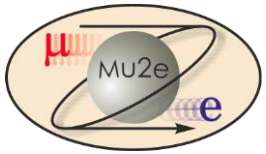
Fermilab

Risk Management
Conventional Construction

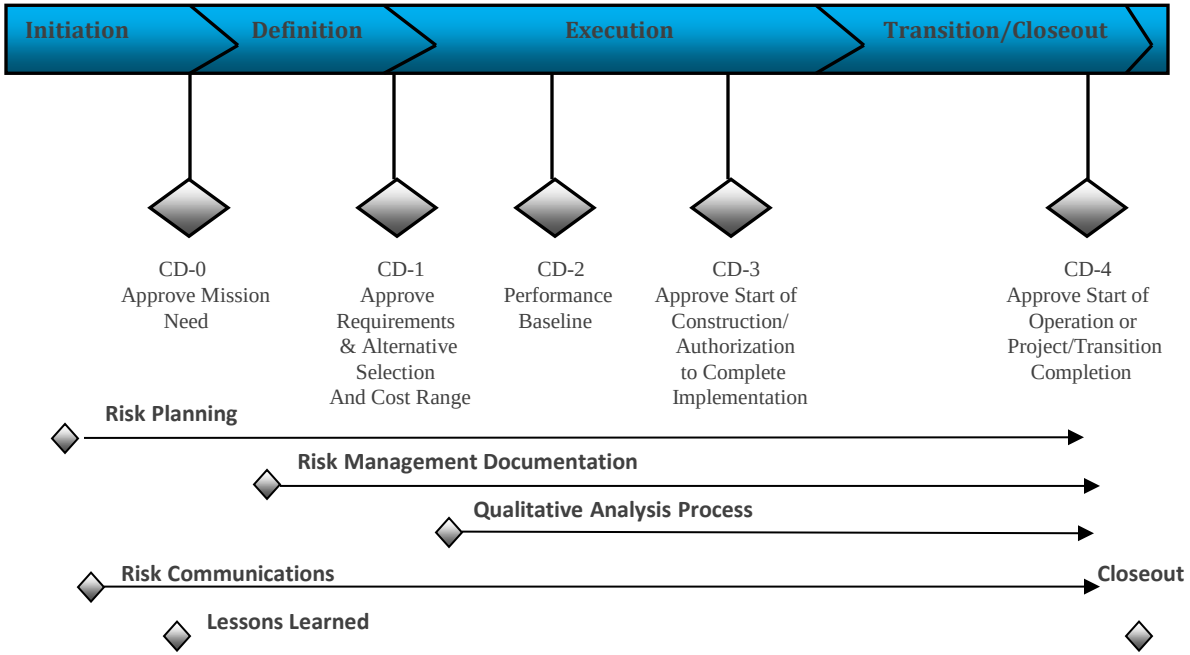


T. Lackowski

L2 Manager

10/22/2014

RISK MANAGEMENT DURING CD PHASES



Critical Decision Phases with continuous and iterative risk management.

KEY ELEMENTS OF RISK MANAGEMENT

1. Risk Planning
2. Risk Identification
3. Qualitative Risk Analysis
4. Quantitative Risk Analysis
5. Risk Handling and Mitigation Strategies
6. Risk Monitoring

Risk Identification

- Identified and documented Risk items.
- Clearly state the risk event and impact to the Project.
- Note the interdependencies within the Project.
- Compile and review risks at the subproject level, then submit to Project Office.
- Project Manager determines which risks are above threshold that will be held in the Project Risk Registry”
  - Currently, Mu2e Risk Register contains two Conventional Construction risks that are held by the L2 and one risks that are held by the Project Manager.
  - Lower level risks are held by the Conventional Construction L2.

Risk Analysis Tools Qualitative

Table 1: Impact Assessment Matrix. Impacts range from *Very Low* to *Very High*.

