QC, Risk, and Safety Overview

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PIP-II LINAC Complex Mechanical Fluid Systems PDR

April 21, 2021

A Partnership of:
- US/DOE
- India/DAE
- Italy/INFN
- UK/UKRI-STFC
- France/CEA, CNRS/IN2P3
- Poland/WUST

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- Quality Control
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Quality Control (QC) Plan

- PIP-II Linac Installation Commissioning QA Plan (Document number: pip2-docdb-2611)
- PIP-II Building Infrastructure Materials Quality Control Plan (Document number: *PIP-II-Doc-ED0013639)*
- QA/QC by project phase:
  - Before Installation
    - Plans and Specifications, Sequence of Operations, Commissioning Procedures
    - Preliminary and Final Design Reviews to verify system designs
    - Coordination and sign offs from other L3s for rack locations
  - During Installation
    - Vendor visits
    - Receiving Inspections
    - Construction oversight and change order processes
  - After Installation
    - Acceptance Inspections/Testing
    - Commissioning
    - Training
    - Procurement Quality / Supplier Quality
    - Issues Management (Corrective Action/Preventive Actions)
  - Lessons Learned (in process)

Quality Control (QC) Plan (Continued)

- Installation Plan – In Stages
  - LCW
    - F37 Service Building Pump Room
    - BTL Enclosure, Absorber, High Bay Building Warm Front End
    - Connection to accelerator components – coordinated with Accelerator Complex Upgrades/BTL Installation group under a separate scope
  - PCW
    - Utility Plant Pump Room, Utility Bridge
    - LINAC Gallery
    - High Bay Building/Warm Front End
    - Connection to LINAC Gallery components – coordinated with LINAC Installation group under a separate scope

Quality Control (QC) Plan (Continued)

- Sequence of Installation
  - Equipment mounted; pipe supports installed; piping connected
  - Acceptance of physical installation
  - Pneumatic (snoop) pressure test
  - Hydrostatic pressure test (test and final acceptance may be delayed).
  - Coordination with Fermilab designated personnel (i.e. Task Manager)

Risk Assessment Summary for Mechanical Fluid Systems

Fermilab

Engineering Risk Assessment

Project: PIP-II Building Infrastructure - Mechanical
Lead Engineer: Maurice Ball
Reviewed By: Sample
Date: April 19, 2021

	Chapter	Engineering Risk Element								High Risk	Subtotal	Assessment
		A	B	C	D	E	F	G	H			
1	Requirements and Specifications	2	2				2		1	≥ 12	7	Standard Risk
3	Requirements and Specification Review	2	2		3	1	2		1	≥ 18	11	Standard Risk
4	System Design	2	2	2		1	2	1	1	≥ 21	11	Standard Risk
5	Engineering Design Review	2	2	2		1	2	1	1	≥ 21	11	Standard Risk
6	Procurement and Implementation		2		3	1	2	1	1	≥ 18	10	Standard Risk
7	Testing and Validation	2				1	2	1	1	≥ 15	7	Standard Risk
8	Release to Operations						2			≥ 4	2	Standard Risk
9	Final Documentation		2				2			≥ 7	4	Standard Risk

Project Risk Element								High Risk	Subtotal	Assessment
I	J	K	L	M	N	O	P			
2	3	1	1	1	2	1	2	≥ 25	13	Standard Risk

Engineering Risk Elements	
A	Technology
B	Environmental Impact
C	Vendor Issues
D	Resource Availability
E	Quality Requirements
F	Safety
G	Manufacturing Complexity
H	Transportation and Rigging Complexity

Project Risk Elements	
I	Schedule
J	Interfaces
K	Experience / Capability
L	Regulatory Requirements
M	Project Funding
N	Project Reporting Requirements
O	Public Impact
P	Project Cost

Risk – Technical and Safety

- We have a process for assessing technical and safety risk.
- We have started drafting these and will complete them in the near future (i.e. within the next few weeks)
- Safety Risk
  - Prevention through Design Table == Personnel Risk/Safety
- Technical Risk
  - FMEA == Failure Mode and Effect Analysis

