other conditions that may cause death or serious harm shall be identified during the preliminary survey and evaluated during the detailed survey. Examples of such hazards include, but are not limited to, confined space entry, potentially explosive or flammable situations, visible vapor clouds, or areas where biological indicators such as dead animals or vegetation are located	Both	DOE facility cleanup operations
29 CFR 1910.120, *Hazardous Waste Operations and Emergency Response*	(c)(7)	Risk identification. Once the presence and concentrations of specific hazardous substances and health hazards have been established, the risks associated with these substances shall be identified. Employees who will be working on the site shall be informed of any risks that have been identified….Risks to consider include, but are not limited to: [a] Exposures exceeding the permissible exposure limits and published exposure levels. [b] IDLH Concentrations. [c] Potential Skin Absorption and Irritation Sources. [d] Potential Eye Irritation Sources. [e] Explosion Sensitivity and Flammability Ranges. [f] Oxygen deficiency.	Both	DOE facility cleanup operations
DOE O 151.1, *Comprehensive Emergency Management System*	Attachment, Chap. IV, 3 (a) (1)	The release of or loss of control of hazardous materials (radiological and non-radiological) shall be quantitatively analyzed.	Both	Any facility or activity involving hazardous materials or radionuclides in quantities greater than limits established in the standard
DOE O 420.1, *Facility Safety*	4.2, (5) CRD, 4.2, (5)	Fire hazards analyses (FHA) for all nuclear facilities, significant new facilities and facilities that represent unique or significant fire safety risks. The FHA shall be developed using a graded approach. The conclusions of the FHA shall be incorporated in the Safety Analysis Report (SAR) Accident Analysis and shall be integrated into design basis and beyond design basis accident conditions	Both	Applies to all nuclear facilities, significant new facilities and facilities that represent unique or significant fire safety risks.

Requirement Source	Section	Requirement Text	Applicability to DOE or Contractor	Area of Coverage
DOE O 420.1, *Facility Safety*	4.4.2 CRD, 4.4.4	The design and evaluation of facilities to withstand natural phenomena shall be based on an assessment of the likelihood of future natural phenomena occurrences. The natural phenomena hazards assessment shall be conducted commensurate with a graded approach and commensurate with the potential hazard of the facility.	Both	Applies to all hazardous facilities as defined by the Order
10 CFR 830, *Nuclear Safety Management*	830.202 (b) (2)	Identify and analyze the hazards associated with the work	Contractor	Hazard Category 1, 2, or 3 nuclear facilities
10 CFR 830, *Nuclear Safety Management*	830.204 (a)	The contractor responsible for a hazard category 1, 2 or 3 DOE nuclear facility must obtain approval from DOE for the methodology used to prepare the documented safety analysis for the facility unless the contractor uses a methodology set forth in Table 2 of Appendix A to this Part	Contractor	Hazard Category 1, 2, or 3 nuclear facilities
10 CFR 830, *Nuclear Safety Management*	830.204 (b) (2)	The documented safety analysis for a hazard category 1, 2 or 3 DOE nuclear facility must, as appropriate for the complexities and hazards associated with the facility: (2) Provide a systematic identification of both natural and man-made hazards associated with the facility.	Contractor	Hazard Category 1, 2, or 3 nuclear facilities
10 CFR 830, *Nuclear Safety Management*	830.204 (b) (3)	The documented safety analysis for a hazard category 1, 2 or 3 DOE nuclear facility must, as appropriate for the complexities and hazards associated with the facility: (3) Evaluate normal, abnormal, and accident conditions, including consideration of natural and man-made external events, identification of energy sources or processes that might contribute to the generation or uncontrolled release of radioactive and other hazardous materials, and consideration of the need for analysis of accidents which may be beyond the design basis of the facility.	Contractor	Hazard Category 1, 2, or 3 nuclear facilities
DOE 5480.23, *Nuclear Safety Analysis Reports*	8 (b) (3)	A SAR shall include the results of the safety analysis that identifies the dominant contributors to the risk of the facility so that these vulnerabilities can be better managed. The safety analysis report shall address the following topics:…(e) Hazard analysis and classification of the facility	Contractor	Hazard Category 1, 2, or 3 nuclear facilities
DOE 5480.23, *Nuclear Safety Analysis Reports*	8 (c) (2)	Inventory of Hazardous Materials. The hazard analysis shall be based on an inventory enveloping all radioactive and nonradioactive hazardous materials that are stored, utilized, or may be formed within a nuclear facility.	Contractor	Hazard Category 1, 2, or 3 nuclear facilities
DOE 5480.23, *Nuclear Safety Analysis Reports*	8 (c) (3)	Evaluation of Potential Releases. The hazard analysis shall identify energy sources or processes that might contribute to the generation or uncontrolled release of hazardous materials. The hazard analysis shall estimate the consequences of accidents in which the facility or process and/or materials in the inventory are assumed to interact, react, or be released in a manner to produce a threat or challenge to the health and safety of individuals on site and off site.	Contractor	Hazard Category 1, 2, or 3 nuclear facilities

