REPORT ON

NOvA PROJECT COST-TO-COMPLETE/CORRECTIVE ACTIONS ASSESSMENT

December 2012

Fermilab

Contents

EXECUTIVE SUMMARY

The NOvA Project is well along in the construction phase of the project. The Accelerator and NuMI Upgrades (ANU) will complete its accelerator shutdown work in spring 2013 and the detectors are scheduled to be completed in spring 2014. The planned early date for CD-4 is May 2014. Although significant technical progress and risk reduction have recently been achieved in both the ANU and detectors, remaining contingency is low.

An independent assessment of the cost to complete and needed contingency on work to go was requested by the Fermilab Directorate, and conducted in late November – early December 2012 by a team of experienced project managers external to the project. This assessment was performed through interviews with the project team and used cost and schedule project status as of 30 September 2012, plus additional cost/schedule changes that occurred during October and November 2012.

The reviewers examined the future tasks on the project and the associated current base costs. Through the interviews, the team also identified costs that are known to be needed on future tasks in addition to the base costs, which when added to the base costs, comprise the Estimate To Complete (ETC). As part of the assessment the review team worked with the project to identify risks that could occur related to the work to go and a likely cost for them. This was identified as the possible contingency needed to complete the project. Finally, the reviewers and the project team identified possible opportunities to create contingency through scope reductions, sale of spares to Fermilab, reassessment of cost categories on work to go, or work that could be performed by the NOvA science collaboration and thus be taken off-project.

The assessment estimated that the ETC is $70.9M, the Estimate at Completion (EAC) is $276.8M, and $6M may be needed for risk contingency. The total of cost opportunities is $6.1M, but the feasibility of implementation of these items is not known, and thus none are included as an offset to the project cost. The assessment identified that the process by which the monthly ETC may omit known costs that are expected to occur, contignency is not necessarily associated with known risks, the project team is burdened during the monthly processing cycle fixing imminent performance issues rather than incorporating future planning.

A series of recommendations to assure that the project and laboratory management understand the costs to complete the project, as well as costs to reduce risks, are included in this report. The list of potential project cost savings is compiled and included for use by the project and Fermilab.

INTRODUCTION

Gregory Bock, Fermilab Associate Laboratory Director for the Particle Physics Sector, requested an assessment of the NOvA Project cost-to-complete. This was in recognition of very low contingency on the activities remaining on the project, and to help understand what issues remain and what possible corrective actions are needed.

The assessment occurred from November 20 to December 6, 2012. The review team consisted of experienced project managers at Fermilab and Argonne National Laboratory, who met individually with L2 Managers, the Project Manager, and the NOvA project controls team, to assess the status of the estimate to complete, remaining risks by L2 system, and possible cost savings. Each reviewer then provided their judgment on the estimate to complete, the risks on the work to go, and offered ideas for generating contingency. A smaller team then reviewed the L2 data and made the composite assessment.

The report contains summaries of answers to specific charge questions at WBS L2 explored by each reviewer:

1. When was this L2 system cost estimate for the remaining work last updated?
2. What changes are needed to include recent experience for installation, production, and waste rates?
3. Do quotes for materials or services appear to be current?
4. What are the risks or estimate uncertainties associated with this system and can a cost impact and probability be estimated for them?
5. Are there adjustments that could be made to this system to generate more contingency?
6. Estimate to complete on work to go for this system is:

Base cost to go	$
Risk or uncertainty in this estimate	$
Other risks that can be quantified	$

A summary of the assessed estimate to complete and risks with associated contingencies follow, with conclusions and recommendations, addressing these questions:

For the project management and laboratory:

7. Is the available contingency, planned agreements with Fermilab to generate contingency, and potential non-critical scope or other offsets sufficient to complete the work to go within the TPC, considering the estimated and unknown risks for the work-to-go?
8. Are there adequate processes and authority in place to manage the cost and contingency balance to the end of the project? What if any adjustments may be helpful?

ACCELERATOR AND NUMI UPGRADES ASSESSMENT

Participants: Steve Holmes, Paul Derwent

When was this L2 system cost estimate for the remaining work last updated?

The budget at completion was last formally updated in September. Since then a new estimate to complete has been developed on November 29.

The current budget to complete is $6.5M of SWF and $0.78M of M&S (fully loaded). This was updated through the addition of $1.3M to the SWF budget in September.

A new estimate to complete was initiated on November 14 and completed earlier this week. This estimate is based on 25 different activities within ANU. The new estimate shows labor needs ~$93K below and M&S needs at $19K below the current BAC. The conclusion is that the current BAC is good to $100K.

What changes are needed to include recent experience for installation, production, and waste rates?

Contingency utilization on ANU (as measured by the increase in the cost variance) has averaged about 20% over the last two years.

The primary activity remaining on ANU is installation in the Recycler, Main Injector, and NuMI target hall. The costs to complete are dominated by labor. Following the September adjustment to the labor budget the cost variance relative to labor appears to have been largely eliminated.

The cost variance on ANU has been dominated by the labor variance. As measured by the labor CPI, labor has been underestimated in the budget by about 40%, averaged over FY12). The September adjustment to the labor budget restored the CPI to very close to 1, providing some assurance that labor costs are now more accurately estimated. It is worth noting that T&M contracts appear as SWF in the budget – they represent ~10% of the costs to complete. The remaining T&M work is primarily riggers. Work for electricians and pipefitters should be done over the next several weeks, so exposure here is relatively benign.

As of November 1 the M&S budget to complete is $650K (down from $780K on October 1). Of this $376K is under contract, $41K is requisitions in process, and $213K is requisitions still to be written (+$19K estimated underrun). About half of the requisition $213K to go is for the purchase of corrector element power supplies off an WIP code. It needs to be verified that the cost in the budget corresponds to the actual upcoming purchase price. The balance of requisitions to be written are myriad small items.

Do quotes for materials or services appear to be current?

Yes, modulo comment on establishing price for the corrector power supplies and uncertainties on the small stuff.

What are the risks or estimate uncertainties associated with this system and can a cost impact and probability be estimated for them?

The primary risk elements are related to Recycler rf cavities, Recycler extraction kickers, and installation in the RR30 area. The upper limit exposure on these items is ~$1M. But the probability of risk being realized in all areas simultaneously is low.

Recycler RF cavities: One cavity is under test and looks good. The second cavity will be ready in mid-December. Two cavities are required operationally. A third (spare) cavity will be complete in mid-February. The total cost per cavity is about $1.3M. It is hard to imagine a failure that would require a complete rebuild, so the exposure here is probably $300-600K.

Recycler extraction kickers (RKB): Four units and two spares are being constructed. The first two are complete but not yet subject to high voltage testing. Two more are due momentarily and two spares are about 1 month behind. All parts are in house for the spares, with only fabrication to go. The kickers are valued at ~$600K each. The budget to complete already includes sale of the two spares to SPS. The extraction RKB is 50% longer than previously constructed RKD, which have been tested successfully. The total exposure here for a failed kicker is probably ~$300K.

RR30 installation: This is work in a highly activated area. There is an ALARA plan, but if work takes longer than expected, qualified vacuum techs could be pulled off the job. To the extent that these techs are no longer charging ANU there is no direct cost impact. However, there are likely to be indirect impacts if this happens.

Are there adjustments that could be made to this system to generate more contingency?

Yes, the third Recycler rf cavity could be sold to SPS, generating a $1.3M credit. There are also a few candidate activities that could be defined as operations that might generate an additional $200K.

The sale of the third Recycler rf cavity to SPS would generate $1.3M in contingency. However, this will not happen in FY13 as there are no funds in the laboratory operating budget to do this. A potential downside is that sale to SPS would preclude installation of the cavity in the Recycler as a hot spare. A cavity failure would then result in ~4 weeks of downtime for full replacement, rather than ~1 day for modest reconfiguration in the tunnel.

Three candidates for moving from ANU to operations were identified: work associated with MI-60 cleanup ($20K); and installation of the new NuMI target ($120K); and installation of the new hadron monitor ($80K).

Estimate to complete on work to go for this system is:

Base cost to go	$5.9M*
Risk or uncertainty in this estimate	$600K (10%)**
Other risks that can be quantified	$250-500K***
Opportunities for generating contingency	$1.3M sale of the third Recycler cavity $0.2 for moving some installation activities to operations

*As of 9/30: $7.3M of work to go, plan to sell kickers into SPS at $1.4M

** Historically contingency has been drawn down at 20% of BCWP. The recent increase in the labor budget should mitigate this exposure. Approximately 1/3 of the remaining M&S budget remains to be obligated/allocated. Required contingency is probably 25-50%, but this applies to only about 3% of the outstanding budget.

***Outstanding risks associate with Recycler rf, Recycler kickers, and RR30 installation. Worst case exposure is ~$1M. But the probability is very low of realizing this level

LIQUID SCINTILLATOR ASSESSMENT

Participants: Ron Ray, Stuart Mufson, John Cooper

When was this L2 system cost estimate for the remaining work last updated?

In October when the P.O. for the tanker truck transport was issued. All P.O.s are now in place. There is some cost uncertainty because some costs are tied to a moving index and some durations are not precisely known. This is discussed in more detail below.

What changes are needed to include recent experience for installation, production, and waste rates?

The full production and delivery chain for this L2 has been demonstrated to work, so changes are not necessary. Waste rates are negligible.

Do quotes for materials or services appear to be current?

Quotes are all current, though in some cases the price moves because it is indexed.

What are the risks or estimate uncertainties associated with this system and can a cost impact and probability be estimated for them?

The biggest cost risk remains the mineral oil because it is tied to an index that can change based on supply and demand and world events. Since NOvA has started purchasing mineral oil the index has been higher than anticipated and has been more weakly correlated to the price of crude oil than has been the case historically. The index has been trending down recently.

The biggest technical risks at this stage are the possibility that scintillator is improperly blended, contaminated during the blending process or contaminated during shipping. Because of an extensive, multi-step QC procedure, the financial burden is held by the blending and shipping companies, not the Project. A single bad batch or shipment would not have a significant schedule impact because of buffers and the fact that the schedule is determined by the slower block filling operation. If this becomes a chronic problem it will eventually impact the schedule and ultimately increase cost. The probability of a chronic problem is small given that many batches have been successfully blended and transported without incident.

Are there adjustments that could be made to this system to generate more contingency?

None that are apparent. Credit has already been taken for the savings resulting from filling some extrusions with water. The waveshifting fluors have all been paid for though some should be left over. The excess could possibly be sold to the lab since they are commonly used by the scintillator extrusion facility and have a potential application for LBNE, but it does not add up to much money (~60k).