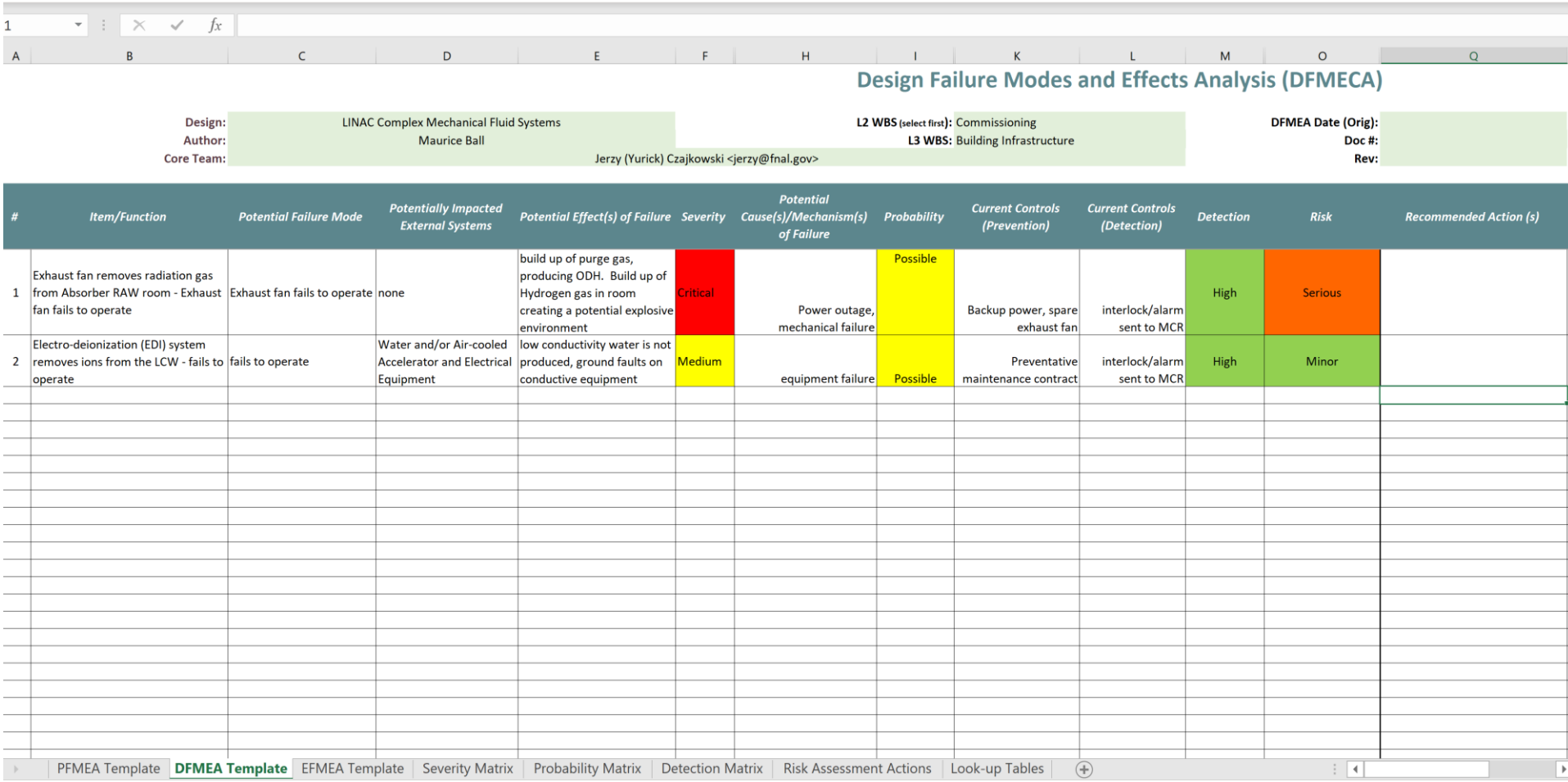
FMEA - Personnel Risk/Safety - Prevention through Design Table

