Bulk H_2 Storage: Leveraging H_2 Safety Plans to Comply with Regulatory Requirements

Aaron Harris, Group Leader, Hydrogen Services

Tuesday, May 5, 2026

12:00pm EDT
9:00am PDT

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About AcuTech

Since 1994, AcuTech has been a global leader in providing best-in-class consulting, training, and software solutions to manage process risk.

With deep expertise in both the management and technical aspects of risk management, AcuTech is uniquely positioned to support clients ranging from the world's largest companies to specialized private companies to trade organizations and government agencies in improving safety, security, environmental, and operational performance.

This extensive experience across industries and in-depth knowledge of the tools and methods available for managing risk, allows our consultants to be responsive and flexible to meet client needs. In addition, they possess strong project management skills, broad technical expertise, and emphasize high-quality, on-time project work to support safer, more efficient, and, ultimately, more profitable operations.

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Speaker

Aaron Harris

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Mr. Harris has over 20 years of hands-on experience developing, implementing, training and conducting operations, maintenance, and incident response for hydrogen fueling vehicles and infrastructure. He has led safety and compliance initiatives for hydrogen vehicle and infrastructure systems, developed organizational safety programs, and contributed to the advancement of hydrogen safety codes, standards, and regulations, including NFPA 2 and SAE J2601.

Mr. Harris helped spearhead the development of the American Institute of Chemical Engineers (AIChE) Center for Hydrogen Safety (CHS) and served as the first chairperson of the Managing Board. He currently serves on the U.S. Department of Energy's Hydrogen Safety Panel.

His passions for hydrogen include:

- Pre-normative research to inform codes and standards
- RAGAGEP for hydrogen
- Hydrogen safety training

A quick poll...

How confident are you in your understanding of the regulatory requirements for bulk storage of hydrogen?

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What is Bulk Storage and Why is it Regulated?

Major Chemical Safety Incidents (1974 – 2005) informed today's Hydrogen quantity thresholds

1 – Flixborough Chemical Plant (1974)
28 fatalities and 36 serious injuries in UK plant explosion

2 – Seveso Dioxin Release (1976)
Thousands exposed to dioxin in Italy, causing long-term health and environmental impact

3 – Bhopal Gas Disaster (1984)
~3,000 immediate fatalities and >500,000 exposed/injured in India

4 – Piper Alpha Offshore Platform (1988)
167 fatalities and platform destruction, leading to offshore safety reforms

5 – Phillips 66 Chemical Explosion (1989)
23 fatalities and ~300 injured in US chemical plant explosion

6 – BP Texas City Refinery Explosion (2005)
15 fatalities and ~180 injured, prompting major regulatory changes

United States – OSHA PSM[1] & EPA RMP[2]

10,000 pound threshold for mandatory program participation

1. 1992 - OSHA PSM - Process Safety Management - Background
2. 1996 – EPA RMP - Risk Management Program (RMP) Rule | US EPA

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Demystifying the 'Magic' of 10,000 Pounds

- **Process quantities over 10,000 lbs of hazardous materials are regulated**:
  - OSHA 29 CFR 1910 Subpart H Process Safety Management (PSM) of Highly Hazardous Chemicals[3]
  - EPA 40 CFR Part 68 Risk Management Program (RMP)[4]

- Quantity calculation considerations:
  - Interconnections: piping, components
  - Physical equipment: tanks, vessels, control systems
  - Temporary storage (e.g. on-site deliveries)

List of Regulated Substances under the Risk Management Program

The Risk Management Program rule provides a List of Regulated Substances under section 112(r) of the Clean Air Act. This includes their synonyms and threshold quantities (in pounds) to help assess if a process is subject to the RMP rule. Where the Clean Air Act Section 112(r) program has been delegated to a state, that state may have additional requirements for the federally listed chemicals, and/or additional listed chemicals.

List of Regulated Substances and Thresholds for Accidental Release Prevention

Chemical Name	CAS No.	Threshold Quantity (lbs.)
Hydrofluoric acid (conc. 50% or greater)	7664-39-3	1,000
Hydrogen	1333-74-0	10,000
Hydrogen chloride (anhydrous)	7647-01-0	5,000

3. https://www.ecfr.gov/current/title-29/subtitle-B/chapter-XVII/part-1910/subpart-H/section-1910.119
4. https://www.epa.gov/rmp/list-regulated-substances-under-risk-management-program

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Should we just stay under 10,000 lbs to avoid regulation?

Reflection

- What if hydrogen fueling stations were granted exemption from PSM/RMP requirements?
- Does the 10,000 lbs threshold influence your safety policies and procedures?
- What quantity do you recommend as the threshold for applying process safety best practices?

Incidents don't discriminate based on process size, neither should safety.

CSB Report[5]:

"tanks had no engineered system to direct flammable gas, including hydrogen, to a safe location"

"there were no flammable gas detectors or hydrogen gas detectors with alarms to warn workers"

"does not store chemicals in sufficient amounts for the company's operations to be regulated under the EPA's Risk Management Program (RMP) or the OSHA's Process Safety Management (PSM) standard"

5. https://www.csb.gov/csb-releases-ab-specialty-silicones-factual-update-/

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Develop Requirements

Federal Regulations

Facilities handling hazardous chemicals must navigate complementary federal regulatory frameworks designed to prevent incidents and protect workers and communities.

Compliance (14 Elements)

- Process Safety Information
- Employee Participation
- Process Hazard Analysis (PHA)
- Compliance with Standards
- Trade Secrets
- Operating Procedures
- Mechanical Integrity
- Management of Change
- Pre Startup Safety Review (PSSR)
- Compliance Audits
- Training
- Hot Work Permit Process
- Incident Investigation
- Emergency Planning & Response
- Contractors

OSHA®

Occupational Safety

Process Safety Management (PSM)

www.osha.gov/process-safety-management

While OSHA's PSM focuses on occupational worker safety through 14 management elements, the EPA's RMP addresses environmental protection and community risk from accidental chemical releases. Together, they form the foundation of comprehensive process safety compliance.