Estimate to complete on work to go for this system is:

Base cost to go	\$11.2M
Risk or uncertainty in this estimate	\$1.8M
Other risks that can be quantified	Small (see comments below)

Ron’s Comments:

This subsystem is relatively straightforward since it consists primarily of contracts that are already in place and just a small amount of labor. There are some risks, however. The mineral oil and pseudocumene price are each connected to an index that can change with time. Since mineral oil makes up 95% of the scintillator blend, it is by far the most important risk. The base cost of mineral oil in the NOvA baseline is $3.92/gal. The average cost that they have paid thus far is $4.97/gal, 27% above the base estimate. However, the cost has come down recently and is now only 5% above the base estimate. There is some reason for optimism regarding the price of mineral oil because of this recent trend, a newly opened pipeline and increasing inventories. Of course, there is always the risk that world events could intervene and drive the price higher. The Project does have some flexibility as to when they purchase mineral oil, but this is not always easy to take advantage of. If the price turns upward it is impossible to know if this is a short-term or long-term trend. Do they buy before the price goes up even more or wait for it to come down? When the price is more favorable, as it is now, they can only buy so much because of the cost of storage space.

An additional risk/opportunity exists in how the scintillator endgame is managed. John and Stuart have not thought this through in detail, but a significant cost is incurred every month for storage tanks. As the scintillator blending progresses the buffering and flexibility provided by the storage tanks is no longer needed and it may be possible to go straight from railcars into the blending tank, saving $34,000 per month. However, schedule delays could result in a cost increase of $34,000/month.
John believes that 15% contingency is adequate to cover the remaining scintillator work. If recent trends continue then 15% will be more than adequate, but recent trends could reverse themselves. Without the ability to see into the future there is no right answer. Based on a reading of recent weekly Base Oil Price Reports, the downward trend should continue for some time because of reduced demand. This could change once the economy picks up, so proceeding without delay is imperative. Unexpected world events could change this picture however.

Ron’s Conclusion:

I don’t believe that NOvA should be required to carry contingency to cover the risk of a blow-up in the Middle East. This falls under the category of Force Majeure and is beyond the responsibility of projects. Based purely on recent market trends and projections combined with the successful production and delivery of several batches, 15% contingency should be more than adequate. If NOvA is expected to carry contingency to cover price spikes due to world events, then 30% would be more appropriate based on a cost of nearly 5.00/gal. that resulted after events in Libya last year.

PVC EXTRUSIONS ASSESSMENT

Participants: Peter Garbincius, Rich Talaga, John Cooper, Suzanne Saxer, Bill Freeman

On the morning of November 29, 2012, the reviewer met with Rich Talaga, the Level 2 Manager for WBS 2.4 PVC Extrusions, followed by a conversation with John Cooper, NOvA Project Manager. Also reviewed was the NOvA EVMS reporting for this WBS and the Estimate to Complete (ETC), previously discussed with Bill Freeman and Suzanne Saxer of the NOvA Project Office.

When was this L2 system cost estimate for the remaining work last updated?

The estimate seems to be continuously updated, both by the Project Manager (John Cooper) and the L2 Manager (Rich Talaga). However, their numbers do not agree because of differing levels of aggressiveness as to *future* projections of percentage of waste product.

The big summary picture (through Sept 30, 2012) for this WBS:

ACWP:	$ 20.5 M	Actual Cost of Work Performed
ETC:	$ 10.0 M	Estimate to Complete
Extra resin:	$ 3.3 M	to be ordered Rich Talaga estimate (current upper estimate)
	=======	
Total:	$ 33.8 M	so approximately 61% completed

In terms of the ETC:

93.8 % is Extrusion Production
2.8 % is Production QA and Extrusion Evaluation (labor)
1.8 % is Shipping & Handling (mainly storage costs)
1.7 % is Management PVC Extrusions (labor & travel)

Since we intend to continue with the other tasks and they are such a small component, the reviewer concentrated only on Extrusion Production.

The costs for Extrusion Production (totaling 100%) break down into

56.5 % Obtain PVC Resin
39.3 % Produce PVC Extrusions
1.8 % Ship Extrusions (Manitowoc => Minneapolis)
2.4 % QC & Documentation of Extrusions

Again, since shipping and QC/Documentation are small and will continue, the reviewer concentrated on Resin and Extruding.

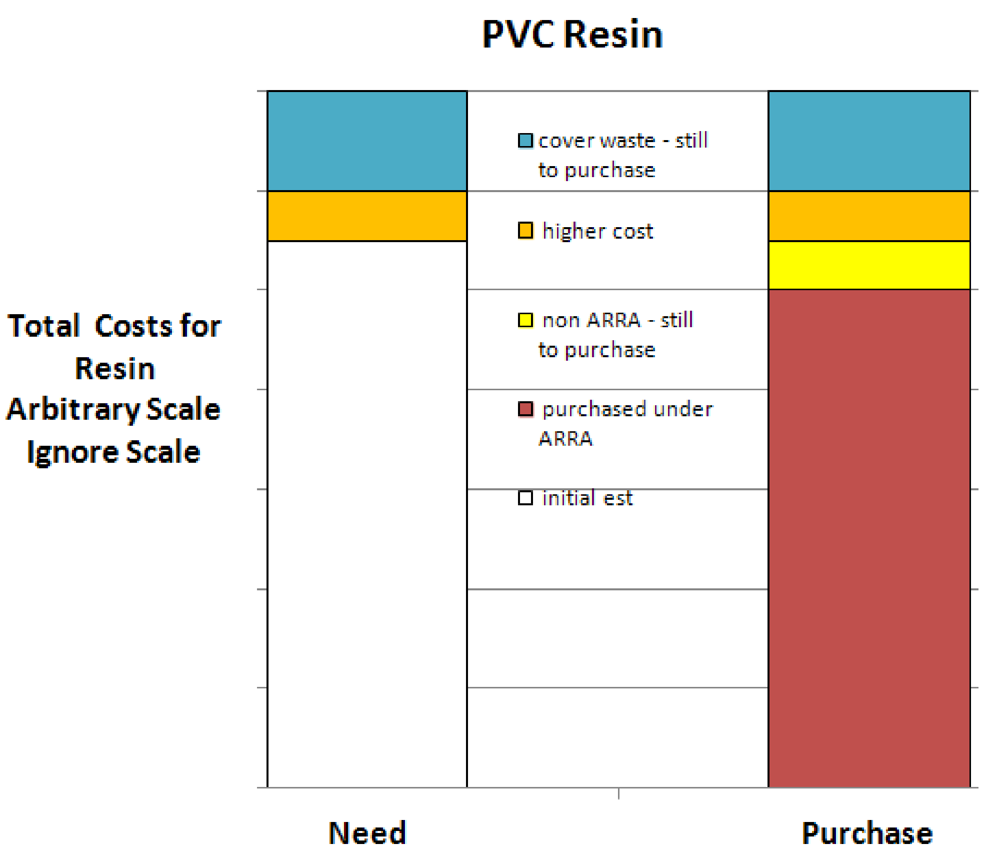
There were at least two "disconnects" noted in this process.

The first "disconnect" involved the use of the ETC table. These were mostly based on Baseline Estimates, and estimates for future tasks were only rarely updated for past and continuing experience. The tasks "Obtain PVC Resin – Block X – Planes Y-Z" were particularly difficult for a non- insider to interpret. Not all the resin to complete 28 blocks have been purchased. Moreover, considerably more resin than expected was consumed in the R&D and prototype production run, implying that there is insufficient resin already on order for producing the blocks for which it was scheduled, implying that even more resin needs to be procured to complete 28 blocks. Although the L2 Manager, Rich Talaga, quantitatively understands this situation in detail, these features were not reflected in the ETC tables.

To determine the costs actually needed to complete the resin purchase required evaluating what was presented by NOvA Project Manager John Cooper in his November 20, tele-presentation to the DOE Review as well as recent estimates by the L2 Manager. The Project Manager concludes that, to finish 28 blocks and make up for the resin used in R&D a draw on contingency is required, as seen the presentation at the DOE Mini-review on November 20, 2012, the Contingency History (page 33) which shows this number as $ 1.942 M + $ 1.006 M = $ 3.008 M total needed for resin procurement.

The Project Manager's number was based on a 6% waste at the extruder factory and $ 1.2425 per pound for PVC resin. L2 Manager Rich Talaga recently recalculated the need and came up with a new total of $ 3.316 M needed, assuming 8% factory waste which represents actual historical experience over the last year of production, and a slightly higher cost for resin of $ 1.25 per pound.

A second "disconnect" is what is in estimate and what is "contingency"?



Although it looks like ~ $ 3 M in contingency is needed to cover future resin costs, the accounting is not clear, which the table above tries to display. The ~ $ 1 M to cover the difference in initial estimated need and the amount of resin purchased under ARRA funding would appear to have always been a planned expense. Then in addition, there is a need to cover ~ $ 2 M in unexpected resin waste during the R&D and early pre-production phases, which is considered a call against contingency. These identified needs for contignency include purchasing resin to produce extrusions to complete part of Block 27 and all of Block 28, which are part of the current project scope. The manner in which the accounting has been done and presented to oversight groups (DOE reviews and Fermilab PMGs) mixes together the ETC, possible calls against remaining contingency, and the possible use of extrusions which are currently classified as waste. This can lead to an unrealistic assessment of the necessary remaining costs, the contingency that has to be consumed to cover those remaining costs, and the contingency available to cover future unknowns or variances.

The NOvA Project Manager John Cooper will wait as late as possible to commit the ~ $ 3 M funding for resin. This is because he definitely does NOT want to have extra resin surplus at the end of construction. This is a GOOD procedure. It is not apparent at this time as to how much resin will actually still be needed. This depends on production waste (will it get to average 6% or remain at 8%) and how many of the currently rejected 51 foot long extrusions eventually can be used. In this latter case, NOvA would not have to supply resins for replacements, but would likely have to pay the extrusion factory for their costs for the all modules that NOvA takes from the factory, regardless of whether they were initially rejected, but later deemed usable for the Ash River detector. It is important to understand as soon as possible, from an engineering viewpoint, how many of these "waste" extrusions could actually be used, so as to understand how many extra extrusions must be produced (at the cost of additional resin).

The question of providing PVC Extrusions for a new Near Detector had a simple and cost effective answer. The already existing (~200) scrap 51 foot (612 inch) modules from the Minnesota module factory can each be cut down into three 162" extrusions for the Near Detector. Therefore, no additional resin or extruding costs are expected for extrusions for the near detector…but there will be some cutting, finishing, cleaning costs incurred. John Cooper said these extra costs would not be incurred against 2.4 PVC Extrusions, but against 2.8 Near Detector Assembly. (It appears, after discussions with Ken Heller, that these costs are covered in 2.5 PVC Modules, the additional cost identified in that section of this report for Near Detector module production at $350k, and not in 2.8 Near Detector Assembly.)

What changes are needed to include recent experience for installation, production, and waste rates?