Prevention through Design (PtD) Hazard Risk Assessment

Date: 10/31/2019 **Assessed By:** Yurick Czajkowski **Design Phase** Conceptual
System: Building Infrastructure - Mechanical **WBS Assessed** 121.04.04.03

Identifier	Potential Hazard Description	Life Cycle Stage	Who is at risk?	What is at risk?	Pre-Mitigation Severity	Pre-Mitigation Probability	Pre-Mitigation Risk Score	Mitigations	Post-Mitigation Severity	Post-Mitigation Probability	Post-Mitigation Risk Score	Mitigation Action	Status of Implementation	Comments
	RAW Leak	Operations	Personnel working on/near skid	electrical equipment (power panel, control enclosures), environment, operation interuption	Minimal	B - Likely	4 - Minor	Technical specifications for how to remove RAW water	Minimal	B - Likely	4 - Minor	No Action Required	Implemented	Could we consider better seals/magnetic driven pump?, what if nitrogen causes ODH issue
	LCW Leak	Operations	Personnel/Contractors working on system	electrical equipment (amplifiers, racks, power panels, transformers), operation interuption	Medium	C - Possible	3 - Moderate	follow AD-MS design standards, Alarm/trip on water temp,	Medium	C - Possible	3 - Moderate	No Action Required	Implemented	water moved to ground? Radiography (5 yrs.) (10 gauge)
	Compressed Air Leak	Operations	Personnel working on or near compressed air	Equipment damage, loss of control	Medium	C - Possible	3 - Moderate	Use compression fittings, follow AD-MS standards, Alarm/trip for High Pressure	Low	C - Possible	3 - Moderate	No Action Required	Implemented	clamp free length, remove unused hose?,
	Stored Energy	Operations	Personnel working on equipment		Medium	C - Possible	3 - Moderate	FESHM LOTO, Interlocks (flow, pressure), pressure gauges for personnel	Medium	C - Possible	3 - Moderate	No Action Required	Implemented	
	Shock Hazard	Operations	Personnel		High	C - Possible	2 - Serious	Add switch rated wet environment disconnects	Low	D - Unlikely	4 - Minor	Integrate into Design	In Process	

FMEA - Technical Risk



Design Failure Modes and Effects Analysis (DFMECA)

Design:	LINAC Complex Mechanical Fluid Systems	**L2 WBS (select first):**	Commissioning	**DFMEA Date (Orig):**	
Author:	Maurice Ball	**L3 WBS:**	Building Infrastructure	**Doc #:**	
Core Team:	Jerzy (Yurick) Czajkowski <jerzy@fnal.gov>			**Rev:**	

#	Item/Function	Potential Failure Mode	Potentially Impacted External Systems	Potential Effect(s) of Failure	Severity	Potential Cause(s)/Mechanism(s) of Failure	Probability	Current Controls (Prevention)	Current Controls (Detection)	Detection	Risk	Recommended Action (s)
1	Exhaust fan removes radiation gas from Absorber RAW room - Exhaust fan fails to operate	Exhaust fan fails to operate	none	build up of purge gas, producing ODH. Build up of Hydrogen gas in room creating a potential explosive environment	Critical	Power outage, mechanical failure	Possible	Backup power, spare exhaust fan	interlock/alarm sent to MCR	High	Serious	
2	Electro-deionization (EDI) system removes ions from the LCW - fails to operate	fails to operate	Water and/or Air-cooled Accelerator and Electrical Equipment	low conductivity water is not produced, ground faults on conductive equipment	Medium	equipment failure	Possible	Preventative maintenance contract	interlock/alarm sent to MCR	High	Minor	

PFMEA Template | DFMEA Template | EFMEA Template | Severity Matrix | Probability Matrix | Detection Matrix | Risk Assessment Actions | Look-up Tables

ES&H

- Construction of Building Infrastructure will be in full compliance with the PIP-II Integrated Safety Management Plan (docdb #141) developed by the Project ES&H Coordinator
- Work with ES&H Coordinator to define mitigations for the following hazards:
  - Electrical
  - Welding/cutting/brazing
  - Pressurized systems
  - Cooling water
  - Material handling and rigging