EPA

Environmental Safety

Risk Management Program (RMP)

www.epa.gov/rmp

Compliance (RMP)

- Worst-Case Release Analysis
- Alternative Release Analysis
- 5-Year Accident History
- Process Safety Information
- Process Hazard Analysis (PHA)
- Operating Procedures
- Training
- Mechanical Integrity
- Management of Change
- Pre-Startup Safety Review (PSSR)
- Compliance Audits
- Incident Investigation
- Employee Participation
- Hot Work Permit
- Contractors
- Emergency Response

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Navigating PSM and RMP requirements requires expertise in both regulatory frameworks.
AcuTech helps facilities achieve compliance with both standards while building effective, integrated management systems.

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State Regulations: California

California Accidental Release Prevention Program (CalARP)

- Administrates the PSM and RMP requirements for facilities with greater than 10,000 lbs of hydrogen
- State delegates authority to local agencies designated as Certified Unified Program Agencies (CUPA)
  - Additional requirements may be implemented by the CUPA
  - **Note:** CEC grant requires reporting safety incidents to CUPA, regardless of process size

Reporting Safety Incidents: The stations proposed by the Applicant shall conform to the California Health and Safety Code Section 25510(a). Recipients of funding under this solicitation shall submit report(s) of any unintended hydrogen releases to the Certified Unified Program Agency (CUPA), http://cersapps.calepa.ca.gov/Public/Directory.

Compliance Step One:

- Determine the program level[6]
- Program Levels 1, 2 and 3 have various reporting requirements
- Note: Preliminary offsite consequences evaluation

PROGRAM I	PROGRAM II	PROGRAM III
Worst-Case Release Analysis	Worst-Case Release Analysis	Worst-Case Release Analysis
	Alternative Release Analysis	Alternative Release Analysis
5-Year Accident History	5-Year Accident History	5-Year Accident History
	Document Management System	Document Management System
PREVENTION PROGRAM		
Certify No Additional Prevention Steps Needed	Safety Information	Process Safety Information
	Hazard Review	Process Hazard Analysis
	Operating Procedures	Operating Procedures
	Training	Training
	Maintenance	Mechanical Integrity
	Incident Investigation	Incident Investigation
	Compliance Audit	Compliance Audit
		Management Of Change
		Pre-Startup Review
		Contractors
		Employee Participation
		Hot Work Permits
EMERGENCY RESPONSE PROGRAM		
Coordinate with local emergency responders	Develop plan and program (if applicable) and coordinate with local emergency responders	Develop plan and program (if applicable) and coordinate with local emergency responders

6. https://calepa.ca.gov/california-accidental-release-prevention/california-accidental-release-prevention-program-levels/

