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A Tree Map Approach to Pre-Startup Safety Review (PSSR) for Electrolyte Storage System

Ekin Yurdakul Erkut(1), Bryan Haywood(2), James Bilimek(1), Samuel J. Little(1), Mathew Schwab(1)

(1) L-H Battery Company, Inc. , Jeffersonville, OH, (2) SAFTENG, Milford, OH

ABSTRACT

1. Pre-Startup Safety Review
   - PSSR is a systematic review for a new or modified process.
2. Electrolyte Hazards in Battery Manufacturing
   - Electrolytes are flammable liquids.
3. Tree Diagram/Map Methodology
   - An Excel macro-based approach
   - Transforms the complex checklist into an organized, hierarchical, and readable diagram

OSHA PSM[1] and EPA RMP[2] Compliant: Electrolyte [3]:

Class:	Flammable Liquid
Condition:	Flash Point < 100 °F (37.8°C)
Threshold:	10,000 pounds (4535.9 kg) or more on site in one location

TREE MAP APPROACH

In our model, the main tree is PSSR, and the main branches are the other 13 PSM elements.

- The sub-branches consist of control items specific to each element. Beyond the 13 OSHA PSM elements (excluding PSSR), an 'Other' category has been added. This section covers additional EPA and OSHA requirements, such as air and water permits, the industrial hygiene plan, and waste disposal protocols.

The checklist shared by AIChE in the Guidelines for Performing Effective Pre-Startup Safety Reviews [14] has been simplified and divided into branches.

PSSR Category/ Item	*Status? (YES / NO and NA)*	*If it is YES, NOTE*	*If it is NO, Action Item Description(s)*	*If it is NO/YES, Assigned to:*	*If it is NO, Due Date*	*If it is Not Applicable, WHY?*
Operating Procedures						
Process Safety Information						
Management of Change						
Process Hazard Analysis						
Mechanical Integrity						
Contractor Safety						
Emergency Planning and Response						
Employee Participation						
Hot Work Permit						
Incident Investigation						
Audit						
Trade Secret						
Training						
Other						

The purpose of this methodology is to visualize all components, including their completion percentages and main branches, using color coding. This must be completed before startup and the introduction of Highly Hazardous Chemicals to system.

	Checklist	Tree Map/Diagram
Data Structure	Linear	Hierarchical
Risk	High (complex)	Minimized (red color visually block system greenlight)
Progress	Manual	Dynamic, macro-driven
Visibility	Text-heavy, line-by-line reading	Color-coded

- Microsoft Excel macros automatically generate this entire diagram from standard checklist data.
- The system calculates the except percentage of complete and incomplete nodes.
- Main headings in the Tree Map and Summary Table changes color strictly based on their completion percentage.

INTRODUCTION

Electrolyte:

High Flammability and Thermal Decomposition [10,11,12]:

Electrolytes (LiPF6 is widely used in lithium-ion batteries [6,3]) decompose at high temperatures to form Hydrogen fluoride (HF)

High Moisture/Water Reactivity [10]:

$$LiPF_6 + H_2O \rightarrow LiF + POF_3 + 2HF$$

Important parameters [7,8,9]:
Temperature and Humidity

HF is a highly toxic substance.
Generation of HF, causing severe pipeline/tank corrosion[13] leading to long-term safety/mechanical integrity problems!

Incidents:

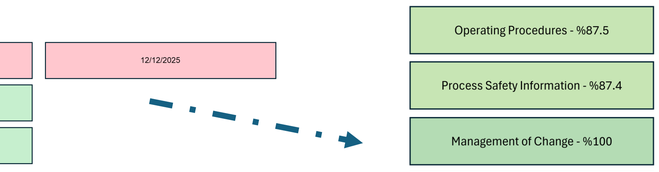
BP America, Texas [4]

Failure: If the PSSR had been completed before the Isomerization Unit start-up:
- The need for repair of the splitter level transmitter, malfunctioning of the control valves, etc. could have been identified.

Williams Geismar, Louisiana[5]

Failure: If PSSR questions were answered completely and correctly before process changes of propylene fractionator reboilers:
- The new process over pressurization hazard could have been identified.

Process: electrolyte storage systems, distribution/transfer of electrolyte, and electrolyte injection/packaging of battery cells:



Prioritizing safety in PSM-covered processes is not just a regulatory requirement, but a fundamental responsibility to protect people and the environment.

Pre-Startup Safety Review (PSSR)

- Verify that equipment has been placed in accordance with the design specifications
- Ensure that completion of safety critical equipment functional test, instrument test and calibrations.
- Validates that safety, maintenance, emergency, and operating procedures are written and employees are trained.
- Conduct the PHA where necessary and confirm its recommendations have been resolved.

Last Safety Barrier before Operation after Changes and/or Install a Plant!

IMPLEMENTATION

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CONCLUSION

PSSR: Validates electrolyte storage and packing system safety and integrity before startup.

Risk: Using a PSSR Tree Diagram/Map methodology prevents oversights by visualizing complex, multilayered checklists.

Management: Progress tracking makes the review process manageable.

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