Requirement Source	Section	Requirement Text	Applicability to DOE or Contractor	Area of Coverage
10 CFR 835, *Occupational Radiation Protection*	835.104	Written procedures shall be developed and implemented as necessary to ensure compliance with this part, commensurate with the radiological hazards created by the activity…	Contractor	Applies to any facility with radiological materials
10 CFR 835, *Occupational Radiation Protection*	835.204 (d) (2)	Prior to a planned special exposure, written consent shall be obtained from each individual involved. Each such written consent shall include…(2) The estimated doses and associated potential risks and specific radio-logical conditions and other hazards which might be involved in performing the task;	Contractor	Applies to any facility with radiological materials
10 CFR 835, *Occupational Radiation Protection*	835.501 (b)	The degree of control [over personnel entry into radiological areas] shall be commensurate with existing and potential radiological hazards within the area.	Contractor	Applies to any facility with radiological materials
10 CFR 850, *Chronic Beryllium Disease Prevention Program*	850.21 (a)	If the baseline inventory establishes the presence of beryllium, the responsible employer must conduct a beryllium hazard assessment that includes an analysis of existing conditions, exposure data, medical surveillance trends, and the exposure potential of planned activities.	Contractor	Facilities that have beryllium inventory
10 CFR 850, *Chronic Beryllium Disease Prevention Program*	850.21 (b)	The responsible employer must ensure that: (1) The hazard assessment is managed by a qualified individual (e.g., a certified industrial hygienist); and (2) The individuals assigned to this task have sufficient knowledge and experience to perform such activities properly.	Contractor	Facilities that have beryllium inventory or residual material
29 CFR 1910.119, *Process Safety Management of Highly Hazardous Chemicals*	(d)	Process safety information. In accordance with the schedule set forth in paragraph (e)(1) of this section, the employer shall complete a paragraph (e)(1) of this section, the employer shall complete a compilation of written process safety information before conducting any process hazard analysis required by the standard. The compilation of written process safety information is to enable the employer and the employees involved in operating the process to identify and understand the hazards posed by those processes involving highly hazardous chemicals. This process safety information shall include information pertaining to the hazards of the highly hazardous chemicals used or produced by the process, information pertaining to the technology of the process, and information pertaining to the equipment in the process.	Both	Facilities with chemical inventories that exceed OSHA PSM threshold quantities