And, do quotes for materials or services appear to be current?

No changes are needed for this cost to complete exercise, but continue to monitor waste rates and order resin (at latest practical time) to cover accumulated and end-game projected waste rates. Quotes for M&S appear to be current.

There will also be an extra purchase order to increase the number of good, meeting spec, acceptable extrusions from 19,455 to 21,504 to complete the 28 blocks (plus Rich Talaga expects ~ 500 spares – to cover the 2% reject rate in Minnesota module factory). The original contract with the extruding company was for $ 𝒩 M, before the actual geometry of the extrusions and the quantity were determined. That $ 𝒩 M corresponds to 19,455 extrusions of the current geometry now in production. However, the difference between 19,455 and the actual need (21,504 + spares) must be procured. The cost of these extra extrusions is included in the base estimate, not under contingency, as the number of additional extrusions times the same unit cost based on the current contract for 19,455 extrusions. Informal conversation with the vendor production manager (a former Fermilab employee) has indicated that these additional extrusions can be produced at the same unit price. However, that may not be in the contract, which apparently set the unit price for up to 38 blocks worth of extrusion, and may not represent the future cost.

What are the risks or estimate uncertainties associated with this system and can a cost impact and probability be estimated for them?

These are semi-fixed costs, based only on quantities. However, there are two costs which are related to commodity indices: the fuel surcharge for shipping (a small perturbation on a small number) and the fluctuating cost of TiO_2 which is passed along in the cost of PVC resin. Initially, the estimated cost of PVC resin was bid at $ 0.96/pound based on the then price of TiO_2. Since then, the cost of TiO_2 has risen by 80% with fluctuations over the last year or so causing the price of resin to vary between $ 1.213/pound and $ 1.288/pound => $ 1.25 +/- $ 0.037 per pound. Considering that there are still 5.66 Million pounds of resin still to be delivered, both already under order (cost is determined on delivery) and for future contracts, this gives a potential range of +/- $ 0.21 M, assuming the median cost and fluctuation range remains the same over the future delivery period. Although it is not included in the contingency list, a budget reserve is needed to cover this range of possible costs (and maybe even some more).

Are there adjustments that could be made to this system to generate more contingency?

NOvA is considering using currently rejected (scrap) extrusions for the Far Detector. This will require an engineering study to determine how much "waste" is useable. The cost impact of such a study, likely using on-project personnel, needs to be considered.

Quality Assurance is being provided by NOvA, both in real-time at the extrusion vendor and more extensively on 6" test samples at both Fermilab and Argonne National Laboratory. The manpower devoted to this quality assurance task is deemed as necessary not only to guarantee an acceptable product, but also to prevent excessive waste rate, which would incur completion delays and costs for additional resin to extrude additional modules to replace those waste. (The extrusion vendor guarantees acceptable extrusions at no extra cost, so it really is only additional time and resin.) This includes a FTE contract employee at the factory, plus periodic visits by Fermilab staff. This QA effort should continue, but Greg Bock asked if it could be transferred to Fermilab or NOvA collaboration personnel who are not chargeable against the NOvA project costs. Small $, but every bit helps.

Estimate to complete on work to go for this system is:

Base cost to go	$10.0M
Additional costs for resin NOT in ETC. This current upper limit could possibly be reduced by using waste/rejected extrusions.	$3.3M
Other risks that can be quantified	±$0.21M

PVC MODULES ASSESSMENT

Participants: Gina Rameika, Ken Heller

When was this L2 system cost estimate for the remaining work last updated?

It is constantly being updated – for example the scuffing task was added as an initial cost and then revised with experience this month. The steady state production of modules is constantly reviewed (see graphs of labor).

Waste rates are under constant review to try to reduce them. There are several known expenses not yet in the plan:

- the module scuffing costs to completion (est $350K)
- the cost of assembling the near detector modules (est $350K)
- the management costs for FY14 (est $296K)
- crew training and QA/QC (est $165K)

The module scuffing cost and the near detector cost has been estimated by project management but the detailed CR documents have not yet been approved.

What changes are needed to include recent experience for installation, production, and waste rates?

To more closely monitor and control our costs and waste rates we are constantly upgrading our QA system as less probable perturbations to the production system are found.

Do quotes for materials or services appear to be current?

Materials and services quotes are still valid but some fluctuate with the market such as gas charges for shipping and glue costs. The average of these fluctuations so far is within the range of the quotes.

What are the risks or estimate uncertainties associated with this system and can a cost impact and probability be estimated for them?

Because of the delay in installing at Ash River, the factory space contingency is very close to being full. That means any additional significant delay at Ash River will require additional warehouse rental space to store the raw extrusions. As we have been through one production transition from full time summer labor to a four times greater workforce of part time workers during the academic year, we can estimate the consequences for the coming summer/semester transition. For about 2 months, our labor costs will increase by less than 2% and our production rate will decrease by about 25%. That translates into an overall cost increase of less than 1% and a schedule change of 2 weeks. Both are well within our ability to predict the future.

Are there adjustments that could be made to this system to generate more contingency?

One could relax some of the specified physical tolerances on the modules based on assembly experience at Ash River. This will save by reducing the number of measurements made in the module production process to assure the quality. There are associated risks.

Estimate to complete on work to go for this system is:

Base cost to go (September)	$8.84M

CRs in process or needed	$ 1.2M
Risk or uncertainty in this estimate	$0.20M
Other risks that can be quantified	$

Summary/Comments from review (Gina Rameika and Ken Heller) :

2.5.1 End Seals
CTC - $674, 382
Of this $674,382 is materials, so to the extent that the estimate is still valid, there should be minimal additional risk here.

2.5.2 Optical Connector Production
Complete; no additional cost or risk

2.5.3 Module Production
Tasks in this WBS :
1) Tooling, QA/QC devices : Current baseline includes remaining budget of $85,000; this should be adequate to complete the tasks.
2) Occupy and operate factory space : This is currently budgeted through March 2014. The cost is $83,000 per month. We should include a small risk, consistent with the weather risk at Ash River. A two month delay would need $166,000 to cover this risk.
3) Train technicians and students : The baseline plan has no budget beyond October 2013 to train technicians. The budget for student training expires in August 2013. It is clear that there will be both technician and student turnover, and training will need to be budgeted. The current budget is ~$36,000 per month. This is probably high and should ramp down from August through December 2013. An additional budget of $126,000 should cover this expense.
4) Module production :
Steps include sanding, 2-to-1 assembly, assemble and test modules, ship modules to Ash River, ship pallets to extruder.
4.1) Sanding task is not currently built into the estimate – estimate from the L2 Project Manager is $350,000.
4.2) Near Detector module production is not yet in the baseline – estimate from the L2 Project Manager is $350,000.
5) QA/QC tracking and testing –
In the current plan, this task only extends through August 2013. It needs to be extended an additional 6 months. The cost is $6,500 per month. So the additional CTC is $39,000.

2.5.4 – The baseline plan only has management costs included through August 2013. The module production baseline plan extends through March 2014. Management costs for September 2013 through April 2014 need to be estimated and included. The monthly estimate in the baseline (which is actually a bit higher than the actuals indicate) is ~$37,000 per month. For an additional 8 months this adds $296,000. The only risk here is if the entire schedule slips past April, which we will not anticipate here. (But is included in the risk to 2.5.3.)

ELECTRONICS PRODUCTION and DAQ ASSESSMENTS

Participants: James Proudfoot, Leon Mualem, John Cooper

When was this L2 system cost estimate for the remaining work last updated?

The cost estimate has recently been changed to reflect a baseline change associated with the decision to fill half the cells in 4 blocks with water. Other WBS elements were considered in spring 2012. Following this, the L2 manager is relying on the monthly cost updates at Level 3 to monitor cost versus work performed. Although this is not an unreasonable approach, there are some inconsistencies between the ETC and the cost basis for a couple of items between what John Cooper presents as current and the latest full roll-up to Oct 1st 2012.

What changes are needed to include recent experience for installation, production, and waste rates?

There has been significant work performed, including:

1. APD procurement placed
2. Delivery of all TEC units
3. Production of 86% of the FEBs
4. Deployment of the Data Acquisition system at Ash River
5. Tests of APD module assembly
6. Delivery of the first 400 production APDs
7. Installation of the air dryer system at Ash River
8. Problems were also identified in the assembly of prototype APD modules early mortality rate is between 14% for option being adopted
9. Diagnosis of the failed units has uncovered potential root causes for a large fraction of the failures – explicit response to this is needed (improved QC prior to mounting fiber inserts)
10. Testing of the custom polymer coating of the APD is in progress and showing good results – there is good justification for this approach, even if it does invalidate the vendor warranty of the APDs
11. Testing of the TEC units is underway and showing good progress – the MTBF is estimated to be > 30 yrs/unit (adequate but not great)

This work needs to be concisely documented and the costs for work performed compared to estimates in the baseline budget so that consistency with the data in OpenPlan can be demonstrated

The test plan for APD units installed at Ash River needs to be documented to take account of prototype experience – this is a critical element in the reduction of technical risk associated with early mortality.

Only 10% of the bare APDs are tested on receipt before coating. This represents a balance between QC on the unit and the potential for damage as a result of the tests (since the APD is bare)

There are several production unit number that need to be stated more precisely in terms of devices required for CD4 (FEBs, TECs, APDs) together with planed spares and expected wastage.

Do quotes for materials or services appear to be current?

- For much of the planned assembly work the BOE is based on material estimated in 2009. However, the production start date for many of these elements is imminent and following that there will be less uncertainty.

- There has been one major procurement; that of the 12000 APDs. The base price per APD for procurement in the BOE is 4% higher than the actual vendor cost per unit (a $~240000 effect). The baseline has been changed to reflect the fact that 4 blocks will be filled with water and therefore the number of PMTs required for is 10,620 (CR 586). This therefore provides for a component contingency of 13%, to be compared to a potential wastage of 14%. There is in addition 5% contingency on this element in the BOE. Therefore the cost and contingency is larger than necessary at a total of 13% on components and 9% on cost.
- There are several procurements of materials of a fairly common nature. The BOE assigns these a 15% contingency which is reasonable. I may not have caught them all in my contingency estimate.

What are the risks or estimate uncertainties associated with this system and can a cost impact and probability be estimated for them?

There are remaining technical and schedule risks in this project:

APD delivery schedule has slipped by 6 weeks, but current delivery plan meets (may even slightly exceed) the baseline goal. Cost contingency may need to be added to the ETC to account for the possibility that increased labor costs are needed beyond the assigned contingency of 50% (which reflects only the expected duration of the task) to account for increased costs due to use of overtime to meet the schedule.

Based on the prototype experience early mortality of order 14% for the APDs must be anticipated until the experience from the first 400 production modules is obtained, and a test plan for modules installed at Ash River is documented and shown to insure that the potential number of damaged modules will be small before intervention is made to develop and implement corrective action.