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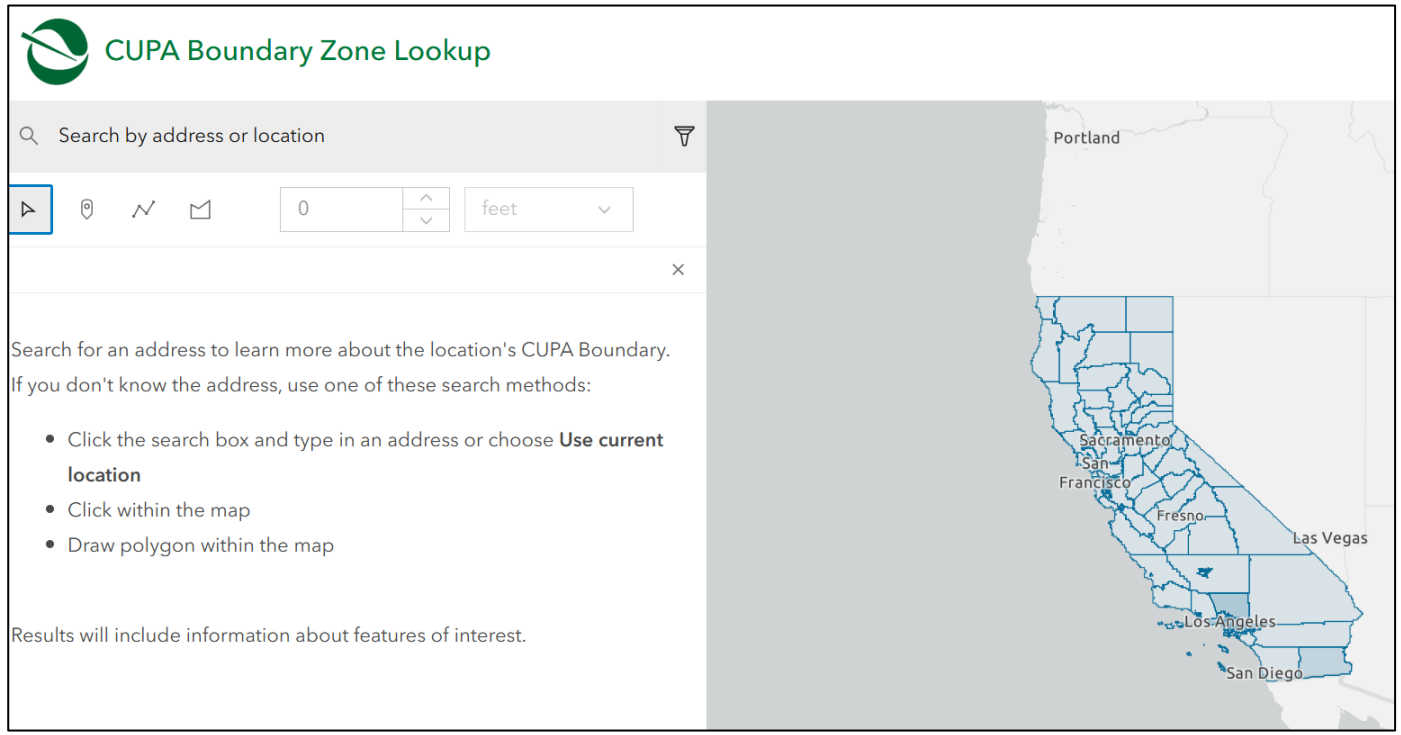
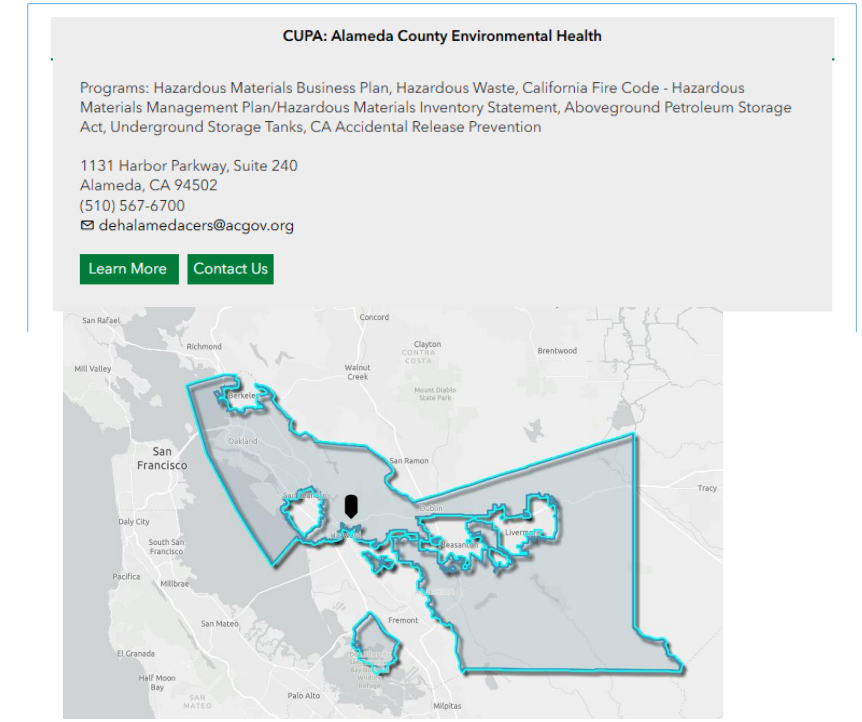
Who is my CUPA?

- Local level implementation of CalARP requirements
- How to identify your CUPA:
  - [CUPA Boundary Zone Lookup]





CUPA Example: City of Los Angeles Fire Department

Hazardous Materials Business Plan (HMBP)

- Required when storing more than 200 cubic feet; approx. 1 laboratory bottle of hydrogen
- HMBP submitted to California Environmental Reporting System (CERS)
- City of Los Angeles FD uses CERS to issue permit, invoice and administrate accounts

Risk Management Plan (RMP)

- Technical information on site, equipment, and process
- Offsite consequences of an accidental release
- Required topics based on program level:
  - Accident history
  - Emergency response program, including coordination with the local emergency responders
  - Hazard review or process hazard analysis
  - Operating procedures
  - Training of the stationary source's personnel
  - Maintenance and mechanical integrity program
  - Incident investigation

References:

7. RMP Summary: https://lafd.org/fire-prevention/calarp/fact-sheets/risk-management-plan
8. Annual CUPA Permits: https://lafd.org/fire-prevention/cupa-permits-annual
9. CUPA Project Permits: https://lafd.org/fire-prevention/cupa-permits-project
10. Additional Requirements: https://lafd.org/sites/default/files/pdf_files/small-business-compliance-manual.pdf
11. Fire Safety Plan – Chapter 4 LA Fire Code https://lafd.org/sites/default/files/pdf_files/small-business-compliance-manual.pdf
12. CalARP Registration Form: calarp-registration-form-v2.pdf
13. Public review process: https://lafd.org/fire-prevention/calarp/fact-sheets/public-review-process
14. CalEPA Title 19, Div 5, Chp 2 reference: https://calepa.ca.gov/wp-content/uploads/2024/08/California-Code-of-Regulations-Title-19-Division-5-Chapter-2-%E2%80%93-California-Accidental-Release-Prevention.pdf

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Need for a Comprehensive Plan

CEC Safety Plan and RMP cover these topics:	RMP or CEC Safety Plan does NOT cover:
Both documents provide basic process safety information.	Submitted CalARP RMP does ensure compliance to all obligations under OSHA PSM.
The RMP satisfies federal and state Community Right-To-Know Laws.	The CEC Safety Plan does not ensure compliance to the RMP nor PSM obligations.
The RMP is used by first responders to prevent or mitigate impacts from an accidental release of a regulated substance.	The CEC Safety Plan is not required beyond the concept phase submission.
The CEC through the Safety Plan communicates safety performance expectations.	The CEC Safety Plan does not enable communication of process safety related project history to the process operations.