Requirement Source	Section	Requirement Text	Applicability to DOE or Contractor	Area of Coverage
29 CFR 1910.119, *Process Safety Management of Highly Hazardous Chemicals* 40CFR68.67, *Chemical Accident Prevention Provisions-Process Hazards Analysis*	(e) (a)	Process Hazard Analysis. The employer shall perform an initial process hazard analysis (hazard evaluation) on processes covered by this standard. The process hazard analysis shall be appropriate to the complexity of the process and shall identify, evaluate, and control the hazards involved in the process. Employers shall determine and document the priority order for conducting process hazard analyses based on a rationale which includes such considerations as extent of the process hazards, number of potentially affected employees, age of the process, and operating history of the process.	Both	Facilities with chemical inventories that exceed OSHA PSM and EPA RPM threshold quantities
29 CFR 1910.119, *Process Safety Management of Highly Hazardous Chemicals* 40 CFR 68.67, *Chemical Accident Prevention Provisions-Process Hazards Analysis*	(e) (2) (b)	The employer shall use one or more of the following methodologies that are appropriate to determine and evaluate the hazards of the process being analyzed.(e)(2)(i) What-If; (e)(2)(ii) Checklist;(e)(2)(iii) What-f/Checklist; e)(2)(iv) Hazard and Operability Study (HAZOP); (e)(2)(v) Failure Mode and Effects Analysis (FMEA); (e)(2)(vi) Fault Tree Analysis; or (e)(2)(vii) An appropriate equivalent methodology.	Both	Facilities with chemical inventories that exceed OSHA PSM and EPA RPM threshold quantities
29 CFR 1910.119, *Process Safety Management of Highly Hazardous Chemicals* 40 CFR 68.67, *Chemical Accident Prevention Provisions-Process Hazards Analysis*	(e) (3) (c)	The process hazard analysis shall address: (e)(3)(i) The hazards of the process; (e)(3)(ii) The identification of any previous incident which had a likely potential for catastrophic consequences in the workplace; (e)(3)(iii) Engineering and administrative controls applicable to the hazards and their interrelationships such as appropriate application of detection methodologies to provide early warning of releases. (Acceptable detection methods might include process monitoring and control instrumentation with alarms, and detection hardware such as hydrocarbon sensors.); (e)(3)(iv) Consequences of failure of engineering and administrative controls; (e)(3)(v) Facility siting; (e)(3)(vi) Human factors; and (e)(3)(vii) A qualitative evaluation of a range of the possible safety and health effects of failure of controls on employees in the workplace.	Both	Facilities with chemical inventories that exceed OSHA PSM and EPA RPM threshold quantities

Requirement Source	Section	Requirement Text	Applicability to DOE or Contractor	Area of Coverage
29 CFR 1910.119, *Process Safety Management of Highly Hazardous Chemicals* 40 CFR 68.67, *Chemical Accident Prevention Provisions-Process Hazards Analysis*	(e) (4) (d)	The process hazard analysis shall be performed by a team with expertise in engineering and process operations, and the team shall include at least one employee who has experience and knowledge specific to the process being evaluated. Also, one member of the team must be knowledgeable in the specific process hazard analysis methodology being used.	Both	Facilities with chemical inventories that exceed OSHA PSM and EPA RPM threshold quantities
29 CFR 1910.119, *Process Safety Management of Highly Hazardous Chemicals* 40 CFR 68.67, *Chemical Accident Prevention Provisions-Process Hazards Analysis*	(e) (5) (e)	The employer shall establish a system to promptly address the team's findings and recommendations; assure that the recommendations are resolved in a timely manner and that the resolution is documented; document what actions are to be taken; complete actions as soon as possible; develop a written schedule of when these actions are to be completed; communicate the actions to operating, maintenance and other employees whose work assignments are in the process and who may be affected by the recommendations or actions.	Both	Facilities with chemical inventories that exceed OSHA PSM and EPA RPM threshold quantities
29 CFR 1910.119, *Process Safety Management of Highly Hazardous Chemicals* 40 CFR 68.67, *Chemical Accident Prevention Provisions-Process Hazards Analysis*	(e) (6) (f)	At least every five (5) years after the completion of the initial process hazard analysis, the process hazard analysis shall be updated and revalidated by a team meeting the requirements in paragraph (e)(4) of this section, to assure that the process hazard analysis is consistent with the current process.	Both	Facilities with chemical inventories that exceed OSHA PSM and EPA RPM threshold quantities