Impact / Risk	Very Low	Low	Moderate	High	Very High
Cost	< $50K	$50K - $100K	$100K - $250K	$250K - $500K	> $500K
ES&H	Negligible	Minimal	Concern	Significant risk	High risk
Schedule	Delays Level 3 milestone or Project critical path by < 1 month	Delays Level 3 milestone or Project critical path by 1 - 3 months	Delays Level 3 milestone or Project critical path by 3 - 6 months	Delays level 3 milestone or Project critical path by 6 – 9 months	Delays Level 3 milestone or Project critical path by > 9 months
Technical	Negligible	Negligible, if any, degradation.	Significant technical degradation.	Technical performance effectively useless for attaining physics objectives.	Technical performance useless for attaining physics objectives.

Table 2: Risk Classification Matrix

	Impact				
Probability	Very Low	Low	Moderate	High	Very High
Very High (> 90%)	Low	Moderate	High	High	High
High (75% – 90%)	Low	Moderate	Moderate	High	High
Moderate (25% - 75%)	Low	Low	Moderate	High	High
Low (10% - 25%)	Low	Low	Moderate	Moderate	High
Very Low (< 10%)	Low	Low	Low	Low	Moderate

Table 1: Impact Assessment Matrix. Impacts range from *Very Low* to *Very High*.

Impact / Risk	Very Low	Low	Moderate	High	Very High
Cost	< $50K	$50K - $100K	$100K - $250K	$250K - $500K	> $500K
ES&H	Negligible	Minimal	Concern	Significant risk	High risk
Schedule	Delays Level 3 milestone or Project critical path by < 1 month	Delays Level 3 milestone or Project critical path by 1 - 3 months	Delays Level 3 milestone or Project critical path by 3 - 6 months	Delays level 3 milestone or Project critical path by 6 – 9 months	Delays Level 3 milestone or Project critical path by > 9 months
Technical	Negligible	Negligible, if any, degradation.	Significant technical degradation.	Technical performance effectively useless for attaining physics objectives.	Technical performance useless for attaining physics objectives.

Project Risk Form

Mu2e Risk Form

Risk Identifier:	T. Lackowski	**Risk Owner:**	T. Lackowski
Risk ID:	CONST-050	**Risk Type:**	THREAT
Date:	11/1/2013	**Date revised:**	

Risk Title: Conventional construction bids exceed estimated cost.

Risk Description: The world, national or local construction market experiences high volumes of work at the time the project requests proposals for construction are issued.

Detailed Risk Cause: High demand for construction services.

Detailed Risk Effect: Cost increase to the Project along with the risk that less qualified contractors are the only ones looking for work.

WBS Affected: 1.3

Other WBS Affected:

Actual Start Date (when available from schedule)	Actual Finish Date (when available from schedule)
FY14	FY14

Initial Risk Analysis – (description of selection of impacts and probability, text length commensurate with risk complexity): Since 2008 a depressed overall economy has resulted in more competition between contractors lowering pricing on general construction. Will obtain proposals prior to Baseline CD-2 review. Since 2008 a number of contractors have been forced out of business due to the competition, possibly limiting the number of interested contractors and leading to increased costs.

Initial Risk Probability and Impact scores selected from Mu2e Risk Management Plan (Mu2e-doc-461) Tables 1 and 2

Initial Probability (VH,H,M, L,VL)	Initial Schedule Impact (Delays Level 3 milestone or project critical path by) in days (VH,H,M,L,VL)	If HIGH SCHEDULE IMPACT, Upper Bound of Current Schedule Impact (Days)	Initial Cost Impact (VH,H,M,V,VL)	If HIGH COST IMPACT, Upper Bound of Current Cost impact ($)	Initial Scope Impact (VH,H,M,L,VL)	Initial ES&H and Quality Impact (VH,H,M,L,VL)
M	N		VH	$1,200,000	N	N

Exposure (What the risk will cost when it occurs):
10% of estimated construction cost. $1,200,000 plus 3months for change control.