The present MTBF for the TEC units is sufficiently large as to pose a significant issue for detector operation. This will incur increased effort associated with detector status monitoring and repair and the use of information concerning non-operating units in event reconstruction. The collaboration is aware of this but now is the time to begin the plan to deal with it (monitoring, replacement effort, database services and use in reconstruction software).

Are there adjustments that could be made to this system to generate more contingency?

There is an ensemble of tasks described in DAQ associated with Failure Modes Analysis: 2.7.2.1, 2.7.2.2,2.7.2.3,2.7.2.4,2.7.2.5,2.7.2.6,2.7.2.7. These date back to early days of the WBS and may no longer be necessary. The total budgeted cost for these tasks is $130,274.

Execute a change request to re-baseline the APD cost and contingency. Estimated reduction is 4% on cost ($194K) and $10K on contingency.

Estimate to complete on work to go for this system is:

The base cost to go is from the current project base cost to go by work package received in a CAP report from Suzanne Saxer.

Contingency calculation for 2.6 (this estimate should be further evaluated by the project to ensure that understanding of the risks on the APD procurement to go in conjunction with the current understanding regarding waste rates):
5% for the APD procurement (0.05 * 4,842,455) = $242,122
Total remaining materials estimated at $849,229 with 15% contingency = $127,384

25% contingency on remainder relative to the base cost adjusted for the transfer of spares to operations (=$77,315) = $19,328

2.6 Base cost to go	$5769K
Risk or uncertainty in this estimate	$389K
Other risks that can be quantified	$

Contingency calculation for 2.7:
Materials procurement of $654k with 15% contingency = $98,239
25% on all remaining costs of $904,068 = $226,017

2.7 Base cost to go	$1559K
Risk or uncertainty in this estimate	$324K
Other risks that can be quantified	$

NEAR DETECTOR ASSESSMENT

Participants: Bob Kephart, Gina Rameika, Ting Miao, John Cooper

When was this L2 system cost estimate for the remaining work last updated?

The last full update was a few weeks ago. Costs for Near Detector assembly and installation are based on Prototype experiences. Costs for the civil construction work to go are based on the project manager's assessment of how the contracted work for this element will wrap up, which is ahead of schedule.

What changes are needed to include recent experience for installation, production, and waste rates?

The ND assembly and installation costs are estimated based on construction of the prototype about 2 yrs ago. Waste is expected to be small since practice modules (rejects from Minn) are available to practice with before starting the real assembly of ND blocks.

Recommendations:

- Include some cost for technician oversight of collaboration labor.
- Track (eg plot) labor burn rates vs. time, block assembly rates vs. time, and labor vs. block assembly rates and compare with "basis of estimate" to track contingency usage.

The civil construction work does not need any adjustments for recent experience.

Do quotes for materials or services appear to be current?

The M&S costs are largely adhesive and steel frames, both of which are under contract and appear elsewhere in the cost estimate. Misc M&S usage is expected to be small.

What are the risks or estimate uncertainties associated with this system and can a cost impact and probability be estimated for them?

Principle cost uncertainty is related to the actual labor required for tasks vs. estimated labor. This effort is relatively protected against schedule delay since the workforce (4 techs) can be used for D&D activities in the CDF building if not working on NOvA.

Similarly, much of the block filling, APD and electronics installation will be with collaboration labor at zero cost to the project so delays do not cost the project.

Are there adjustments that could be made to this system to generate more contingency?

The collaboration has chosen a 3x3 configuration vs. 2x3 in the original prototype. This choice was driven by physics considerations related to containment of events and the fact that larger theta13 means more events at Ash River requiring better understanding of backgrounds via the near detector. At most there is a few hundred K to be saved via a 50% reduction in ND mass.

We discussed reuse of parts from the prototype. There does not seem to be much to be gained. The extrusions are thin and still cracking/leaking, the APD mounts are not good, and the labor to extract the 4" steel plate is more than the value of the steel. (note that this assumes some funds other than "NOvA project" pays for the D&D

of the prototype) If other funds paid for the immediate D&D of the prototype the plates might be used avoiding some costs.

Estimate to complete on work to go for this system is:

Base cost to go	$1,460,000
Risk or uncertainty in this estimate	$73,000
Other risks that can be quantified	$ 60,000

Overall the costs risks for this effort seem small on the scale of the NOvA Project.

Risks that can be quantified include the need for more labor. $ 73,000 is assigned by the Project Manager as contingency. This would allow 6-8 weeks of additional effort by the 4 tech team over the 13 month duration of the project. This seems reasonable.

"Other Risks that can be quantified" include the likely need for a FNAL tech to oversee filling and installation work with collaboration labor for the Near Detector. ½ FTE man year of tech is estimated at $ 60, 000 for this. This might be avoided if an off-project scientist at FNAL plays this role.

Estimates for "unknown unknowns" are not included.

FAR DETECTOR ASSESSMENT

Participants: Bob Kephart, Gina Rameika, Pat Lukens, Rick Tesarek, John Cooper

When was this L2 system cost estimate for the remaining work last updated?

The last full update was summer 2011 but some pieces were updated more recently

What changes are needed to include recent experience for installation, production, and waste rates?

Principle cost uncertainty is related to labor required to finish the blocks in Ash River. Block assembly costs are becoming known, outfitting and filling costs are still based on original estimates.

Crew size at Ash River is close to estimated size.

What is known about labor use:
21 shifts each 10hrs/block was the original estimate
25 shifts each 10 hrs/block is the best so far
23 shifts each 10 hrs/block may be achievable (➔ need to include a 10% increase in labor estimate for this work, see comment in section below concerning Project Manager's thoughts on this)

Estimates to fill and outfit a block may be less than estimated but it is too early to include these savings.

Waste appears to be small so far. Not an important risk factor barring some unforeseen event.

Recommendation: Track (eg plot) labor burn rates vs. time, block assembly rates vs. time, and labor vs. block assembly rates and compare with "basis of estimate" to estimate and track contingency usage.

Do quotes for materials or services appear to be current?

The M&S costs are largely adhesive and steel frames, both of which are under contract.

Actual adhesive use is 10% less than what is in the cost estimate. Misc M&S usage appears to be small.

What are the risks or estimate uncertainties associated with this system and can a cost impact and probability be estimated for them?

There are potential risks associated with work flow since effective buffers in the system at this time are small.

Buffer for workforce will increase with time when more outfitting and filling work is available.

Risks associated with weather have not been included in estimates. One guess is ~6 days/250 working days in which weather interrupts work either because crew cannot make it in or parts do not arrive. Guess that this may be a 3 % overall effect that is not currently included.

Are there adjustments that could be made to this system to generate more contingency?

There is a risk associated with rework because APD's are dying. Infant mortality is 12% or so. Consider moving this off project by declaring modules operational if more than 85% of channels work and them fixing failures off project (does not save cost, may shift it to different cost category).

The Project is paying for electricity, septic system, rent of lunch trailer, ES&H person, etc. $300k spent so far, another $ 300 K is in the plan. However another $ 200 K is needed beyond what is in the current plan. These costs more logically should be operations. There is an opportunity to move $ 800 K off project by declaring these costs to be operations. (again does not save costs, may shift to different cost category).

Estimate to complete on work to go for this system is:

Base cost to go	$11,898,720
Risk or uncertainty in this estimate	$
Other risks that can be quantified	$ 1,000, 000

Risks that can be quantified include:

10 % more labor at $ 550, 000. The L2 Manager (Pat Lukens) feels this is likely (see discussion in section above on "changes needed to include recent experience"). The Project Manager (John Cooper) feels this is would be better categorized as a risk. In this report it is carried conservatively in the ETC.

3% weather related delays at $ 165, 000, dry gas installation at $ 20,000, Data base inventory work for outfitting not included in estimate at $ 120,000.

Conversion of the block pivot to the North book end was estimated at $ 72 K five yrs ago. The general belief based on previous design costs in the mechanical group is that this cost is low by factor of ~ 3 so I added $ 143, 000 as a risk. (OK, so I added the extra $ 1 K to make the quantified risks an even million $)

There is a risk that key people leave before the project is complete. Consider a plan either to hire key people (e.g. foreman) into operations early and/or to provide a "to stay" bonus for temporary workers to make sure that workers in Minnesota stay through the end of the project. (i.e. avoid delays and/or retraining costs) The bonus plan would cost the Project money but moving the foreman to operations early could move money off-Project.

Estimates for "unknown unknowns" are not included

Bob's Recommendation: Insure close connection between near detector work and far detector work force to avoid relearning.

PROJECT MANAGEMENT ASSESSMENT

Participants: Dean Hoffer, John Cooper, Bill Freeman, Suzanne Saxer

When was this L2 system cost estimate for the remaining work last updated?

The last update to WBS 2.10 Project Management was July 19, 2011 reflected in the BOE and processed by CR360. Below is the table from the BOE:

LABOR RESOURCE		FTE's per yr (FTE's in bold are part of the project cost , FTE's non-bold have zero cost) NOTE: FY09 revisions changed some of the scientists to on project costs, therefore are bold								Contingency %	Notes
		FY08*	FY09**	FY10	FY11	FY12	FY13	FY14	FTE Total		
Project Manager	Scientist	0.58	1.00	1.00	1.00	1.00	1.00	0.50	6.08	-	
Deputy Project Mgr	Scientist	0.58	1.00	0.70	0.70	1.00	1.00	0.35	5.33	-	
Assoc. Project Mgr	Scientist	0.17	0.36	0.50	0.50	0.50	0.50	0.25	2.78	-	
Costed Guest scientific L2 manager	Scientist	-	-	-	1.00	0.15	-	-	-	0%	Typically 50% of a sabbatical
Assistant Project Mgr	Non-scientist	-	-	-	1.00	1.00	1.00	0.25	3.25	0%	
Assistant Project Mgr	Non-scientist	-	-	-	1.00	0.67	0.67	0	2.33	0%	
Project Engineer	Engineer	0.50	1.00	1.00	1.00	0.5	0.2	0.00	4.2	-	
Project Chemist	Scientist	0.38	0.77	0.77	0.77	0.77	0.77	0.25	4.48	-	Off-proj
Procurement Expert	Procurement	0.056	0.90	0.90	0.90	0.90	0.90	0.07	4.626	-	Provided to project by the laboratory as part of G&A
Document Manager	Scientist	0.19	0.40	0.20	0.20	0.20	0.20	0.05	1.44	--	Off-proj
Expediter	Now a tech and on 2.9	0.056	0.30	0.30	0.10	0	0	0	1.606 minus 0.6	-	Off WBS 2.10
ESH	ESH Officer	0.375	0.75	1.00	1.00	1.00	0.50	0.13	4.755	-	part of G&A
Scheduler(s)	Scheduler	0.92	1.60	1.35	1.35 +0.65	1.00 +1.0	1.00 +1.0	0.25 +0.25	7.47 +2.9	25%, reduce to 0%	

Assistant to Scheduler	Scheduler	-	-	-	1.00	0	0	0	1.0	0%	Only effort in FY11
Budget	Budget Officer	0.50	1.00	1.00	1.00	1.00	1.00	0.25	5.75	25%, reduce to 0%	
Assistant to Budget Officer	Budget hire	-	-	-	1.00	0.67	0.67	0	2.33	0%	
Admin	Administrator	0.25	1.00	1.00	1.00	1.00	1.00	0.25	5.5	25%, reduce to 0%	
FY09 costed total FY10 rev costed total FY11 rev costed total		4.557	10.08	9.72	9.72	9.37	8.87	2.38	25.8 54.70 48.9		
University Engineer		0.00	0.75	0.75	0.75	0	0	0.00	2.25	25%, now reduced to zero	J. Oliver retires, consultant in future

The only other change since the July 2011 update was the project taking costed scientist labor in this WBS and zero out their hours because of an agreement with Lab Management and DOE. The project reduced the budgeted hours for the ANU subproject costed scientist manager in FY13 by 33% by eliminating his hours over the last four months of the fiscal year, since the ANU subproject will be essentially complete by then; they eliminate his budgeted hours entirely in FY 14.