Requirement Source	Section	Requirement Text	Applicability to DOE or Contractor	Area of Coverage
29 CFR 1910.119, *Process Safety Management of Highly Hazardous Chemicals* 40 CFR 68.67, *Chemical Accident Prevention Provisions-Process Hazards Analysis*	(e) (7) (g)	Employers shall retain process hazards analyses and updates or revalidations for each process covered by this section, as well as the documented resolution of recommendations described in paragraph(e)(5) of this section for the life of the process.	Both	Facilities with chemical inventories that exceed OSHA PSM and EPA RPM threshold quantities
DOE 440.1A, *Worker Protection Management*	4(i)	Identify existing and potential workplace hazards and evaluate the risk of associated worker injury or illness.	DOE	All DOE facilities
DOE 440.1A, *Worker Protection Management*	4 (i) (1)	Analyze or review: (a) designs for new facilities and modifications to existing facilities and equipment; (b) operations and procedures; and(c) equipment, product, and service needs.	DOE	All DOE facilities
DOE 440.1A, *Worker Protection Management*	4 (i) (2)	Assess worker exposure to chemical, physical, biological, or ergonomic hazards through appropriate workplace monitoring (including personal, area, wipe, and bulk sampling), biological monitoring, and observation. Monitoring results shall be recorded. Documentation shall describe the tasks and locations where monitoring occurred, identify workers monitored or represented by the monitoring, and identify the sampling methods and durations, control measures in place during monitoring including the use of personal protective equipment), and any other factors that may have affected sampling results	DOE	All DOE facilities
DOE 440.1A, *Worker Protection Management*	4 (j)	Implement a hazard prevention/abatement process to ensure that all identified hazards are managed through final abatement or control.	DOE	All DOE facilities
DOE 440.1A, *Worker Protection Management*	4 (j) (1)	For hazards identified either in the facility design or during the development of procedures, controls shall be incorporated in the appropriate facility design or procedure	DOE	All DOE facilities
DOE 440.1A, *Worker Protection Management*	4 (j) (2)	For existing hazards identified in the workplace, abatement actions prioritized according to risk to the worker shall be promptly implemented, interim protective measures shall be implemented pending final abatement, and workers shall be protected immediately from imminent danger conditions	DOE	All DOE facilities
DOE 440.1A, *Worker Protection Management*	4 (j) (3)	Hazards shall be addressed when selecting or purchasing equipment, products, and services	DOE	All DOE facilities

Requirement Source	Section	Requirement Text	Applicability to DOE or Contractor	Area of Coverage
DOE 440.1A, *Worker Protection Management*	Att. 1, (1)(b)(2)(d)	Construction Project Managers shall…Ensure that the project safety and health plan is approved prior to any on-site project work and that required hazard analyses are completed and approved prior to start of work on affected construction operations.	DOE	DOE construction activities
DOE 440.1A, *Worker Protection Management*	CRD, 5	Encourage employee involvement in the development of program goals, objectives, and performance measures and in the identification and control of hazards in the workplace.	Contractors	All DOE facilities
DOE 440.1A, *Worker Protection Management*	CRD, 9 (a)	Analyze or review: (1) designs for new facilities and modifications to existing facilities and equipment; (2) operations and procedures; and (3) equipment, product, and service needs.	Contractor	All DOE facilities
DOE 440.1A, *Worker Protection Management*	CRD, 9 (b)	Assess worker exposure to chemical, physical, biological, or ergonomic hazards through appropriate workplace monitoring (including personal, area, wipe, and bulk sampling), biological monitoring, and observation. Monitoring results shall be recorded. Documentation shall describe the tasks and locations where monitoring occurred, identify workers monitored or represented by the monitoring, and identify the sampling methods and durations, control measures in place during monitoring (including the use of personal protective equipment), and any other factors that may have affected sampling results.	Contractor	All DOE facilities
DOE 440.1A, *Worker Protection Management*	CRD, 10 (a)	For hazards identified either in the facility design or during the development of procedures, controls shall be incorporated in the appropriate facility design or procedure.	Contractor	All DOE facilities
DOE 440.1A, *Worker Protection Management*	CRD, 10 (b)	For existing hazards identified in the workplace, abatement actions prioritized according to risk to the worker shall be promptly implemented, interim protective measures shall be implemented pending final abatement, and workers shall be protected immediately from imminent danger conditions	Contractor	All DOE facilities
DOE 440.1A, *Worker Protection Management*	CRD, 10 (c)	Hazards shall be addressed when selecting or purchasing equipment, products, and services.	Contractor	All DOE facilities
DOE 440.1A, *Worker Protection Management*	CRD 10 (d)	Hazard control methods shall be selected based on the following hierarchy: (1) Engineering controls. (2) Work practices and administrative controls that limit worker exposures. (3) Personal protective equipment.	Contractor	All DOE facilities
DOE 440.1A, *Worker Protection Management*	CRD, 14 (a) (1)	Hazard Analyses. For each construction operation presenting hazards not experienced in previous project operations or for work performed by a different subcontractor, the construction contractor shall prepare a hazard analysis and have it approved prior to commencement of affected work. These analyses shall identify foreseeable hazards and planned protective measures, provide drawings and/or other documentation of protective measures that a Professional Engineer or other competent person is required to prepare, and define the qualifications of competent persons required for workplace inspections.	Contractors	DOE construction activities