Initial Risk Mitigation Plan considered in the Initial Risk Analysis and included in the Base Plan Cost and Schedule:
Schedule has been advanced to try and take advantage of the construction market that has not yet fully recovered.

Base Plan Mitigation Cost ($)	Base Plan Mitigation Cost Uncertainty ($)	Start and Finish Dates or Description of Current Mitigation Plan Duration
0		Start 47503.02.05.1050 Mar 5 2014 Finish 47503.04.01.1010 Aug 8 2014

New Mitigation Plan or Additional Risk Mitigation Measures Description:
Obtain proposals prior to Baseline CD-2 review. This risk will be retired or accepted to a quantifiable amount prior to baselining.

Response Type (Accept, Reduce, Avoid, Transfer)	New or Additional Mitigation Cost Range ($)		Schedule impact of undertaking the mitigation plan – delays Level 3 milestone or project critical path (Days)		Probability of plan failing to achieve expected mitigation (H,MH,ML,L)
	Low Bound	Upper Bound	Lower Bound	Upper Bound	
Accept					

Residual/Current Risk Probability and Impact Scores:

Residual/ Current Probability (VH,H,M, L,VL)	Residual Schedule Impact (Delays Level 3 milestone or project critical path (Days) (VH,H,M, L,VL)	If HIGH SCHEDULE IMPACT, Upper Bound of Residual Schedule Impact (Days)	Residual Cost Impact (VH,H,M, L,VL)	If HIGH COST IMPACT, Upper Bound of Residual Cost Impact ($)	Residual Scope Impact (VH,H,M, L,VL)	Residual ES&H and Quality Impact (VH,H,M, L,VL)
L	N		VH		N	N

Additional Notes:

Point estimate (cost k$)	Point Estimate (schedule-days)	Point estimate (probability)	EXPECTATION VALUE IN k$	EXPECTATION VALUE IN Days
$1200k	60	10%	$120k	6

Lower Level Risks

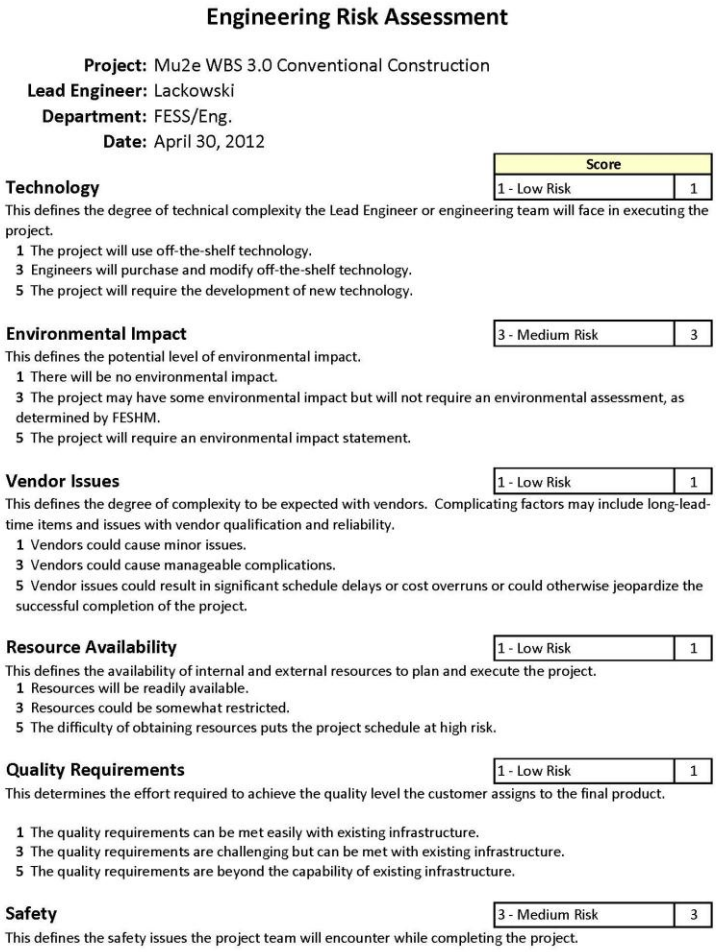
- Project level risks were generated from the sub-project risk registry.
- Lower level risks are reviewed monthly at the sub-project level.