They eliminated the budgeted hours in FY14 for PPD costed scientist managers since the primary activity during that year will be detector commissioning. (This eliminated 2240 hours of scientific management. This reduction of costed effort was not moved over to the uncosted scientific labor. Some of John Cooper's, Rick Tesarek, and Pat Lukens time will still be spent managing the project during this period, yet this time as uncosted scientific resources is not reflected in the schedule.)

What changes are needed to include recent experience for installation, production, and waste rates?

No recent changes have been made even though the project's CD-4 completion date has moved since the last bottoms up estimate in July of 2011. In July 2011 the estimated CD-4 completion date was around February 10, 2014. Today's estimated completion date is May 30, 2014. There has been a slippage of 78 work days since the last bottoms up estimate. It appears that the estimates for labor need to be revised to reflect the impact of the expected CD-4 completion date of May 30, 2014.

With an additional 3 ½ months added to the estimated CD-4 completion date, it would make sense that the estimate to complete needs to be updated to increase the FY14 resources for the Scheduler, Assistant Scheduler, Budget, and Assistant Project Manager. The Budget needs a slight increase over the others to cover project closeout of PO and CTC after CD-4 is achieved (an additional 176 hours was included in my calculation). See the detailed numbers below.

	Current FY14 FTE	Recommend FY14 FTE	Increase FY14 FTE	Increase in Hours	Fully Loaded Cost Increase
Scheduler	0.25	0.5	0.25	446.5	$66,781
Assistant Scheduler	0.25	0.5	0.25	446.5	$66,781
Budget	0.25	0.6	0.35	625.1	$82,981
Assistant Project Manager	0.25	0.5	0.25	446.5	$59,272
				Total	$275,816

If the projected CD-4 moves there is a cost increase or decrease. Using the average FTE weekly hours of 34.3, the cost increase or decrease per week is just under $20K (see detail below).

	Average FTE hours per week	Fully Loaded Cost Increase/Decrease
Scheduler	34.3	$5,130
Assistant Scheduler	34.3	$5,130
Budget	34.3	$4,553
Assistant Project Manager	34.3	$4,553
	Total	$19,367

Do quotes for materials or services appear to be current?

Currently for M&S for FY13 it is $74.5K and for FY 14 it $7.0K (see table below from the latest BOE). It appears the FY13 budget is reasonable. The FY14 budget appears to be appears to be short because of the slippage of the estimated CD4 completion date of over 15 weeks to May of 2014 from the last bottoms up estimate. Because of the slippage there will be more trips in FY 14, which there is $0 currently. I assume a cost increase of $18K for M&S in FY14 for M&S.

	$K/FY08	$K/FY09	$K/FY10	$K/FY11	$K/FY12	$K/FY13	$K/FY14	Contingency

M&S:								**%**
Travel:	**$5.0**	**$26.6**	**$35.5**	**$35.5**	**$35.5**	**$35.5**	**$0.0**	**25%**
7 domestic trips @$1.5k/trip								
5 foreign trips @$5k/trip								
Equipment:	**$5.0**	**$12.8**	**$17.0**	**$17.0**	**$17.0**	**$17.0**	**$5.0**	**25%**
Computer $5k								
Printer $2k								
Welcom Licenses $5k (Open Plan, Cobra, Welcom Home) 10k								
Materials & Supplies:	**$5.0**	**$12.8**	**$22 .0**	**$22 .0**	**$22 .0**	**$22 .0**	**$2 .0**	**25%**
Training $10k								
Supplies/software/ misc $12k								
Consultant fee **J. Oliver would now appear here if we required his time.**	**$0.0**	**$15.0**	**$15.0**	**$15.0**	**$0.0**	**$0.0**	**$0.0**	**25%**
TOTAL	**$15.0**	**$67.2**	**$89.5**	**$89..5**	**$74.5**	**$74.5**	**$7.0**	**25%**

What are the risks or estimate uncertainties associated with this system and can a cost impact and probability be estimated for them?

The cost risks to the current base are associated with the CD-4 estimated completion date. I have addressed the cost increase based on the current date in the other sections of the write-up. The uncertainty/risk is if that date will stay the same, slip, or moved earlier. Until there is a good re-plan with a good bottoms up estimate for the work to go, the confidence of the current projected CD-4 completion date is indeterminate.

Are there adjustments that could be made to this system to generate more contingency?

Contingency can be generated if the projected CD-4 completion date can be moved earlier to reduce the standing project office costs. Additionally, if the number of change requests processed each month can be reduced by developing a stable schedule/cost replan with a thorough bottoms-up cost/schedule estimate, the church can be minimized, which could result in some cost savings even in FY13 by reducing the required effort for project controls staff.

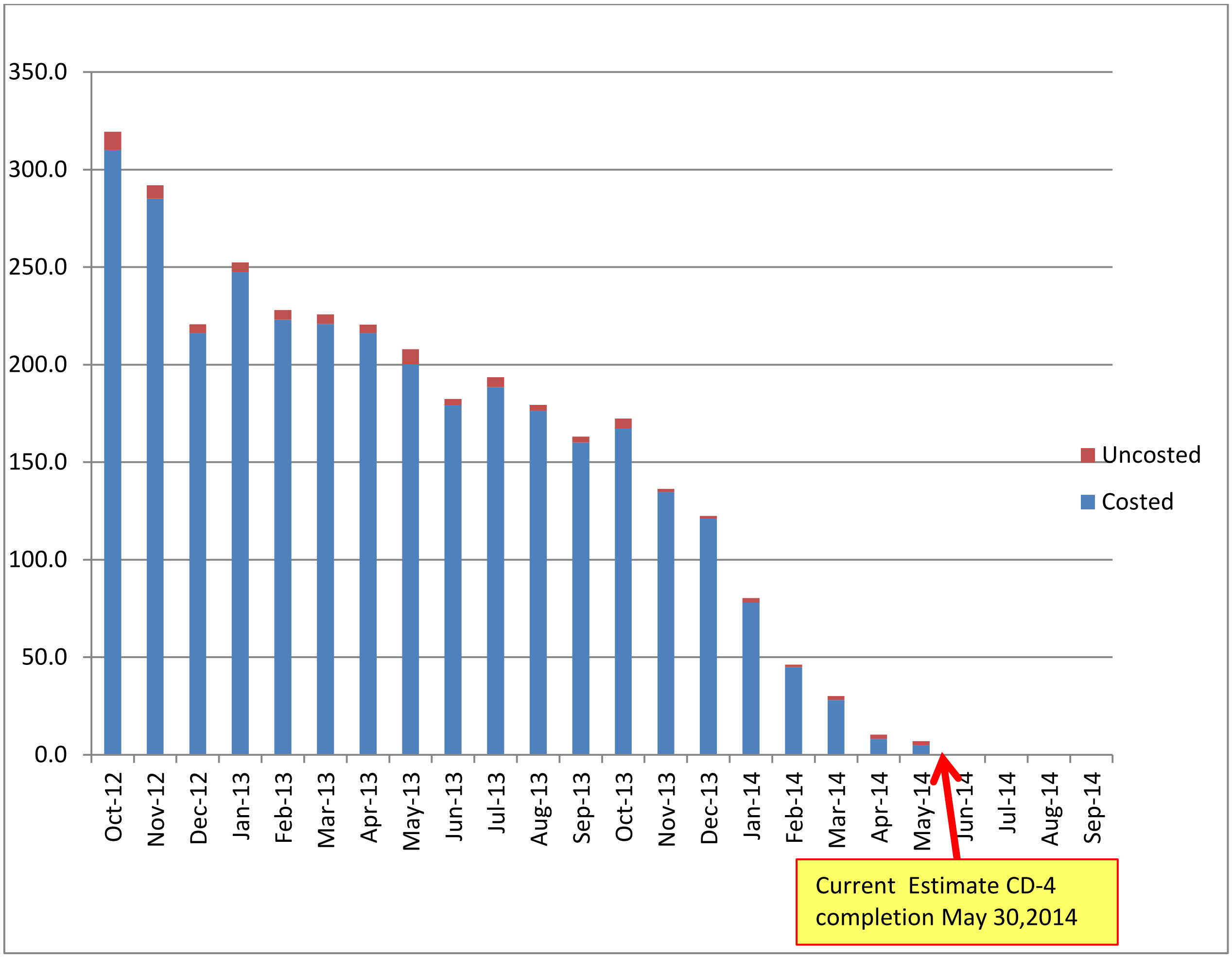
Estimate to complete on work to go for this system is:

The base costs do not include the 3 ½ month slippage for the project CD-4 date for the project office standing army. This cost increase is shown in the risk estimate, but should be included into the base with bottoms up re-estimate. The number in the other risks box is the potential cost increase for the project office standing army if the projected CD-4 completion date slips further than May 30, 2014. The rate shown is per week. If the projected CD-4 date can be pulled back earlier, then this number would be the increase in contingency for each week.

Base cost to go	\$2,356,900 – From Nov 26 CAP report
Risk or uncertainty in this estimate	Labor\$275,816 Material \$18,000 increase to be added to base
Other risks that can be quantified	\$19,367 Per week increase or decrease depending on CD-4 project date moving

Dean's additional Overall Project Information/Analysis:

The chart below is the current overall projected resource needs in FTE's for the work to go (both costed and uncosted on project resources). This chart does not include any of the project management scientists that were removed per CR 586. With the current projected CD-4 date of May 30, 2014, there are very few resources budgeted for several months before the projected CD-4 date and none after July 2014 for project closeout. This data puts in question if the resource estimate is based on current estimated CD-4 completion date or based on the Feb 2014 date that existed when the last bottom-up estimate was performed in July 2011. I expect the ANU work estimate is pretty up to date, but other areas of the project may not be.