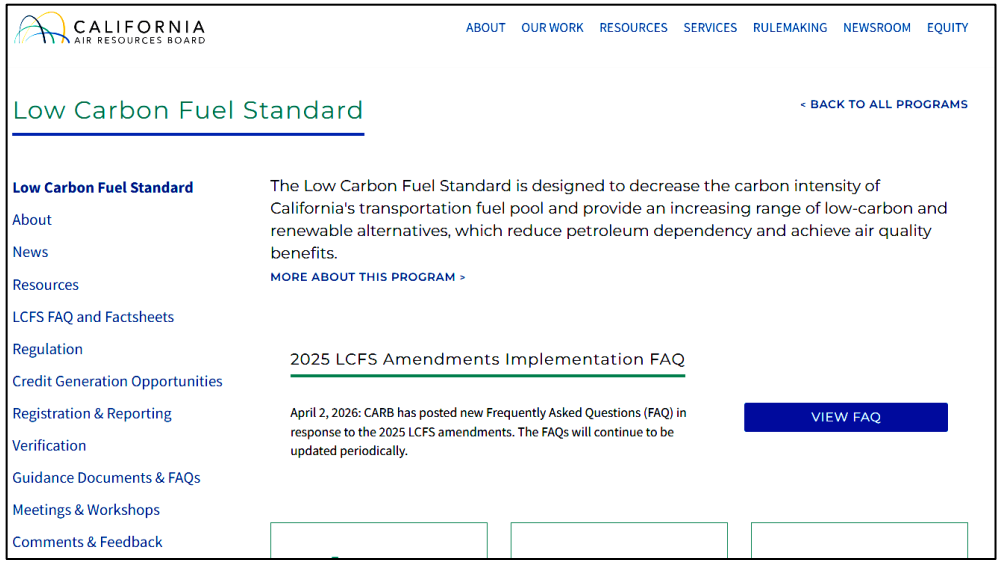
Therefore, a comprehensive safety plan must:

1. **Establish expectations and framework for hazard identification, mitigation and maintenance**
2. **Establish planned delivery of on-time and complete documents when required:**
   Ex. CEC Safety Plan, HMBP and RMP
3. **Establish a plan for turnover of a compliant process for operations**
4. **Facilitate continuous improvement**

Leveraging the Safety Plan: Availability & Carbon Intensity

Plan for Availability

- Qualitative and Quantitative availability analysis
- Mechanical Integrity methods used to identify components critical to availability
- Training and competency management



Plan for LCFS[15] Management

- KPI and metric reporting
- Technical requirements monitoring
- Training and competency management

15. https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard

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What about Best Practices?

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Best in Class Process Safety Management: CCPS Risk-Based Process Safety (RBPS)

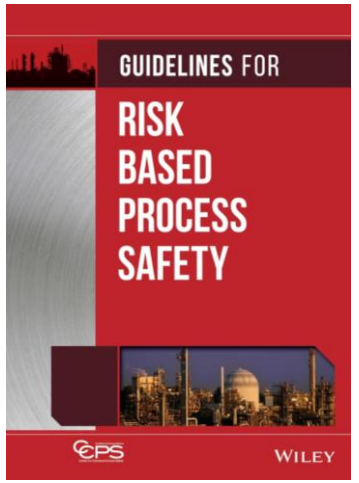
December 1984 – Bhopal incident causes 3,000+ fatalities & 500,000+ exposed/injured

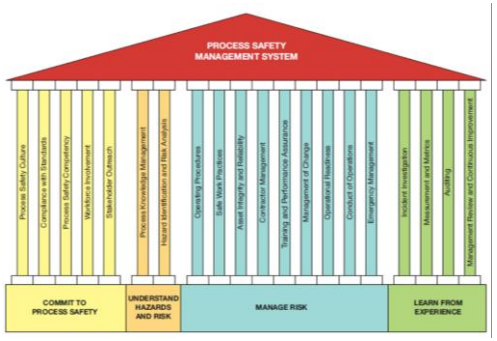
- Leaders from the chemical industry asked AIChE to lead a collaborative effort to eliminate catastrophic process incidents by advancing state of the art technology and management practices

March 1985 – AIChE forms the Center for Chemical Process Safety (CCPS) with 17 charter member companies.

To commit to process safety, facilities focus on four aspects:

1. developing and sustaining a culture that embraces process safety,
2. identifying, understanding, and complying with codes, standards, regulations, and laws,
3. establishing and continually enhancing organizational competence, and
4. soliciting input from and consulting with all stakeholders, including employees, contractors, and neighbors





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AcuTech's CCPS approach

- AcuTech recommended Process Safety Management (PSM) system
- 20 Elements of CCPS Risk Based Process Safety Management System
- **Organized by 4 Pillars:**
  - **Commit to Process Safety**
  - **Understand Hazards & Risks**
  - **Manage Risk**
  - **Learn from Experience**
- "Plan-Do-Check-Act"
  - Demming style continuous improvement & culture focused
- Influenced the CHS Planning Guidance update

AcuTech Model Process Safety Management System

Based on four underlying pillars supported by the 20 elements of the Center for Chemical Process Safety (CCPS) Risk Based Process Safety Model.

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Compliance & Process Safety Management Systems

- AcuTech approach combines best of AIChE technical knowledge:
  - CCPS RBPS
  - CHS Safety Planning Guidance