Risk Document

	Potential Problem	Probability	Impact	Severity	Type	Owner	Likely Causes	Consequence	Mitigation	Status
1.1 Project Management										
1.3 Conventional Construction										
1	Inadequate FESS/Eng Resources	Moderate	Moderate	Moderate	C, S, T	T. Lackowski	Lab management directs talent to other FRA projects	Higher A&E costs, slower development of project documents	Accellerate efforts and production of documents before other projects become critical	Retired - Documents complete
2	Design Development Late	Moderate	Moderate	Moderate	S	T. Lackowski	Development of Criteria for Technical Equipment late for project schedule	Project reviews not properly executed, project delays	EStablish schedule requirements; Employ EVMS on A&E contract	Retired
3	Increased shielding requirements	Moderate	Moderate	Moderate	C, S	T. Lackowski	Shielding requirements increase requiring deeper excavation/ additional Structure	Deeper Excavation / Additional Structure	Beam Energy lowered from 25 to 8 MW. Maintain communications with those establishing shielding criteria	Retired - Prelim Radiation Assessment Approved
4	Scientific Equipment Increase in Dimension	Moderate	High	High	C, S	T. Lackowski	Technical Requirements significatly increase dimension of structures	Building increases in size and cost	PM has clearly stated that the experiment will need to change to fit building	Retired
5	High Radiation Source	Low	High	Moderate	C, E	T. Lackowski	Groundwater Protection Requirements	Requires additional shielding		Retired - Prelim Radiation Assessment Approved
6	Design Development Late	Low	Moderate	Moderate	C, S	T. Lackowski	Funds not availble for design development or funds arrive too late	Final desing late in starting	Estabished requirements from other L2's in schedule, reported on progress at weekly tech board meeting	Retired - Completed
7	EA required	Low	High	Moderate	C, S, E	T. Lackowski	Site delineation finds Hazardous wast or environmental impact	High impact costs for cleanup with schedule and permit fillings	Cleanup of site to allow construction to proceed	Retired - NEPA in hand
8	Unforeseen/Undocumented Subsurface Conditions	Low	Moderate	Moderate	C	T. Lackowski	Pockets of unsuable soils, or large boulders	Claims and delays in excavation activities	Design foundation system to bridge poor soils.	Ongoing - Boring program completed
9	Safety Incident	Low	High	Moderate	S, E	T. Lackowski	Significant Injury or Death	Stop Work Placed, Type A or B investigation		Risk Transferred to Project Management
10	Ongoing Operational Constraints	Moderate	Moderate	Moderate	S	T. Lackowski	The contractor does not get outages or tie-ins as scheduled	Imposed construction delay	Utilities are bing routed around the project	Retired
11	Submittal Of Contractor Substantial Claim	Moderate	Moderate	Moderate	C	T. Lackowski	The AE or GC submits a substantial claim	Additional contract cost	Monitor contractor activities closely during out of scope work	Accept
12	Construction Market - Materials & Labor - Unavailability Of Subcontractors/Construction Workforce- Proposals are high	Moderate	Moderate	Moderate	C, S	T. Lackowski	The world, national, or local construction market is experiencing high volumes of work at the time the project requests proposals for construction (as may occur in response to efforts to stimulate the world economy)	Costs exceed availble funds		Accept
13	Construction Market - Proposals Come In Low	Moderate	Moderate	Moderate	C, S	T. Lackowski	The world, national, or local construction market is experiencing low volumes of work at the time the project requests proposals for construction.			Accept
14	Requirement Changes	Low	Moderate	Moderate	C, S, T	T. Lackowski	The Scientific Requirements Change	Increase scope and cost	Place building design under change control	Risk transferred to Project Management
15	Delay In Critical Decisions	Moderate	Moderate	Moderate	S	T. Lackowski	CD-2 and CD-3 approval takes longer than scheduled	Schedule delay, cost escalation		Accept
16	Field Permit Delays	Low	Moderate	Moderate	S	T. Lackowski	Key permits (dig permit, State of Illinois air/water, etc.) are not received in time	Delay construction start	Obtain permits early	Substantially Retired
17	Late Equipment/Material Deliveries By GC	Moderate	Moderate	Moderate	S	T. Lackowski	Major equipment/material is delivered late or damaged	Schedule delay	Monitor submittals	Accept