Dean's Conclusion/Recommendation:

- Re-estimate both the labor and M&S for WBS 2.10 considering the projected CD-4 completion date to adequate staff until that date and have adequate resources after that date to closeout the project.

- Complete a bottom-up estimate for the whole project for cost and schedule and update the BOEs/Schedule appropriately. This will help validate the estimated CD-4 completion date, validated the Cost to Complete, determine what the real % Contingency is available on work-to-go. The project did review all their BOEs in May 2012, resulting in a revision to 9 out of the 170. Some areas have more recent bottoms-up estimates with revised BOEs, but not all. It is anticipated that the active work may involve ~100 BOEs.

This bottom-up estimate should include both costed and uncosted on-project resources. (Validating the estimated uncosted on-project resources will not impact this exercise for what needs to be reported to DOE, but for the Lab's benefit to understand the resources they need to supply, since the project has been underestimating these resources by 14%.)

SUMMARY ESTIMATE TO COMPLETE, CONTINGENCY, & OPPORTUNITIES

This summary includes costs-to-go in the NOvA base cost from September 2012, change requests the Project processed for October statusing, and reviewers' and the project team's estimates of additional costs that should be included in the Estimate to Complete (also identified as Contingency Draws in Appendix B).

It also includes the identified contingency due to risks that should be set aside for future activities, individually listed in the next section and detailed in Appendix C. It does not include any identified ways to create contingency by moving costs off project. This Opportunity List, detailed in Appendix D, is still speculative and needs to be vetted with the project and Fermilab management. It does have promise for ways to reduce the TPC.

			NOvA Costs to Date ($M)	NOvA Review Assessment ETC plus Contingency					EAC plus all risks
			as of	as of 1-oct-2012 budget to go	CRs processed during review & needed contingency draws	ETC Total	Risk Contingency on ETC		Total
	WBS	Items	30-Sep-2012				Total	%	Cost
TEC	2.0	Accelerator & NuMI Upgrades	$ 36.8	$ 5.6	$ -	$ 5.6	$ 0.9	16%	$ 43.3
	2.1	Far Detector Site and Building	$ 6.1	$ -	$ -	$ -	$ -	0%	$ 6.1
	2.2	Liquid Scintillator	$ 10.1	$ 11.2	$ -	$ 11.2	$ 3.6	32%	$ 24.9
	2.3	Wave-Length-Shifting Fiber	$ 12.4	$ 0.8	$ 0.2	$ 1.0	$ -	0%	$ 13.2
	2.4	PVC Extrusions	$ 20.5	$ 10.0	$ 3.3	$ 13.4	$ 0.2	2%	$ 30.8
	2.5	PVC Modules	$ 12.1	$ 8.8	$ 1.2	$ 10.1	$ 0.1	1%	$ 22.3
	2.6	Electronics Production	$ 6.1	$ 5.8	$ 0.0	$ 5.8	$ 0.4	7%	$ 12.2
	2.7	Data Acquisition System	$ 4.0	$ 1.6	$ -	$ 1.6	$ 0.2	15%	$ 5.8
	2.8	Near Detector Assembly	$ 5.7	$ 7.0	$ (0.1)	$ 6.9	$ 0.1	2%	$ 12.7
	2.9	Far Detector Assembly	$ 13.5	$ 11.9	$ 0.8	$ 12.7	$ 0.4	3%	$ 26.6
	2.10	Project Management	$ 7.6	$ 2.4	$ 0.3	$ 2.7	$ 0.1	3%	$ 10.4
		Subtotal Construction	**$ 135.0**	**$ 65.1**	**$ 5.8**	**$ 70.9**	**$ 6.0**	**8.5%**	$ 211.9
OPC	**R&D - Accelerator**		$ 6.6	$ -			$ -	0%	$ 6.6
	R&D - Detector		$ 28.1	$ -			$ -	0%	$ 28.1
	Cooperative Agreement		$ 34.9	$ -			$ -	0%	$ 34.9
	Operating - Accelerator		$ 1.3	$ -			$ -	0%	$ 1.3
	Operating - Detector		$ -	$ -			$ -	0%	$ -
		Total OPC:	**$ 70.9**	**$ -**			**$ -**	**0%**	$ 70.9
		Contingency	**						**$ 6.001**
		TPC:	**$ 205.9**	**$ 65.1**	**$ 5.8**	**$ 70.9**	**$ 6.001**	**8.5%**	**$ 282.772**

Notes:

Costs to date include an adjustment for a proposed TSCS burden rebate on FY12 costs that has not yet been finalized by Fermilab management ($.767M)

Risk contingency on Liquid Scintillator includes oil price increases due to Middle Eastern regional instabilities

RISK SUMMARY

This summary includes risks with associated costs that the reviewers and project team identified during the review process as items for which contingency would be set aside for the project going forward. The estimate of risk cost includes some rough assessment of probability, so these should be added linearly to provide a total cost of risk remaining on the project. This being a very quick identification and assessment by selected members of the project team and outsiders, the assessment should be considered preliminary. As with all risk assessment processes, a consensus of stakeholders on each risk is needed before the list can be finalized.

The details are provided in the table in Appendix C.

WBS	RISK	VALUE ($k)
2.0 ANU	Recycler RF cavities failure	$600
	Recycler extraction kickers failure	300
2.1 FD Site & Bldg		-
2.2 Liquid Scintillator	Mineral Oil costs rise more than planned by 15%	1,800
	Mineral oil costs rise due to middle east politics by 15% more	1,800
2.3 WLS Fiber		-
2.4 PVC Extrusions	TiO2 costs rise, increasing cost of resin	210
2.5 PVC Modules	Cost of one month delay beyond March 2014 to operate factory	83
2.6 Electronics Production	5% contingency on APD procurement to go	242
	15% contingency on non-APD procurements to go	127
	25% contigngency on remainder	19
2.7 DAQ	15% contingency on remaining materials procurement to go	15
	25% contingency on non-materials to go	226
2.8 ND Assembly	ND installation labor underestimated	73
	Need FNAL techs to oversee collaboration installation	60
2.9 FD Assembly	Weather-related delays	165
	Key people leave before project is complete	50
	Need more Operations costs at Ash River	200
2.10 Project Management	Projected CD-4 date moves by one month	80
	TOTAL	**$6,001**

CONCLUSIONS AND RECOMMENDATIONS

The NOvA Project has achieved significant technical progress in recent months as the detector components are produced and installed, and ANU shutdown work is completed. In many cases, the project has been learning how well its estimates reflect the actual production and installation rates, and is making adjustments to the budget because of that experience. However, estimates of the required cost needed for completion is not always incorporating these lessons learned in a timely way into the Estimate to Complete, nor have the remaining risks been fully assessed and contingency assigned.

The assessment estimated that the ETC for the project is $70.9M and the contingency that should be carried for risks is $6M. The potential cost opportunities that could provide additional contingency total $6.1M, but their feasibility is undetermined as part of this assessment.

During this assessment, the main issues identified by the project team were:

1. The project has not been using the Estimate to Complete (ETC) in the way it is normally defined in project management. Standard project management practice defines the ETC for a particular element as: ETC = Base Cost to Go + Projected Additional Cost on Work to Go. This can be calculated through statistical methods to provide input to an assessment of the ETC each month. In using such a mainly a statistical method to represent the ETC, the project has generally not been including the second half of the sum in the documented ETC, because it misses the in-progress or planned change requests, giving an incomplete sense of the Estimate to Complete. At some level, the Project Manager's *Identified Contingency Needs* spreadsheet (shown on slides 32-34 of the J Cooper Nov 20, 2012 DOE Mini-review presentation) provides this, but it is not part of the standard monthly reports.
2. The project has been managing contingency as a percent on a task by task basis, and not according to the risks that remain on the project. What the uncertainties are on the work remaining is not transparent in this method. The Project Manager has stated that he is the one who is able to judge how many of these independent assessments are likely to occur together, but without a systematic documentation of this assessment, it is not clear to other managers and stakeholders. This method also allows the L2 Managers to continue to believe that the percent contingencies on each activity are available to them, which is not how the project is being managed, and which can lead to their believing the available budget is higher than it actually is.

   The Project Manager has stated that he manages all the contingency, has the best gauge of what uncertainties exist in each project WBS, and adjusts priorities to accommodate risks as they occur. Again, since contingency for cost risk is not associated with specific risks on the project, it is difficult for Fermilab management and DOE to gauge what the level of risk is and understand the how contingency is being managed.
3. By not having a complete ETC, and not updating the base costs well in advance, plus not managing contingency to the risks that remain, the assessment of contingency remaining on the costs to go is unclear. Carrying contingency for items with a 100% certainty of being needed on the project, instead of incorporating that contingency estimate into the base, gives a false sense of the contingency available.
4. The change control process is, to a large degree, a monthly exercise in 1) getting that month's work that should have started but didn't pushed out so that variance thresholds are not triggered and 2) incorporating contingency use into the project base almost as it is used. This is so time-consuming, that there is little time for the estimate-to-complete process and forward planning to occur. This can delay timely issuing of project financial information.

5. There is not been an estimate of the unknown unknowns on the project, which is the responsibility of the Project Manager in conjunction with Fermilab management and the DOE Federal Project Director.

To address these issues, the review committee recommends that:

1. The project perform a bottoms-up re-estimate of all work to go. This has been accomplished already in some subprojects (ANU for example). This should be complete by January for use in conjunction with December monthly reporting.
2. The project incorporate the ‘identified contingency draws’ that come out of the re-estimate into the base budget.
3. The project maintain the ETC with a transparent assessment each month by L2 managers of what work is not in their budget (but may be in pending change requests, planned change requests, or just a new understanding of what is needed for completion), and to communicate this to the Project Office for inclusion in the monthly reports. This could be accomplished by having someone in the Project Office sit with each L2 Manager monthly to talk through the ETC beyond the budget, and prepare the documentation for their review and approval, which should make this easier for the managers. This should start with December monthly report, expected out in January.
4. The project discontinue managing contingency activity by activity on a percentage basis. Confirm with managers that they need to manage to their base budget.
5. The project, with stakeholders as appropriate, validate the list of risks and their cost values identified in this review, update as necessary. Maintain this list by reviewing it monthly with the project team. Use it to manage contingency to go on the project.
6. The project and Fermilab management assess the list of opportunities to see if costs can recategorized, or work performed by the NOvA science collaboration.
7. The project work with the Federal Project Director, OPA, and Fermilab PSS to see how variance thresholds can be utilized to be more reflective of current performance and not driven by past performance either for a short term or for the rest of the project duration.
8. Fermilab management consider providing outside senior management support to the Project Manager to review the monthly ETC and risk updating prior to inclusion in the monthly report.
9. Fermilab management assess in February (after January monthly reporting) if these actions are improving timely communication of cost status as well as understanding of contingency on remaining work.