Compliance (14 Elements) OSHA	Compliance (RMP) EPA	Risk-Based (20 Elements) CCPS	CHS Safety Plan Hydrogen
Process Safety Information	Worst-Case Release Analysis	Process Knowledge Management	Description of Work
Employee Participation	Alternative Release Analysis	Process Safety Competency	Project Safety Documentation
Process Hazard Analysis (PHA)	5-Year Accident History	Workforce Involvement	Organizational Policies & Procedures
Compliance with Standards	Process Safety Information	Stakeholders Outreach	Involve All Parties & Stakeholders
Trade Secrets	Process Hazard Analysis (PHA)	Hazard Identification & Risk Analysis	Identification of Safety Vulnerabilities
Operating Procedures	Operating Procedures	Compliance with Standards	Risk Reduction Plan
Mechanical Integrity	Training	Operating Procedures	Codes & Standards
Management of Change	Mechanical Integrity	Asset Integrity & Reliability	Procedures
Pre Startup Safety Review (PSSR)	Management of Change	Management of Change	Equipment & Mechanical Integrity
Compliance Audits	Pre-Startup Safety Review (PSSR)	Operational Readiness	Management of Change
Training	Compliance Audits	Auditing	Safety Reviews
Hot Work Permit Process	Incident Investigation	Training & Performance Assurance	Training
Incident Investigation	Employee Participation	Safe Work Practices	Safety Events & Lessons Learned
Emergency Planning & Response	Hot Work Permit	Incident Investigation	Emergency Response
Contractors	Contractors	Emergency Management	Contractor Management
	Emergency Response	Contractor Management	Appendix B
		Management Review & Continuous Improvement	
		Process Safety Culture	
		Conduct of Operations	
		Measurement & Metrics	Hydrogen Fuel Cell Experience

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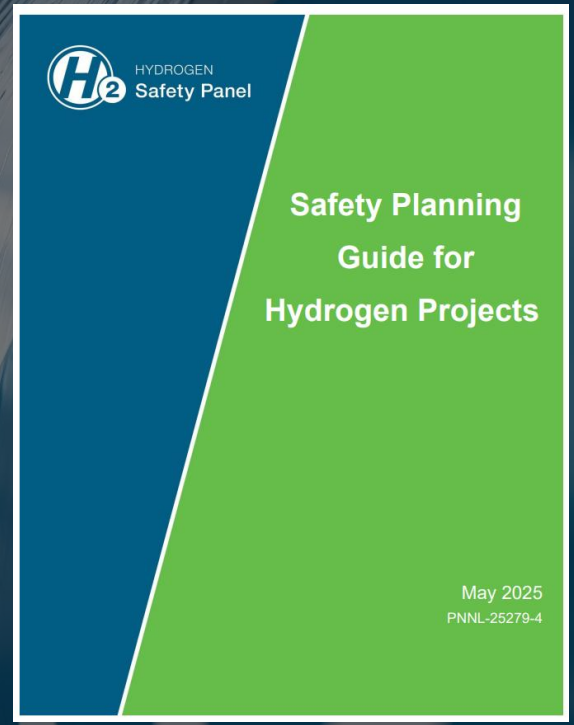
Hydrogen Safety Planning: Putting all the pieces together



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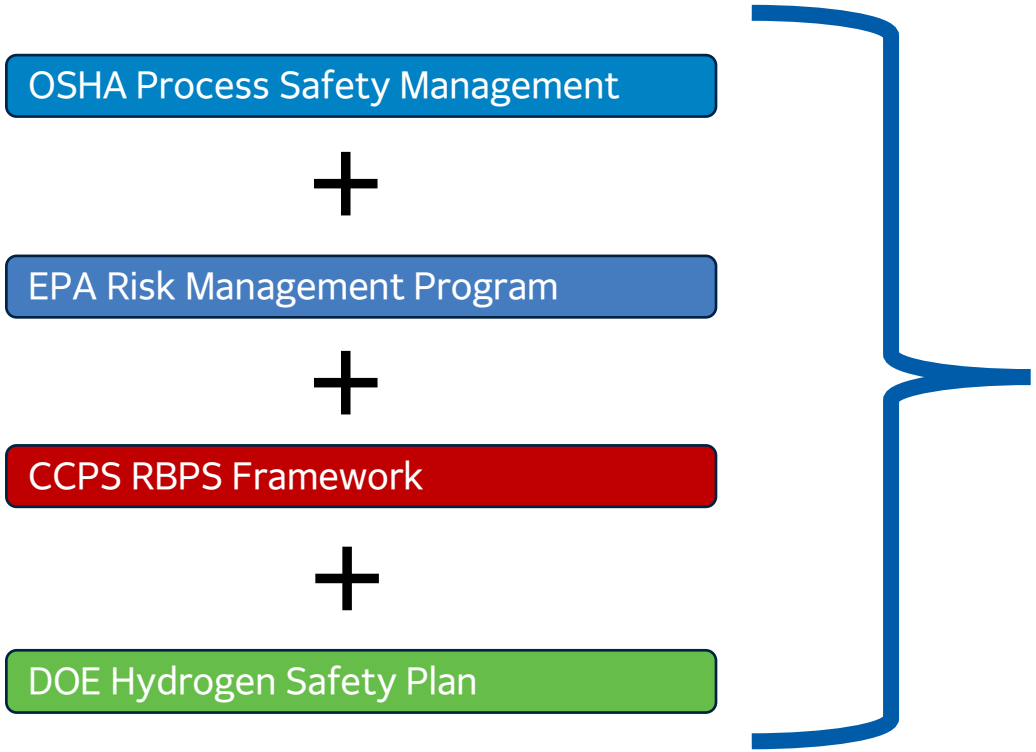
You Need a Plan!

A Comprehensive Safety Plan addresses compliance, best practices and provides a reference for change management.



AcuTech Recommends a Comprehensive Safety Plan

- Combine funding and compliance requirements with best practices into a single planning document
- Maintain a living document across all phases of the project, from concept to operations
- Address compliance needs and keep records for reference during operations

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Safety Planning Covers Compliance thru 4 Pillars

Based on four underlying pillars supported by the 20 elements of the Center for Chemical Process Safety (CCPS) Risk Based Process Safety Model.