18	Owner-Caused Delays	Low	Low	Low	C, S, T	T. Lackowski	Interferences from site operational or other construction activities, excessive design changes, delayed business operations (delayed payments, prolonged contract modifications) cause construction impacts	Claims and schedule delays	Comment and Compliance review has provided notification, presentations to PMG, Fess Operations. Delivery Ring shut down	Accept
19	Design Phase Construction Estimates Are Higher Than Budgeted	Moderate	Moderate	Moderate	C	T. Lackowski	The estimates are higher than Project baseline estimate	Will need to reduce scope	Perform early estimate and revise design if needed	Retired
20	Support Costs Not Adequately Established	Low	Low	Low	C	T. Lackowski	Costs of support by Fermilab support groups go over the agreed budget	Increase costs	Costs included for utility locates, survey and alignment and FESS Operations	Accept
21	Changes Or Losses Key Personnel	Moderate	Moderate	Moderate	S, T	T. Lackowski	The project team has a turnover of key personnel	Loose design continuity		Accept
22	Additional Support Costs Due To Delays	Moderate	Low	Low	C,S	T. Lackowski	Construction extends beyond the current scheduled completion date.	Cost overrun		Accept
23	Design Changes	Moderate	Moderate	Moderate	C, T	T. Lackowski	Customer causes a discretionary change or enhancement in the approved design late in the design phase	cost increase and schedule delay	Place design under change control	Retired
24	AE Design Team Changes Or Loses Key Personnel	Moderate	Moderate	Moderate	C,S	T. Lackowski	The AE design team has a turnover of key personnel	schedule delay	After completion of documents some of the A&E team have left (Civil, Mechanical)	Accept
25	Final Design Delayed	Moderate	Moderate	Moderate	S	T. Lackowski	The AE design team does not deliver the final design on time	Schedule delay		Retired
26	Errors & Omissions In Design By A-E	Moderate	Moderate	Moderate	C	T. Lackowski	There are errors and omissions in the design	Claims, structural or serviceability failure	Design reviewed using several avenues; A&E sealed contract documents	Accept
27	Delay In Procurement Approval Process	Moderate	Moderate	Moderate	C, S	T. Lackowski	The procurement process experiences approval delays that take longer than normal	Schedule delay		Accept
28	Contractor Selected Cannot Complete Work Satisfactorily Or Defaults On Contract	Low	High	Moderate	C, S	T. Lackowski	An inexperienced or weak vendor/sub is selected (award of contract)	Schedule delay	Bonding required, Procurement made finacial assessment	Accept
29	Disruptions To An Fermilab Facility	Low	Low		T	T. Lackowski	The contractor breaks or damages a utility system. Excessive dust, vibrations, or noise created.	Could terminate beam in one or more accellerators	Plan routes utility out of excavation	Retired
30	CUB Chilled Water System Inadequate	Low	Moderate	Moderate	C, T	T. Lackowski	CUB chilled water system does not adequately provide cooling water for mu2e		Flow and capacity is adequate for loads	Transferred to operations
31	ICW System Inadequate	Low	Moderate	Moderate	C, T	T. Lackowski	ICW does not adequately provide cooling water for mu2e		Pressure and flow has been evaluated and meets the fire protection needs	Retired - ICW not used for cooling
32	Inadequate Attention To Safety	Low	High	Moderate	S, E	T. Lackowski	There is inadequate attention to safety (such as may be evidenced by a serious accident or injury, or by minor occurrences that indicate a poor performance trend).	Work stoppage	Increase safety representatives requirements in subcontract documents	Transferred to Project Management
33	Storm Water Pollution Plan Or Implementation Inadequate	Low	Moderate	Moderate	S, T	T. Lackowski	Storm water pollution prevention plan is not adequate. (Necessary documents may not be prepared/submitted, necessary controls may not be implemented, and necessary inspections may not be performed.)	Delay start of work	Optain permit early	Retired - SWPPP on file for Muon Campus
34	System Performance Does Not Meet Criteria	Low	High	Moderate	C, S, T	T. Lackowski	HVAC, electrical, plumbing, or structural do not meet the criteria	Work needs to be revised to meet criteria	Interfaced with stakeholders; requirements documented	Accept
35	Quality Deficiencies With Installed Construction Components	Low	Moderate	Moderate	S, T	T. Lackowski	Construction components (concrete, rebar, etc.) are not properly installed and inspected	Less functionality of equipment		Accept