Requirement Source	**Section**	**Requirement Text**	**Applicability to DOE or Contractor**	**Area of Coverage**
DOE 440.1A, *Worker Protection Management*	CRD, 14 (a) (4)	The construction contractor shall prepare and have approved prior to commencement of any on-site project work a written project safety and health plan that provides a proposal for implementing the above requirements. The construction contractor shall also designate the individual(s) responsible for on-site implementation of the plan, specify qualifications for those individuals, and provide a list of those project operations for which a hazard analysis is to be performed.	Contractors	DOE construction activities
48 CFR 970, *DOE Management and Operating Contracts*	970.5204-2 (c)(2)	DOE elements shall perform an identification and evaluation of hazards associated with work, as part of an overall documented safety management system [paraphrased]	Contractors	All DOE facilities
29 CFR 1910.132, *Personal protective Equipment*	(d) (1)	The employer shall assess the workplace to determine if hazards are present, or are likely to be present, which necessitate the use of personal protective equipment (PPE).	Both	All DOE facilities
29 CFR 1910.146, *Permit-required confined spaces*	(c) (1)	The employer shall evaluate the workplace to determine if any spaces are permit-required confined spaces.	Both	All DOE facilities
29 CFR 1910.146, *Permit-required confined spaces*	(d) (2)	[The Permit-required confined space program shall] Identify and evaluate the hazards of permit spaces before employees enter them.	Both	All DOE facilities
29 CFR 1450, *Occupational Exposure to Chemicals in Laboratories*	(d) (1)	Initial monitoring. The employer shall measure the employee's exposure to any substance regulated by a standard which requires monitoring if there is reason to believe that exposure levels for that substance routinely exceed the action level (or in the absence of an action level, the PEL)..	Both	DOE laboratory operations
29 CFR 1910.94, *Ventilation*	(a) (2) (i)	Abrasives and the surface coatings on the materials blasted are shattered and pulverized during blasting operations and the dust formed will contain particles of respirable size. The composition and toxicity of the dust from these [abrasive blasting] sources shall be considered in making an evaluation of the potential health hazards.	Both	Operations involving abrasive blasting
DOE O 451.1A, *National Environmental Policy Act Compliance Program*		Requires that DOE/contractors: ➢ Evaluate proposed activities and the need to prepare an Environmental Assessment or Environmental Impact Assessment ➢ Analyze "maximum reasonably foreseeable accidents" ➢ Estimate accident impacts (rad and non-rad) to workers, the public and environment ➢ Prepare NEPA document and update every 5 years [Note:paraphrased]	Both	Required when NEPA review is performed on major DOE action (e.g., environmental restoration project, new operation, significant modification to facility)

Attachment 3

"SYNTHESIS OF SAR AND FHA METHODOLOGIES"

A "white paper" developed by representatives of the DOE/contractor safety analysis and fire protection communities.