4 Pillars	Safety Objective
1. Commit to Process Safety	Identify the worst case
2. Understand Hazards and Risks	Identify and plan for all that might go wrong
3. Manage Risk	Address changes from official review
	Build according to plan, make notes, review changes
	Check site, equipment and process readiness to operate
4. Learn from Experience	Maintain safe operations

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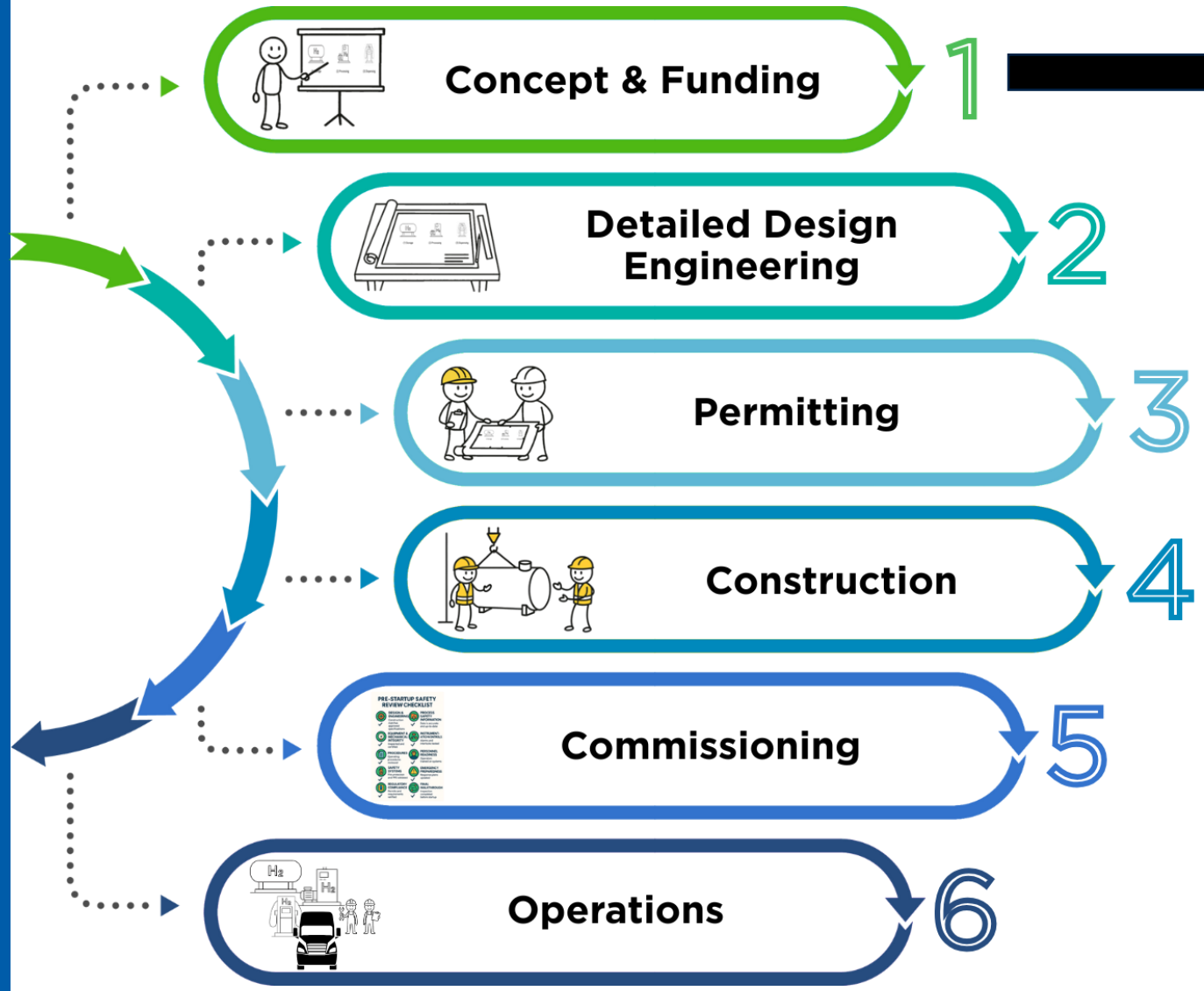
The Required Safety Plan



Safety Plan development (and government submission)

Example CEC Safety Plan requirements:

a. A detailed description of adherence to the most recent public guidelines* through the life of all stations.
b. A detailed description about how the Recipient will conform to NFPA 2, 2020 edition.
c. A detailed description of ongoing safety training for station personnel from initial operation through retraining over the life of each station.

*Links to H2Tools: Safety Planning Guide for Hydrogen Projects

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Comprehensive Safety Plan

Safety Plan Chapters	Safety Objective
1. Commit to Process Safety	Identify the worst case
2. Understand Hazards and Risks	Identify and plan for all that might go wrong
3. Manage Risk	Address changes from official review
	Build according to plan, make notes, review changes
	Check site, equipment and process readiness to operate
4. Learn from Experience	Maintain safe operations