Engineering Risk Assessment

- Assessments were completed by each sub-project.
- 2225



Engineering Risk Assessment

Project: Mu2e WBS 3.0 Conventional Construction
Lead Engineer: Lackowski
Department: FESS/Eng.
Date: April 30, 2012

	Score	
Technology	1 - Low Risk	1

This defines the degree of technical complexity the Lead Engineer or engineering team will face in executing the project.
1 The project will use off-the-shelf technology.
3 Engineers will purchase and modify off-the-shelf technology.
5 The project will require the development of new technology.

Environmental Impact	3 - Medium Risk	3

This defines the potential level of environmental impact.
1 There will be no environmental impact.
3 The project may have some environmental impact but will not require an environmental assessment, as determined by FESHM.
5 The project will require an environmental impact statement.

Vendor Issues	1 - Low Risk	1

This defines the degree of complexity to be expected with vendors. Complicating factors may include long-lead-time items and issues with vendor qualification and reliability.
1 Vendors could cause minor issues.
3 Vendors could cause manageable complications.
5 Vendor issues could result in significant schedule delays or cost overruns or could otherwise jeopardize the successful completion of the project.

Resource Availability	1 - Low Risk	1

This defines the availability of internal and external resources to plan and execute the project.
1 Resources will be readily available.
3 Resources could be somewhat restricted.
5 The difficulty of obtaining resources puts the project schedule at high risk.

Quality Requirements	1 - Low Risk	1

This determines the effort required to achieve the quality level the customer assigns to the final product.
1 The quality requirements can be met easily with existing infrastructure.
3 The quality requirements are challenging but can be met with existing infrastructure.
5 The quality requirements are beyond the capability of existing infrastructure.

Safety	3 - Medium Risk	3

This defines the safety issues the project team will encounter while completing the project.

Mitigations and Monitoring

- Mitigation plans are developed by the risk owner and implemented into the project plan
- The risk owner has a significant role in risk monitoring.
- The risk owner will update information on the risk item's form promptly following recognition.
- After CD-2, the Risk Manager will prepare a monthly report that identifies any and all changes to the Risk Register in the previous month.
- The lower conventional construction risks are reviewed monthly by the owner.

Summary

- Mu2e has a solid foundation of risk entries that all members have agreed on.
- A Risk Management Plan has been developed by the project.
- Mu2e has determined that the Project's Risk Program is acceptable and ready for a CD-2/3b approval.
- Iterative process will continue throughout the life cycle of the Project.
- Both project level risks and sub-project level risks are tracked, and monitored.