Introduction

The purpose of this white paper is to attempt to resolve certain misperceptions that appear to exist among some members of the safety analysis and fire protection communities within the Department of Energy (DOE) regarding acceptable methodologies for the preparation of Safety Analysis Reports (SAR) and Fire Hazards Analyses (FHA). The principal misperception is that DOE directives are written in a way that inherently results in an incompatible approach to the development of the analyses required for these documents.

The need for clarification at this time is stimulated, in part, by the amount of time and resources that are continually expended unnecessarily in resolving conflicting methodologies, redundant documentation, and contrary conclusions. An additional impetus is the steady stream of studies[1] that highlight the fact that fire continues to be one of the, if not **the** most, dominant contributor to risk at most of the Department's existing and proposed facilities.

This paper was written by a team of DOE and contractor safety analysts and fire protection engineers as a result of an action item that was discussed during a July 8, 1999, teleconference of the DOE Secretarial Officers Working Group (SOWG) for Reviews of Implementation Plans and Schedules for Safety Analysis Reports (SARs) and Technical Safety Requirements (TSRs).

Background

The principal DOE Directives that address this issue are as follows:

DOE O 420.1, "*Facility Safety*"

DOE Order 5480.23, "*Nuclear Safety Analysis Reports*"

DOE Standard 3009-94, "*Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*"

G-420.1/B-0, "*Implementation Guide for use with DOE Orders 420.1 and 440.1, Fire Safety Program*"

These directives require that both SARs and FHAs be developed for DOE nuclear facilities (FHAs are required for significant non-nuclear facilities as well) under the "graded approach." In other words, the scope and level of detail necessary for each are directly related to the level and significance of risk and the life-cycle phase of the facility. DOE fire safety directives emphasize additionally the flexibility to pursue alternate approaches to fire protection program

documentation when justified on the basis of costs versus benefits. The above-referenced Implementation Guide reinforces the need for concerted action by representatives of the various safety disciplines in the development of SARs and FHAs and suggests that a comprehensive SAR would obviate the need for a separate FHA. While all of these directives offer specific criteria for the development of safety basis documentation, none contain criteria that are overtly contradictory.

Program Goals

DOE Order 420.1, *Facility Safety*, establishes the nuclear safety goal[1] that DOE non-reactor nuclear facilities be designed and constructed to assure adequate protection for the public, workers, and the environment from nuclear hazards. Thus, the primary purpose of the SAR is to identify and justify a set of controls to ensure that a facility can be constructed, operated, maintained, shut down, and decommissioned safety and in compliance with applicable laws and regulations [DOE 5480.23].

DOE Order 420.1 also establishes the fire protection goals. These are to minimize the potential for:

(1) the occurrence of a fire or related event;

(2) a fire that causes an unacceptable on-site or off-site release of hazardous or radiological material that will threaten the health and safety of employees, the public or the environment;

(3) vital DOE programs suffering unacceptable interruptions as a result of fire and related hazards;

(4) property losses from a fire and related events exceeding defined limits established by DOE; and

(5) Critical process controls and safety class systems being damaged as a result of a fire and related events.

Similarly, the primary purpose of an FHA is to identify the potential for fire loss (life, monetary and mission) and justify the appropriate fire protection programs and systems to meet the DOE fire protection goals established in DOE Order 420.1. While these two purposes are similar, the programmatic goals driving each program are not identical. The differences sometimes result in an appearance that the requirement documents are not in agreement. This paper will demonstrate that the requirement documents are consistent, it is in their implementation that the inconsistencies and misconceptions are sometimes introduced.

[1] DOE Order 420.1 uses the term objectives. In this paper the term goal is being used to maintain consistency with *The SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings*, May 1999.