APPENDIX A – Review Charge and Committee

NOvA Project Cost-To-Complete/Corrective Actions Assessment

Since August, the NOvA project has made good technical progress on several fronts and retired some key risks. Blocks are being assembled and set in place at Ash River; the APD coating decision has been resolved and production devices are arriving; Ash River outfitting is progressing and filling of the first block should commence next week; the Near Detector Cavern excavation is completed; and beamline installation remains on schedule.

However, the remaining contingency seems far too low for the remaining work. Over the past several weeks we have discussed mitigating scenarios within the Lab and with OHEP. The Lab has decided to undertake several steps that will help mitigate the situation. We may not yet be where we need to be—we need to undertake a more thorough cost-to-complete exercise. A review team is being assembled to advise the Laboratory on the extent of any remaining problem and recommend any further actions.

The goal is to have an answer to these questions by November 30 or as soon as possible thereafter:

For each L2 system:

1. When was this L2 system cost estimate for the remaining work last updated?
2. What changes are needed to include recent experience for installation, production, and waste rates?
3. Do quotes for materials or services appear to be current?
4. What are the risks or estimate uncertainties associated with this system and can a cost impact and probability be estimated for them?
5. Are there adjustments that could be made to this system to generate more contingency?
6. Estimate to complete on work to go for this system is:

Base cost to go	$
Risk or uncertainty in this estimate	$
Other risks that can be quantified	$

For the project management and laboratory:

7. Is the available contingency, planned agreements with Fermilab to generate contingency, and potential non-critical scope or other offsets sufficient to complete the work to go within the TPC, considering the estimated and unknown risks for the work-to-go?
8. Are there adequate processes and authority in place to manage the cost and contingency balance to the end of the project? What if any adjustments may be helpful?

REVIEWER ASSIGNMENTS:

L2 SYSTEM	MANAGER	CONTACT	REVIEWER	ANSWER CHARGE QUESTIONS
2.0 ANU	Paul Derwent	derwent@fnal.gov, x8520	Steve Holmes	1-6
2.2 Liquid Scintillator	Stuart Mufson	mufson@astro.indiana.edu	Ron Ray	1-6
2.4 PVC Extrusions	Rich Talaga	rlt@hep.anl.gov	Peter Garbincius	1-6
2.5 PVC Modules	Ken Heller	heller@physics.umn.edu	Gina Rameika	1-6
2.6 Electronics Production	Leon Mualem	mualem@fnal.gov	Jimmy Proudfoot	1-6
2.7 DAQ	Leon Mualem	mualem@fnal.gov	Jimmy Proudfoot	1-6
2.8 ND Assembly	Ting Miao	tmiao@fnal.gov, x8415	Bob Kephart	1-6
2.9 FD Assembly	Pat Lukens (module assembly & setting)/ Rick Tesarek (filling, electronics install, checkout)	ptl@fnal.gov, x8053 tesarek@fnal.gov, x8609	Bob Kephart /Gina Rameika	1-6
2.10 PM	John Cooper	jcooper@fnal.gov, x2235	Dean Hoffer	1-6
Contingency Summary			Mike Lindgren /Elaine McCluskey	7, 8

CURRENT NOvA PROJECT COST STATUS:

For 20 Nov 2012 Project Manager overview of project status and discussion of contingency, see also http://nova-docdb.fnal.gov/0035/003523/088/Cooper%20Final%20Project%20Status%20for%2020%20Nov%202012%20IPR.pdf .

	WBS	Items	NOvA Costs to Date ($M) as of 30-Sep-2012	NOvA 's Cost Estimate AY $M (for October 1, 2012 to project end): Estimated Cost (with indirects) M&S	Labor[1]	Total	Mgmt Reserve Estimate M&S	Labor[1]	Total	Contingency % M&S	Labor[1]	Total	Total Cost
TEC	2.0	Accelerator & NuMI Upgrades	$ 37.3	$ (0.6)	$ 6.4	$ 5.9	$ -	$ -	$ -	0%	0%	0%	$ 43.1
TEC	2.1	Far Detector Site and Building	$ 6.1	$ -	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	$ 6.1
TEC	2.2	Liquid Scintillator	$ 10.1	$ 12.0	$ 0.2	$ 12.2	$ -	$ -	$ -	0%	0%	0%	$ 22.4
TEC	2.3	Wave-Length-Shifting Fiber	$ 12.4	$ 0.7	$ 0.1	$ 0.8	$ -	$ -	$ -	0%	0%	0%	$ 13.2
TEC	2.4	PVC Extrusions	$ 20.5	$ 9.5	$ 0.6	$ 10.0	$ -	$ -	$ -	0%	0%	0%	$ 30.6
TEC	2.5	PVC Modules	$ 12.1	$ 3.4	$ 5.4	$ 8.8	$ -	$ -	$ -	0%	0%	0%	$ 20.9
TEC	2.6	Electronics Production	$ 6.1	$ 5.8	$ 0.8	$ 6.6	$ -	$ -	$ -	0%	0%	0%	$ 12.7
TEC	2.7	Data Acquisition System	$ 4.0	$ 0.7	$ 0.7	$ 1.4	$ -	$ -	$ -	0%	0%	0%	$ 5.4
TEC	2.8	Near Detector Assembly	$ 5.7	$ 6.0	$ 1.0	$ 7.0	$ -	$ -	$ -	0%	0%	0%	$ 12.7
TEC	2.9	Far Detector Assembly	$ 13.6	$ 5.3	$ 6.6	$ 11.9	$ -	$ -	$ -	0%	0%	0%	$ 25.5
TEC	2.10	Project Management	$ 7.7	$ 0.1	$ 2.7	$ 2.9	$ -	$ -	$ -	0%	0%	0%	$ 10.5
TEC		**Subtotal Construction**	**$ 135.7**	**$ 42.9**	**$ 24.6**	**$ 67.5**	**$ -**	**$ -**	**$ -**	**0%**	**0%**	**0%**	**$ 203.2**
OPC		R&D - Accelerator	$ 6.6	$ -	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	$ 6.6
OPC		R&D - Detector	$ 28.1	$ -	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	$ 28.1
OPC		Cooperative Agreement	$ 34.9	$ -	$ -	$ -	$ -	$ -	$ -	0%	0%	0%	$ 34.9
OPC		Operating	$ 1.3	$ 0.0	$ 0.1	$ 0.1	$ -	$ -	$ -	0%	0%	0%	$ 1.4
OPC		**Total OPC:**	**$ 70.9**	**$ 0.0**	**$ 0.1**	**$ 0.1**	**$ -**	**$ -**	**$ -**	**0%**	**0%**	**0%**	**$ 71.1**
		Available Contingency							$ 3.725				$ 3.7
		TPC:	$ 206.6	$ 43.0	$ 24.7	$ 67.7	$ -	$ -	$ 3.73	0%	0%	6%	$ 278.000

Appendix B – Identified Contingency Draws

WBS	Contingency Needs to be captured in ETC	Cost of Contingency added to base in October statusing*	Cost of Identified Contingency Draw *
2.0 ANU		**$ -**	**$ -**
2.1 FD Site & Bldg		**0**	**0**
2.2 Liquid Scintillator		**$ -**	**$ -**
2.3 WLS Fiber		**$ 201,240**	**$ -**
	purchase add'l 387 km WLS fiber CR584	$ 201,240	
2.4 PVC Extrusions		**$ -**	**$ 3,316,000**
	Supplemental resin purchase for PCV extrusions proposed in CR577, not changed (identified in JC table as 1.942M + 1.066M). Estimate from R Talaga using most recent waste rates and assuming need to make enough for 28 blocks		$ 3,316,000
2.5 PVC Modules		**$ 509,000**	**$ 737,420**
	Module sanding CR589 (implemented for October status - was 300k in JC table)	$ 400,000	
	Module sanding machines & tooling CR587 (implemented for October status)	$ 36,000	
	Extend rental of module storage space 3 more mos (Nov-Jan) CR583 (implemented for October status)	$ 33,000	
	QA system changes (hardware and software at factory) CR587 (implemented for October status)	$ 40,000	

WBS	Contingency Needs to be captured in ETC	Cost of Contingency added to base in October statusing*	Cost of Identified Contingency Draw *
	Train technicians and students : The baseline plan has no budget beyond October 2013 to train technicians. The budget for student training expires in August 2013. It is clear that there will be both technician and student turnover, and training will need to be budgeted. The current budget is ~$36,000 per month. This is probably high and should ramp down from August through December 2013 [EM-have revised original 126k to 2/3 to reflect ramp down).		$ 84,420
	QA/QC Tracking & Testing: In the current plan, this task only extends through August 2013. It needs to be extended an additional 6 months. The cost is $6,500 per month.		$ 39,000
	Add ND module production (including cutting, finishing, and cleaning the already existing (~200) scrap 51 foot (612 inch) modules from the Minnesota module factory that can each be cut down into three 162" extrusions for the Near Detector)		$ 350,000
	The baseline plan only has management costs included through August 2013. The module production baseline plan extends through March 2014. Management costs for September 2013 through April 2014 need to be estimated and included. The monthly estimate in the baseline (which is actually a bit higher than the actuals indicate) is ~$37,000 per month. [EM-use 33k/mo avg of Jan-Sep 2012]		$ 264,000
2.6		**$ 197,000**	**$ (194,000)**
	Heat sink assembly & testing CR576 (implemented for Oct status)	$ 197,000	
	Update the APD cost to reflect actual vendor cost (about 4% effect)		$ (194,000)

WBS	Contingency Needs to be captured in ETC	Cost of Contingency added to base in October statusing*	Cost of Identified Contingency Draw *
2.7 DAQ		**$ -**	**$ -**
2.8 ND Assembly		**$ -**	**$ (102,000)**
	Collaboration provides labor to outfit ND (scintillator, cables, electronics)		$ (102,000)
2.9 FD Assembly		**$ 7,000**	**$ 833,000**
	FD installation labor underestimated by 10%		$ 550,000
	Database inventory work for outfitting not included in estimate		$ 120,000
	Add dry gas system installation (CRsxxxx&xxxx)		$ 20,000
	Conversion of block pivotor to north bookend is underestimated, guessed at 2/3 low		$ 143,000
	Winter heating of scintillator tankers CR590 (implemented for October status)	$ 7,000	
	Labor to assemble proximity sensors, strain gauges and crates CR593 (not yet quantified or implemented) [may be covered in 550k estimate above?]		
2.10 PM		**$ 37,000**	**$ 293,817**
	FY13 provisional FNAL burden rate update CR594 (implemented for October status)	$ 37,000	
	With an additional 3 ½ months added to the estimated CD-4 completion date, it would make sense that the estimate to complete needs to be updated to increase the FY14 resources for the Schedule, Assistant Schedule, Budget, and Assistant Project Manager. The Budget needs a slight increase over the others to cover project closeout of PO and CTC. Additional M&S costs to cover travel in FY14 at 18k		$ 293,817
Total		**$ 951,240**	**$ 4,884,237**