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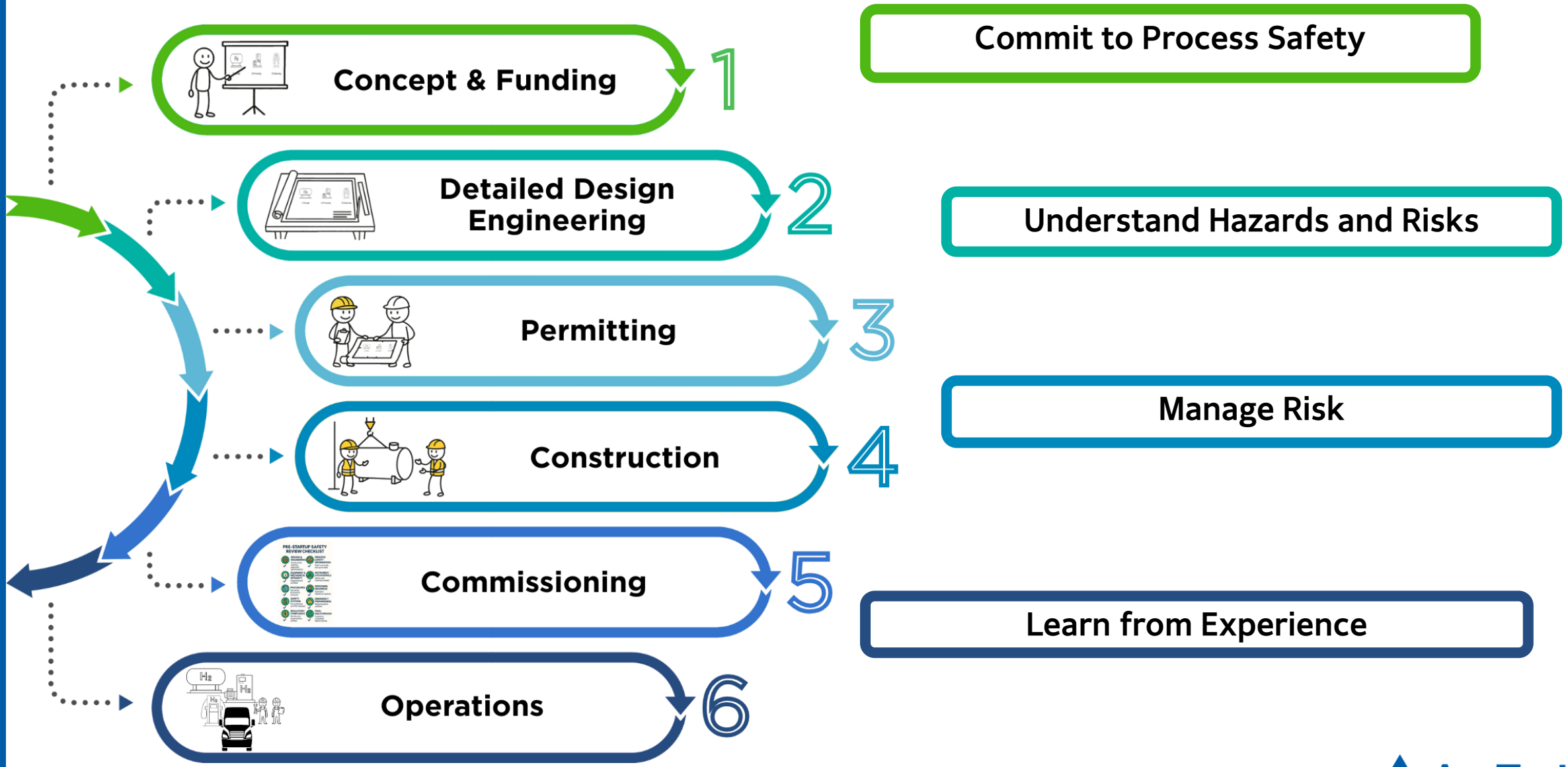
Living Document: Comprehensive Safety Plan



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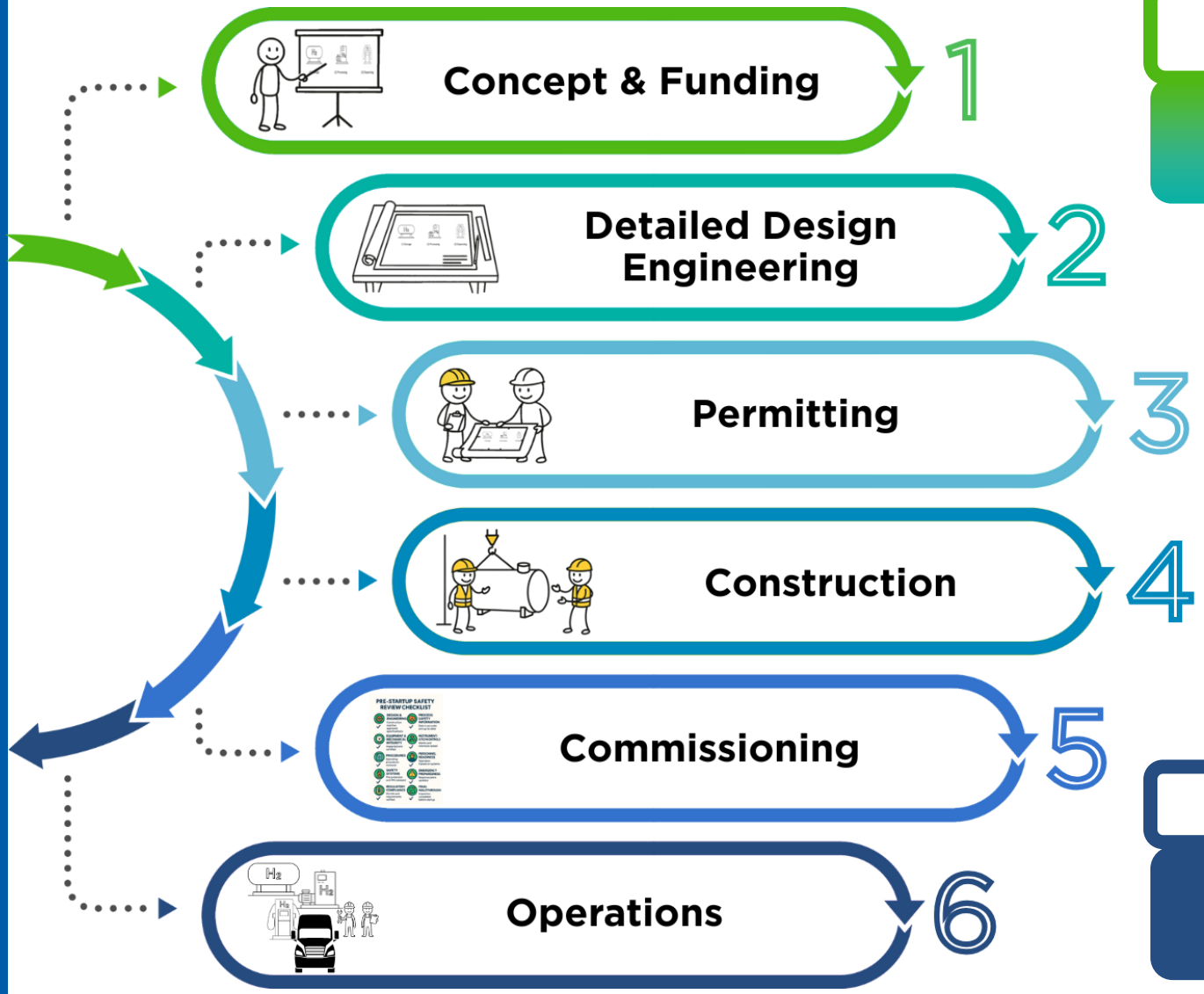
Living Document: Comprehensive Safety Plan