Objectives and Criteria

The Society of Fire Protection Engineers (SFPE) has recently prepared a guide for the preparation of engineered fire protection[2]. This guide has a comprehensive methodology that allows goals to be refined into stakeholder objectives, design objectives and quantified performance criteria. The methods presented in this guide will be used to demonstrate that all of the goals addressed by the SAR are included in the FHA and the FHA includes must address additional goals.

Table 1 lists the goals for the nuclear safety and fire protection programs. The second goal in the fire protection program is the same as the nuclear safety program goal. The first fire protection goal (minimize the potential for fire or related event) is consistent with the nuclear safety goal. Often the controls (e.g., hot work programs) instituted to implement this goal are credited in the SAR. When this occurs, some review mechanism must exist to ensure that changes to the fire protection program will not compromise the SAR conclusions.

The fifth fire protection program goal is consistent with the nuclear safety program goal, however there can be instances where minimizing the potential for fire damage to safety class systems is in excess of the nuclear safety program goals. An example of this would be an interlock that was only required during a process upset event. If the process-upset event and any fire accident were independent, then the SAR would not require the interlock be protected from fire. Fire protection goal 5 would require some level of fire protection. This level of protection should be graded to reflect the importance to safety, the cost of protection, and the cost of replacement. Thus, there will be cases where potential for fire damage to safety class systems is deemed acceptable. In such cases both the FHA and SAR should reflect this decision.

The two remaining fire protection goals (mission continuity and monetary loss protection) are separate from the nuclear safety goal. Often the fire protection features required to accomplish these goals will reduce the nuclear safety risk. When the fire protection features qualify as Safety Class or Safety Significant (SC/SS) the fire protection and nuclear safety programs are perceived as consistent. When a feature is not SC/SS, there is sometimes the mistaken impression that the SAR and FHA are inconsistent. Not every control that reduces the nuclear safety risk to the public need be safety class, nor every control protecting workers need be safety significant. SS/SC controls are those that are considered mandatory to reduce the nuclear safety risk to an acceptable level. In addition to SS/SC controls, DOE requires the identification of Defense in Depth (DiD) items, which are considered additional controls that further reduce the nuclear safety risk. Where the FHA identifies a need for non-SS/SC controls, those controls are good candidates for DiD items. If such an item is not DiD, then it can usually be attributed to the third or fourth fire protection goal.

Methodology

[2] In fire protection vernacular this is performance-based design.

SARs are the cornerstone of the Authorization Basis for most Hazard Category 1, 2 and 3 Nuclear Facilities in the DOE complex. New SARs are prepared to meet DOE Order 5480.23 using the methods described in DOE-STD-3009-94 and is similar to overall process used in preparing an FHA. In preparing a 3009-style SAR a multi-step analytical process is commonly used. The steps in this process are:

Hazard identification that defines inventories of hazardous material and assesses the Facility Hazard Classification,

Hazard analysis that comprehensively characterizes hazards, qualitatively evaluates hazards, and identifies important equipment and administrative controls, and

Accident analysis that quantitatively analyzes accidents of concern.

Functional classification that ranks the importance engineered controls (i.e., Systems, Structures and Components), which maintain facility safety.

Controls selection that establishes the operating limits and programmatic requirements, which maintain facility safety.

An FHA uses a similar logic and starts with hazard identification, however in most instances the remaining steps are accomplished by a demonstration that the facility (both engineered features and administrative programs) are in compliance with the applicable codes (typically the *National Fire Codes*). When such a method is used, the generic analysis and control selection process used by the technical committee preparing the code, is assumed to be applicable. The use of generic analysis and controls (e.g., *The National Fire Codes*) often leads to the misconception that the SAR and FHA methodologies are incompatible. When this occurs, the analytical methods must be evaluated. Sometimes the generic methods introduce controls that are not applicable to the situations normally found in nuclear facilities. Also the SAR analysis could be neglecting objectives or hazards that the FHA must address.