Appendix C – Identified Risks

WBS	Risks	Risk Cost
2.0		**$ 900,000**
	Recycler RF cavities. One cavity is under test and looks good. The second cavity will be ready in mid-December. Two cavities are required operationally. A third (spare) cavity will be complete in mid-February. The total cost per cavity is about $1.3M. It is hard to imagine a failure that would require a complete rebuild, to the exposure here is probably $300-600K	$ 600,000
	Recycler extraction kickers (RKB). Four units and two spares are being constructed. The first two are complete but not yet subject to high voltage testing. Two more are due momentarily and two spares are about 1 month behind. All parts are in house for the spares, with only fabrication to go. The kickers are valued at ~$600K each. The budget to complete already includes sale of the two spares to SPS. The extraction RKB is 50% longer than previously constructed RKD, which have been tested successfully. The total exposure here for a failed kicker is probably ~$300K	$ 300,000
	RR30 installation. This is work in a highly activated area. There is an ALARA plan, but if work takes longer than expected, qualified vacuum techs could be pulled off the job. To the extent that these techs are no longer charging ANU there is no direct cost impact. However, there are likely to be indirect impacts if this happens.	**?**
2.1		**$ -**
2.2		**$ 3,600,000**

WBS	Risks	Risk Cost
	Mineral oil and pseudocumene price are each connected to an index that can change with time. Since mineral oil makes up 95% of the scintillator blend, it is by far the most important risk. Base cost of mineral oil in the NOvA baseline is $3.92/gal, average cost paid thus far is $4.97/gal, 27% above the base estimate. However, the cost has come down recently, now only 5% above the base estimate. Optimism regarding the price of mineral oil because of this recent trend, a newly opened pipeline and increasing inventories. Still risk that world events could intervene and drive the price higher. Project has some flexibility as to purchase timing, but not always easy to take advantage of. If the price turns upward it is impossible to know if this is a short-term or long-term trend. Do they buy before the price goes up even more or wait for it to come down? When the price is more favorable, as it is now, they can only buy so much because of the cost of storage space. Based purely on recent market trends & projections + successful production and delivery of several batches, 15% contingency should be more than adequate.	$ 1,800,000
	significant cost is incurred every month for storage tanks. As the scintillator blending progresses the buffering and flexibility provided by the storage tanks is no longer needed and it may be possible to go straight from railcars into the blending tank, saving $34,000 per month. However, schedule delays could result in a cost increase of $34,000/month.	
	If NOvA is expected to carry contingency to cover price spikes due to world events, then 30% would be more appropriate based on a cost of nearly 5.00/gal. that resulted after events in Libya last year. This risk is the differential between 15% and 30% contingency	$ 1,800,000
2.3		**$ -**
2.4		**$ 210,000**
	two costs which are related to commodity indices: the fuel surcharge for shipping (a small perturbation on a small number) and the fluctuating cost of TiO2 which is passed along in the cost of PVC resin. Considering that there are still 5.66 Million pounds of resin still to be delivered, both already under order (cost is determined on delivery) and for future contracts, this gives a potential range of +$ 0.21 M, assuming the median cost and fluctuation range remains the same over the future delivery period.	$ 210,000
2.5		**$ 83,000**
	Occupy and operate factory space: This is currently budgeted through March 2014. The cost is $83,000 per month. We should include a small risk, consistent with the weather risk at Ash River. Estimate a 2 month delay. [EM-weather delay risk is for 6 days, assume can only extend lease by the month, so 83k] This includes system	$ 83,000

WBS	Risks	Risk Cost
	management costs.	
2.6		**$ 388,836**
	5% contingency for the APD procurement to go of $4,842,455	$ 242,123
	15% contingency on total remaining materials cost of $849,229	$ 127,384
	25% contingency on remainder relative to base cost adjusted for transfer of spares to ops of $77,315	$ 19,329
2.7		**$ 240,753**
	15% contingency on materials procurement to go of $98,239	$ 14,736
	25% contingency on non-materials of 904,068	$ 226,017
2.8		**$ 133,000**
	ND installation labor underestimated - 6 to 8 weeks of add'l effort by 4 tech team over 13 months (EM-is this still a cost risk to the project if collaboration installs?)	$ 73,000
	Need FNAL tech to oversee filling & installation by collaboration labor, estimated at 0.5 FTE-yr.	$ 60,000
2.9		**$ 365,000**
	Weather-related delays delay assembly by 3%	$ 165,000
	Key people leave before project is complete, so offer bonus to stay: EM guess at 50k	50000
	Need more for Operations costs at Ash River	$ 200,000
2.10		**$ 80,000**
	If the projected CD-4 moves there is a cost increase. Using the average FTE weekly hours of 34.3, the cost increase per week is just under $20K. Assume one month delay	$ 80,000
	TOTAL	**$ 6,000,589**

Appendix D – Opportunity List

WBS	Opportunities	Opportunity Credit	Implement when?	opportunity may shift costs to different cost category
2.0		**$(1,520,000)**		**$ (1,520,000)**
	The sale of the third Recycler rf cavity to SPS would generate $1.3M in contingency. However, this will not happen in FY13 as there are no funds in the laboratory operating budget to do this. A potential downside is that sale to SPS would preclude installation of the cavity in the Recycler as a hot spare. A cavity failure would then result in ~4 weeks of downtime for full replacement, rather than ~1 day for modest reconfiguration in the tunnel. (shifts cost category)	$(1,300,000)	before 3rd cavity would be installed during shutdown	$ (1,300,000)
	work associated with MI-60 cleanup (shifts cost category)	$ (20,000)		$ (20,000)
	installation of the new NuMI target (shifts cost category)	$ (120,000)		$ (120,000)
	installation of the new hadron monitor (shifts cost category)	$ (80,000)		$ (80,000)
2.1		**$ -**		**$ -**
2.2		**$(1,016,000)**		**$ (60,000)**
	The waveshifting fluors have all been paid for though some should be left over. The excess could possibly be sold to the lab since they are commonly used by the scintillator extrusion facility and have a potential application for LBNE, but it does not add up to much money. (shifts cost category)	$ (60,000)		$ (60,000)
	significant cost is incurred every month for storage tanks. As the scintillator blending progresses the buffering and flexibility provided by the storage tanks is no longer needed and it may be possible to go straight from railcars into the blending tank, saving $34,000 per month			

WBS	Opportunities	Opportunity Credit	Implement when?	opportunity may shift costs to different cost category
	MiniBooNE/Columbia/NSF agree to give or loan MiniBooNE mineral oil to NOvA. Needs test to see if it matches NOvA specs. 800 tons = 1.6M lbs = 232k gals. NOvA pays $4.12/gal today, therefore = $956k if free to NOvA	$ (956,000)		
2.3		$ -		$ -
2.4		**$ (310,000)**		**$ (100,000)**
	two costs which are related to commodity indices: the fuel surcharge for shipping (a small perturbation on a small number) and the fluctuating cost of TiO2 which is passed along in the cost of PVC resin. Considering that there are still 5.66 Million pounds of resin still to be delivered, both already under order (cost is determined on delivery) and for future contracts, this gives a potential range of - $ 0.21 M, assuming the median cost and fluctuation range remains the same over the future delivery period.	$ (210,000)		
	QA on extrusions is being provided by NOvA at extrusion vendor, Fermilab, and ANL. Includes a FTE contract employee at the factory, plus periodic visits by Fermilab staff. Transfer to Fermilab or NOvA collaboration personnel who are not chargeable against the NOvA project costs. EM guess at 100k (shifts cost category if Fermilab)	$ (100,000)		$ (100,000)
	Consider using currently rejected (waste) extrusions to save on resin cost. Needs study to determine how much waste is useable.	TBD		
2.5		**$ (200,000)**		**$ -**
	Collaboration provides labor to build Ash River modules at Minneapolis factory to vacate warehouse rental by Apr 1, 2014 (10000 hrs over 6 mos. Sep - March 2014)	$ (200,000)	unlikely per conversation with spokespeople due to lack of available grad	

WBS	Opportunities	Opportunity Credit	Implement when?	opportunity may shift costs to different cost category
			students and postdocs	
	Relax specified physical tolerances on the modules based on assembly experience at Ash River. This will save by reducing the number of measurements made in the module production process to assure the quality. There are associated risks.	TBD		
2.6		**$ -**		**$ -**
	Move APD rework due to infant mortality off project by declaring modules operational if > 85% of channels work and then fixing them off project. (shifts cost category)	idea came from FD assessment, but is this electronics instead?		
2.7		**$ (130,274)**		**$ -**
	Remove Failure Mode and Effects Analysis tasks (which date back to 2005, according to discussions with the L2 manager the need for these is questionable) 2.7.2.1.3, 2.7.2.2.7, 2.7.2.3.11, 2.7.2.4.12, 2.7.2.5.12, 2.7.2.6.11, 2.7.2.7.11	$ (130,274)		
2.8		**$(1,091,000)**		**$ (841,000)**
	Need FNAL tech to oversee filling & installation by collaboration labor, estimated at 0.5 FTE-yr. Off project scientist could possibly play this role.	$ (60,000)		
	Collaboration provides labor to build ND modules at Minneapolis (9500 hrs labor or 10 people over 5.6 mos. Feb-Jul 2013)	$ (190,000)	unlikely per conversation with spokespeople due to lack of	

WBS	Opportunities	Opportunity Credit	Implement when?	opportunity may shift costs to different cost category
			available grad students and postdocs	
	Fermilab buys back NDOS Building Shell cost $841k (223k nova-specific) Outfitting cost $343k (120k nova-specific) (shifts cost category)	$ (841,000)		$ (841,000)
2.9		**$ (800,000)**		**$ (800,000)**
	Move Operations costs at Ash River off project (300k spent, 300k to go in plan, 200k needed beyond that) (shifts cost category)	$ (800,000)		$ (800,000)
2.10		**$(1,072,000)**		**$ (992,000)**
	If projected CD-4 moves there is cost decrease. Using average FTE weekly hours of 34.3, the cost decrease per week is just under $20k. Assume one month acceleration	$ (80,000)		
	reduce indirects from other institutions			
	Scientist managers are not charged to project in FY13 (shifts cost category)	$ (992,000)		$ (992,000)
		$(6,139,274)		**$ (4,313,000)**