Commit to Process Safety

Safety Culture
Standards Compliance
Safety Competency
Workforce Involvement
Stakeholder Outreach

Understand Hazards and Risks

Process Knowledge Management
Hazard Identification & Risk Analysis
Prevention & Mitigation Control

Manage Risk

Operating Procedures
Safe Work Practices
Asset Integrity and Reliability
Training and Performance
Contractor Management
Management of Change
Operational Readiness
Conduct of Operations
Emergency Management

Learn from Experience

Incident Investigation
Measurement & Metrics
Auditing
Management Review
Continuous Improvement
Records of Decision

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AcuTech 'Downstream' Hydrogen Services

Project Phase	Scope of Work Details	Sample AcuTech Services
Concept & Funding	• Management establishes safety commitment, compliance, competency, workforce involvement	• Evaluation of site & equipment layout • **Develop initial Safety Plan** • Conduct HAZID with project team • Facility Siting Study
Detailed Design Engineering	• Process safety information developed and analyzed; unacceptable risks mitigated by elimination, reduction, or validated engineering solutions	• Conduct PHA using HAZOP/LOPA • Code Compliance Review • Consequence Simulation • QRA, functional safety assessment, reliability and availability assessment
Permitting	• Design & major equipment design changes stabilized	• Develop policies & procedures based on existing documents, site, equipment, process, hazard & compliance reviews, and RAGAGEP • Support training and workforce development • Support pre-startup safety review
Construction	• Design changes managed and hazards re-evaluated • Process and controls designs stabilized, process equipment installed, and controls programmed	
Commissioning	• Complete validations • Pre-startup safety review and operational readiness	
Operations	• Management review of KPIs, incidents, and audits	• Finalize Safety Plan and turn over to Operations • Support management review & continuous improvement

References and Helpful Links

1. AcuTech Hydrogen Services: https://acutech-consulting.com/services/hydrogen-safety-security/
2. H2Tools:
   - Safety Planning Resources: https://h2tools.org/hsp/reviews
   - Lessons Learned: https://h2tools.org/lessons
   - HIAD Database: https://h2tools.org/hiad-events
3. OSHA PSM and EPA RMP Regulations:
   - AcuTech Summary Slide: https://acutech-consulting.com/wp-content/uploads/2026/04/Federal-Regulations-OSHA-EPA.pdf
   - OSHA 29 CFR 1910 Subpart H: eCFR :: 29 CFR 1910.119 -- Process safety management of highly hazardous chemicals.
   - OSHA Letter of Interpretation for Hydrogen: https://www.osha.gov/laws-regs/standardinterpretations/2013-02-04-0
   - EPA RMP Guidance: https://www.epa.gov/rmp/risk-management-program-guidance-and-fact-sheets
   - EPA RMP List of Regulated Substances: https://www.epa.gov/rmp/list-regulated-substances-under-risk-management-program
4. CalARP:
   - Program Overview: https://calepa.ca.gov/california-accidental-release-prevention/
   - CalARP Program Levels: https://calepa.ca.gov/california-accidental-release-prevention/california-accidental-release-prevention-program-levels/
   - CUPA Boundary Zone Lookup: https://calepa.maps.arcgis.com/apps/instant/lookup/index.html?appid=0b581f6578bd4b6eb72f6e5982e9d8c3
5. LAFD CUPA:
   - RMP Summary: https://lafd.org/fire-prevention/calarp/fact-sheets/risk-management-plan
   - Annual CUPA Permits: https://lafd.org/fire-prevention/cupa-permits-annual
   - CUPA Project Permits: https://lafd.org/fire-prevention/cupa-permits-project
   - Additional Requirements: https://lafd.org/sites/default/files/pdf_files/small-business-compliance-manual.pdf
   - Fire Safety Plan – Chapter 4 LA Fire Code https://lafd.org/sites/default/files/pdf_files/small-business-compliance-manual.pdf
   - CalARP Registration Form: calarp-registration-form-v2.pdf
   - Public review process: https://lafd.org/fire-prevention/calarp/fact-sheets/public-review-process
   - CalEPA Title 19, Div 5, Chp 2 reference: https://calepa.ca.gov/wp-content/uploads/2024/08/California-Code-of-Regulations-Title-19-Division-5-Chapter-2-%E2%80%93-California-Accidental-Release-Prevention.pdf
6. AICHE CCPS RBPS: https://www.aiche.org/ccps/resources/publications/summaries/guidelines-risk-based-process-safety
7. Center for Hydrogen Safety: https://www.aiche.org/chs

THANK YOU

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