Issues

Duplicate Effort - Both SARs and FHAs are required to describe a broad spectrum of facility attributes. (Reference Section 8.b of DOE 5480.23 and Paragraph 4.5 of G-420.1/B-0.) Examples include; site characteristics, facility description, process equipment and operations, hazards, damage potential, safety features and emergency preparedness, among other facets. Doing so in both documents is unnecessarily redundant. DOE requirements and expectations would be met by a comprehensive description in one, with an explicit reference in the other.

Prescriptive Fire Protection Requirements - There is a perception that FHA development criteria in DOE directives preclude the use of analytical approaches based on probabilistic methodologies and modeling. While it is true that G-420.1/B-0 directs that the risks from fire be qualitatively assessed for each fire area, it does not proscribe the use of probability and statistics as well as validated fire models in the ranking or description of fire scenarios within given areas. There is a general recognition, however, that these analytical tools are subject to varying results

depending the nature of the underlying assumptions. Thus, the ultimate decision on the nature and extent of fire protection within a given fire area must based on established design criteria as tempered by the judgement and experience of qualified fire protection engineers.

Conflicting Controls - The conclusions of a SAR are often perceived to be at odds with those of the corresponding FHA. In fact, it is not uncommon for a SAR to conclude that fire protection features are not needed to mitigate the consequences of bounding fires. While, under the same circumstances, the FHA will conclude that the same fire protection features are required. The following paragraphs demonstrate several reasons why these discrepancies sometimes occur.

Differing Paradigms As stated pr eviously, the SARs primary goal is to identify and justify an adequate set of controls for nuclear safety. Thus the nuclear safety analysts must ensure that the analysis and controls can be successfully implemented as Technical Safety Requirements (TSRs) and Operational Safety Requirements (OSRs). The formality in the use and implementation of these documents, sometimes limits the types of controls that can be successfully credited. The DOE fire protection program has historically been based on best industrial and insurance practices (Highly Protected Risk). These practices have been developed over the past 100 years and have been demonstrated to achieve the desired reduction in fire risk. Unfortunately the formality required of nuclear safety programs is sometimes lacking, and thus duplicate protective features, or conflicting assumptions can occur.

The Small Fire The accidents that are explicitly analyzed in most SARs are severe and most of the effort is focused on demonstrating that the potential consequences will occur at an acceptably low frequency. In most facilities the most severe fires will be at frequencies below 1.0E-3/yr, often approaching 1.0E-6/yr. Since an incipient fire frequency in most nuclear facilities ranges from 0.1 to 1/yr, it is possible that the overall fire risk (worker, monetary, mission, etc.) is dominated by the high frequency fires, rather than the bounding fire that is the dominate nuclear safety fire risk. Thus, the fire protection program may require additional controls, not needed to achieve the appropriate nuclear safety risk.

Independence As with most engineering efforts there is considerable flexibility in selecting the best approach. The definition of best includes such non -technical realities as limited budget, tight schedules and available resources (e.g., people). Thus, the SAR and FHA can develop alternate controls strictly because they selected alternate approaches. This promotes the misconception that the FHA and SAR are not compatible. The correct interpretation is that the two documents must be coordinated in their development and their scheduled updates.

Recommendations

- Prior to the development of a SAR and FHA for a given facility, the (DOE and contractor) stakeholders should be clearly defined and then meet to define mutually acceptable assumptions, methodologies, formatting, etc. and to establish a mechanism for the timely resolution of disputes.

- The schedule for the development of the SAR and FHA should be mutually compatible.

- The selection of controls to reduce nuclear safety and other fire risks should be coordinated to ensure that the most effective set of controls are selected.

- The fire protection engineer who is responsible for the development of the FHA should be on the "team" which is developing the SAR.

- Previously developed and (DOE) approved SARs and FHAs should be used as the models for subsequent safety basis documentation. (Refer also the "model" fire hazards analyses in the DOE Fire Protection Handbook. These models can be downloaded from the DOE Fire Protection Web Site at: http://tis.eh.doe.gov/fire/)

Works Cited

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